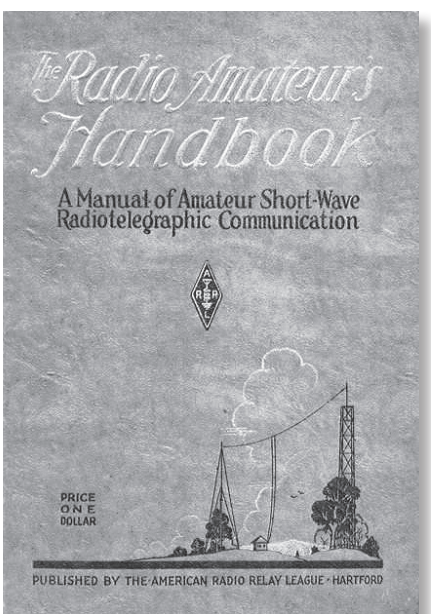
The ARRL Radio Amateur's Handbook — From Its Beginning

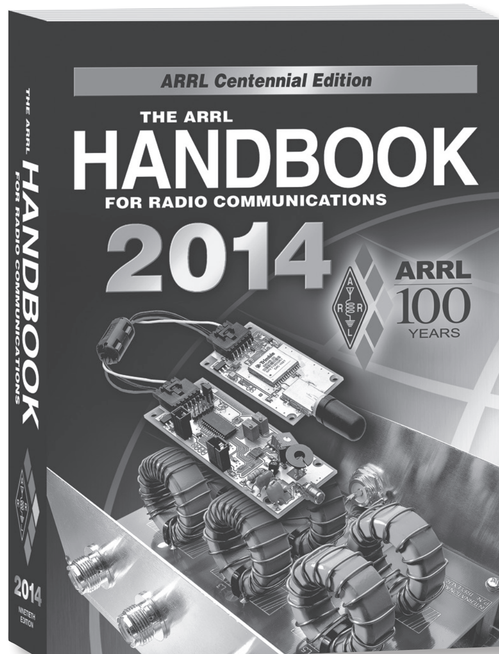
We will take a journey through time and space, looking over the ARRL *Handbooks* from their first edition to the modern era. After looking at the first offering, we will look in some detail at the changes on a decade by decade basis, highlighting the changes over each interval, with focus on the equipment in use and described in each volume. By the time of the first handbook, the art had already advanced from the days of spark and crystal sets to the use of vacuum tubes for both transmitting and receiving equipment.

In the early days of radio, before the ARRL published its first "handbook," there were attempts by others to fill the space. Some were reviewed in *QST*, but most were found to be lacking in technical content or clarity.[1] This might explain why the League decided to enter the handbook business, although they didn't get there until 1926. — *Joel R. Hallas, W1ZR, QST Contributing Editor*

[1]S. Kruse, 1OA, "Book Review — A. F. Collins, The Radio Amateur's Handbook," *QST*, Feb 1923, p 70.



1926 Edition



2014 Edition

ARRL Publishes the First *The Radio Amateur's Handbook* — The 1926 Edition

The first ARRL-published edition of *The Radio Amateur's Handbook* was announced by then *QST* Technical Editor Kenneth B. Warner, 1BHW, in *QST* of October 1926. Warner stated: "At last we have the honor of announcing *The Radio Amateur's Handbook*, the A.R.R.L. handbook we have been dreaming about for several years… The book has been written by Mr. F. E. Handy, A.R.R.L. Communication Manager, eminently qualified for the job not only because of his sound engineering knowledge but perhaps more particularly because this business of actually operating amateur stations is the subject about which his department deals daily and he knows it inside and out…."[2]

This volume was quite comprehensive for its time, as shown in the table of contents (see Figure 1926-1), with the emphasis spread among underlying technology, building a station, operating a station and a bit about the ARRL's activities. A total of 5000 copies of the first edition of the *Handbook* were produced.

The book opens to a view of typical full-size stations of the era (see Figure 1926-2). Note the use of open construction without attention to operator safety (no safety rules back then) and no attempt at shielding (that would change with the popularity of

[2]K.B. Warner, 1BHW, "Our *Handbook* Announced," *QST*, Oct 1926, p 8.

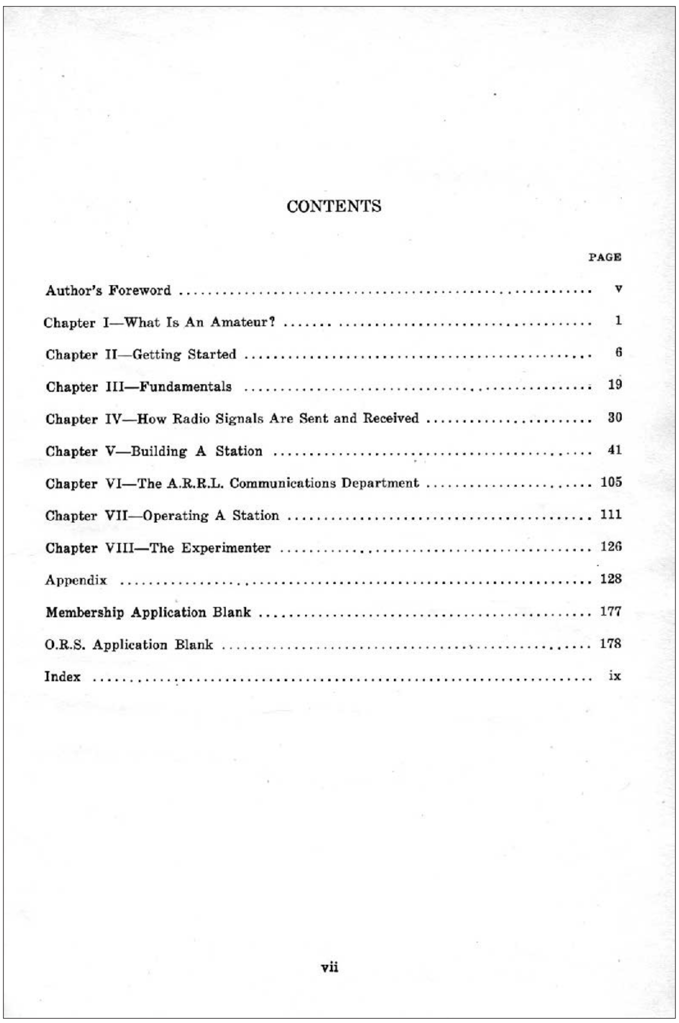


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Figure 1926-1 — The Table of Contents of the First Edition of ARRL's *Radio Amateur's Handbook*, circa 1926.

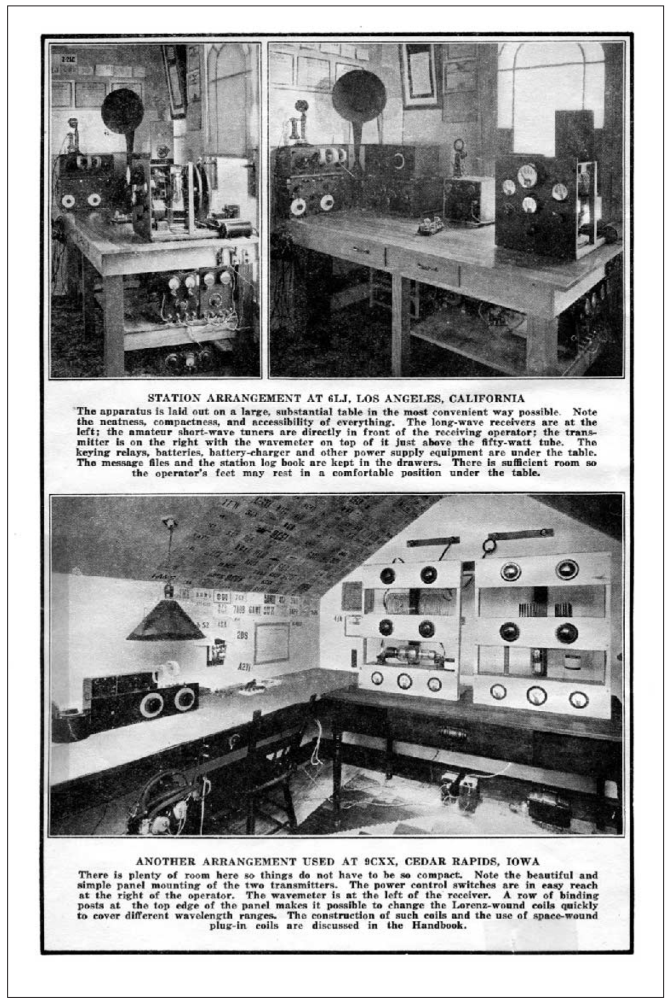


Figure 1926-2 — View of typical full size Amateur Radio stations of the era. From the inside cover of the 1926 ARRL *Handbook*.

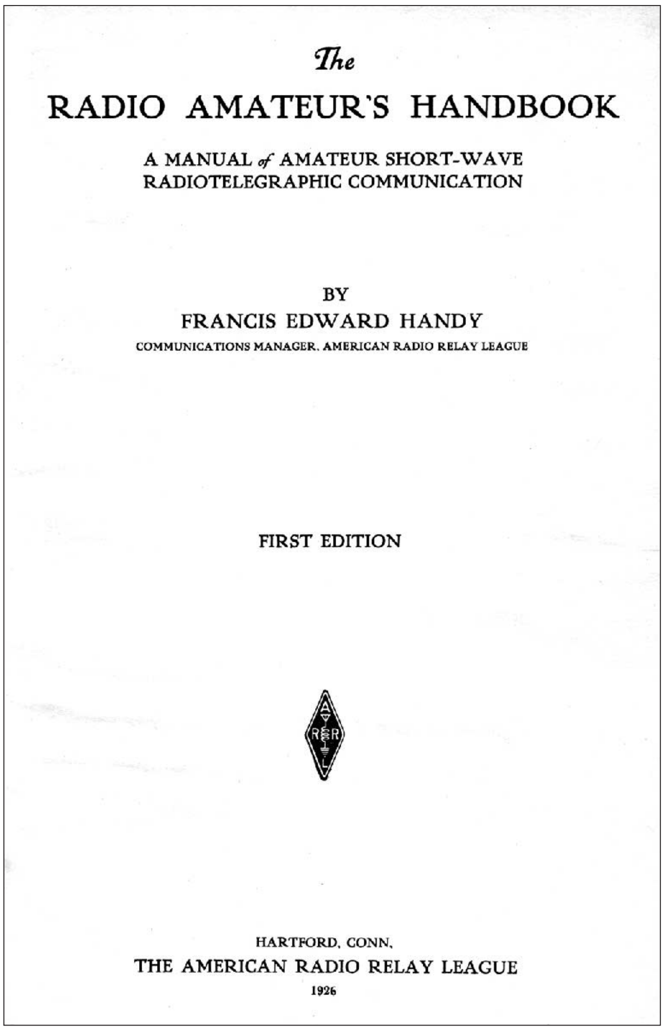
over-the-air TV reception in the 1950s). The cover page (Figure 1926-3) is all business.

Construction projects included a breadboard long wave receiver (see Figure 1926-4), a shortwave regenerative receiver (Figure 1926-5) and both tuned (Figure 1926-6) and crystal controlled (Figure 1926-7) transmitters. At this time the regulations regarding exact frequency band allocations and technical standards were still a few years away with the consequence that many transmitters were shown operating in a "self rectifying" mode with raw ac on the plates. There was also attention given to various wire antenna arrangements.

I found the advertisement section at the rear to be fascinating. While some manufacturers advertised over many years, others came and went quickly.

Interestingly, Vibroplex ads were in all handbooks that I examined, often with ads for the same equipment year after year (see Figure 1926-8). Of course, Horace Martin started making his famous speed keys before there was radio, and the company continues to this day.

Vibroplex was not the only key manufacturer in this edition — Bunnel, developer of the famous sideswiper key, was also represented (see Figure 1926-9). Other common names included National, then making radio parts (see Figure 1926-10) with radio receivers some years away. While primarily focused on the amateur side of radio science, one ad stands out as a predecessor of many who would build on their interest in radio to move from amateur to professional status. Joseph E. Smith of The National Radio Institute (not related to National Radio) in their ad (see Figure 1926-11) even seems to promise salaries to be achieved through their studies.



The

RADIO AMATEUR'S HANDBOOK

A MANUAL *of* AMATEUR SHORT-WAVE RADIOTELEGRAPHIC COMMUNICATION

BY

FRANCIS EDWARD HANDY

COMMUNICATIONS MANAGER, AMERICAN RADIO RELAY LEAGUE

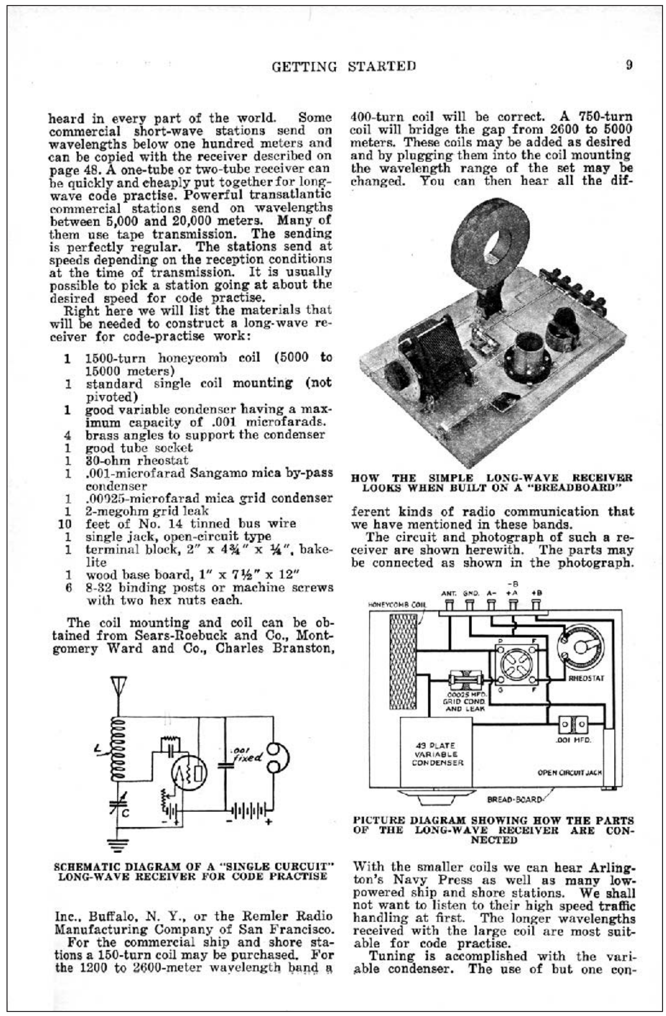
FIRST EDITION

HARTFORD, CONN.

THE AMERICAN RADIO RELAY LEAGUE

1926

Figure 1926-3 — The 1926 ARRL *Handbook* title page — all business here.



GETTING STARTED 9

heard in every part of the world. Some commercial short-wave stations send on wavelengths below one hundred meters and can be copied with the receiver described on page 48. A one-tube or two-tube receiver can be quickly and cheaply put together for long-wave code practise. Powerful transatlantic commercial stations send on wavelengths between 5,000 and 20,000 meters. Many of them use tape transmission. The sending is perfectly regular. The stations send at speeds depending on the reception conditions at the time of transmission. It is usually possible to pick a station going at about the desired speed for code practise.

Right here we will list the materials that will be needed to construct a long-wave receiver for code-practise work:

1 1500-turn honeycomb coil (5000 to 15000 meters)
1 standard single coil mounting (not pivoted)
1 good variable condenser having a maximum capacity of .001 microfarads.
4 brass angles to support the condenser
1 good tube socket
1 30-ohm rheostat
1 .001-microfarad Sangamo mica by-pass condenser
1 .00025-microfarad mica grid condenser
1 2-megohm grid leak
10 feet of No. 14 tinned bus wire
1 single jack, open-circuit type
1 terminal block, 2" x 4¾" x ¼", bakelite
1 wood base board, 1" x 7½" x 12"
6 8-32 binding posts or machine screws with two hex nuts each.

The coil mounting and coil can be obtained from Sears-Roebuck and Co., Montgomery Ward and Co., Charles Branston,

SCHEMATIC DIAGRAM OF A "SINGLE CURCUIT" LONG-WAVE RECEIVER FOR CODE PRACTISE

Inc., Buffalo, N. Y., or the Remler Radio Manufacturing Company of San Francisco.

For the commercial ship and shore stations a 150-turn coil may be purchased. For the 1200 to 2600-meter wavelength band a 400-turn coil will be correct. A 750-turn coil will bridge the gap from 2600 to 5000 meters. These coils may be added as desired and by plugging them into the coil mounting the wavelength range of the set may be changed. You can then hear all the dif-

HOW THE SIMPLE LONG-WAVE RECEIVER LOOKS WHEN BUILT ON A "BREADBOARD"

ferent kinds of radio communication that we have mentioned in these bands.

The circuit and photograph of such a receiver are shown herewith. The parts may be connected as shown in the photograph.

PICTURE DIAGRAM SHOWING HOW THE PARTS OF THE LONG-WAVE RECEIVER ARE CONNECTED

With the smaller coils we can hear Arlington's Navy Press as well as many low-powered ship and shore stations. We shall not want to listen to their high speed traffic handling at first. The longer wavelengths received with the large coil are most suitable for code practise.

Tuning is accomplished with the variable condenser. The use of but one con-

Figure 1926-4 — Construction projects were featured in even the first *Handbook*. Here is a one-tube regenerative long wave receiver you could build on a breadboard.

BUILDING A STATION 47

All distributed capacity in coils does not come from the capacity between turns. Running leads through the finished coil adds to the distributed capacitance, especially if the lead happens to be one of the coil leads itself. If a lead *must* be run through a coil by all means run it through the center as this adds least distributed capacitance. Running the lead near one side of the coil raises the effective resistance of the coil considerably especially at the shorter wavelengths.

A simple way of making quite good space-wound coils is to wind the wire on a cardboard form, spacing it with a thread, string, or another wire which is taken off after the winding is completed Cardboard tubing should be first prepared by waterproofing with a celluloid varnish and binder. Wire should never be wound on the form until the varnish is dry. This prevents the varnish from soaking into the insulation which raises the dielectric constant making a poorer coil with higher effective resistance and distributed capacitance. A "Quaker Oats box" form is as good as they come electrically. Don't think that all coils must be of three inch diameter just because those mentioned here and all those you have seen are of that diameter. This is just a convenient size and good shortwave coils performing beautifully can be made 1½ and 2 inches in diameter. A thick form should be provided with longitudinal supporting strips to keep the wire off the form to reduce dielectric losses.

Here is a table showing the wavelength ranges that can be covered using 3½" diameter Lorenz coils of the following numbers of turns and a tuning condenser having the maximum and minimum capacity values specified. The wavelength ranges were determined by means of an oscillator (described in the appendix) and wavemeter (the next instrument we will build for the station after our receiver is in operation).

Tuning condenser capacity range: 20 to 380 micromicrofarads. A smaller maximum capacity (150 µµf) is recommended to give less crowd'ng on the amateur ranges.

Turns	Wavelength meters
55	200 to 625
24	85 to 273
10	40 to 126
5	24 to 70
2	11 to 35

Some space wound coils checked by the writer were three inches in diameter, wound on skeleton forms, of No. 18 B. and S. wire spaced the width of the wire itself. The tuning condenser had a range of from 15 to 100 micromicrofarads.

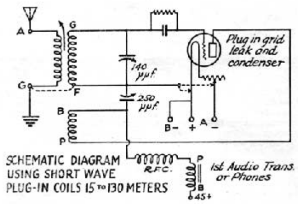
Turns	Wavelength (meters)
19	58 to 115
8	30 to 62
3	11 to 31

Although not allowing much overlap these ranges cover the three lower amateur bands nicely in the center of the dial. The confirmed traffic man will wish to use a still smaller condenser with a much larger number of coils (eight or ten) so that the tuning will not be critical and so that all stations will be spread out well over the dial.

BUILDING THE RECEIVER

A receiver built on a "breadboard" is very effective but picks up dust and dirt after a while and gets noisy. A panel-mounted set is about as cheap. The cabinet can be added later to protect the parts. Photographs show both "breadboard" and panel layouts. The sets can be wired from the photographs and the diagram.

Select every part carefully if you would make your receiver a permanent invest-



THE CIRCUIT

Chosen from the several possible circuits, a fixed tickler and a "throttle" condenser for regeneration control are used. Smooth regeneration control is effected with this arrangement, while at the same time the tuning is but slightly changed by movements of the regeneration condenser.

ment. Do not patronize the local cut price or "gyp" store if you are after the best results obtainable for your money. "Bootleg" parts are cheap it is true—but standard parts and tubes from reputable manufacturers are not so likely to prove defective after a few weeks of use. Buy well and your set will still be giving satisfaction when the friend who was taken in by a misguided idea of saving is paying for expensive replacements.

In putting the "breadboard" receiver together lay out the apparatus as it is shown

Figure 1926-5 — This shortwave regenerative receiver was another construction project in the 1926 *Handbook*.

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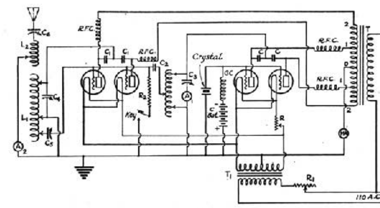
master oscillator is not shielded to keep the coupling between them low so that there will be little feedback to endanger the crystal. The chokes are wound on small dowels using fine wire. The sockets shown are provided for two UX210s and two UV203As. A good mounting for the crystal is shown in the photograph. When a set is shielded, it is important that the coils be

Electrical measurements are based on the use of one or more calibrated instruments especially made for their application. These instruments vary in construction depending on whether they are for use with direct current, alternating current at commercial frequencies (25 or 60 cycles), or for radio measurements where you are dealing with frequencies of millions of cycles.



COMPLETE CIRCUIT OF A 40-METER A.C. CRYSTAL-CONTROLLED SENDING SET

T—Tapped plate transformer. 400 volts between 0 and 1. 1500 volts between 0 and 2.
T1—250-watt filament transformer with a 12-volt secondary.
R—2-ohm rheostat to adjust filaments of crystal tubes.
R1—Primary rheostat to adjust all filaments to supply voltage conditions.
RFC—200 turns No. 30 D.C.C. on half-inch wooden dowels.
GC—140 turns No. 26 D.C.C. on half-inch dowel, tapped every 20th turn after the 80th so that the "best" adjustment can be used.
C—2,000 µµf. Sangamo blocking condensers.
C1—2,000 µµf. mica blocking condensers (7500 volt breakdown).
C2—400 µµf. fixed mica grid condenser (4,000 volt breakdown).
C3—Double-spaced Cardwell receiving condenser, resultant max. capacity 250 µµf.
C4, C5, and C6—National or Cardwell 100-µµf. transmitting condensers.
C—BAT—40 volts.
MA—0-500 milliampere D.C. ammeter.
A1-A2—0-5 ampere scale thermo-ammeter.
L-L1—14 turns flatwise-wound ⅜" brass strip spaced ⅜". Diameter 4½ inches.
L2—6 turns No. 12 wire hinged on hard rubber form.

small to keep the magnetic field from spreading out and inducing heavy R.F. currents in the shielding. Such eddy currents will cause a serious power loss if the set is not very carefully planned and constructed. An un-neutralized set working on amplified harmonics of the crystal is best for the inexperienced builder to attempt.

ELECTRICAL MEASUREMENTS

The simple measurements of resistance (D.C.) and impedance (A.C.) have been described in the explanation of how to find the inductance of the filter choke. The proper use of voltmeter and ammeter followed by a substitution of the scale readings in Ohm's Law makes the determining of many circuit constants possible.

Two of the most important quantities to be measured are *current* and *voltage*. The instrument for measuring the rate of current flow is called an *ammeter* because the unit of current is taken as the "ampere". The unit of potential difference is the "volt" from which we name the instrument for measuring electrical pressure a *voltmeter*. Some instruments may be used for one kind of current only; others are suitable for both D.C. and A.C. Meters are built on various principles, each of which has a field of application and certain advantages and disadvantages. Most commercial instruments are built ruggedly and compactly. A pivoted movement carries a pointer moving over a scale which is calibrated directly in terms of volts, amperes, watts and so on, depending on the construction and circuit of

Figure 1926-6 — Typical of its day, the 1926 *Handbook* featured a self-excited transmitter project.

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capacitance (between turns) and no lumped capacity may be required. The trouble with this sort of thing is that when trying to adjust the set it is impossible to change one thing at a time as we desire—the controls are interlocking. The plate turns and the wavelength will be changed at the same time. Considerable inconvenience will result. Sometimes coils or parts of a circuit will give trouble by putting oscillations in the circuit at their natural period. Certain adjustments will appear to be stable but the tube later will "flop over" to another frequency of some particular part of the circuit. This emphasizes the desirability of using one tube rather than several in parallel on the short waves, as we thus get rid of troubles that may occur from "parasitic" oscillations between the different tubes and their leads. On the ultra-high frequencies we can make use of these oscillations in actual transmission but they are not well suited to practical communication and we will not spend any time on them.

PLANNING THE TRANSMITTER

To design and build a tube set for transmitting on short waves is quite simple. The choice of apparatus to fit the pocketbook is probably the most difficult task. Tube transmission and the use of shorter and shorter wavelengths have simplified this problem. The more powerful the set built, the more consistent the results obtained with least effort and care. The range of the transmitter in miles will not differ greatly with the power used. Low-powered transmitters using receiving tubes often give as good results in "DX" as more powerful sets. The atmospheric conditions, the wavelength used and the time of day all have greater effects on the "DX" worked than the power input.

Our transmitter may be built "breadboard" style or the apparatus can be mounted on a panel. To keep the expense down, a wooden panel or baseboard should be used. Dry oak or maple are as good as anything else we can buy for this.

Contrary to the general superstition, a panel-mounted set with the parts spaced sensibly and wired correctly will give much superior results to the hit-or-miss layout frequently seen with leads running helter-skelter over everything in sight. The apparatus can be neatly arranged in either style of mounting.

CIRCUITS

The choice of a transmitting circuit is not of great importance. There is no excuse for most of the variations from the standard and simple circuits that are used. The principle of feeding back r.f. voltage from the plate to the grid circuit to produce continuous oscillations is the same in all vacuum-tube oscillator circuits. The fundamental circuits are the Hartley and Colpitts circuits, named for the prominent investigators who first used them. In both circuits an inductance and capacitance determine the wavelength. In the Hartley circuit the filament of the tube is connected to the middle of the *coil* and the

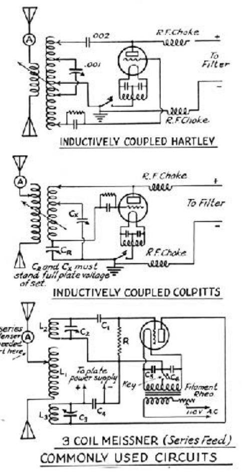


plate and grid connections are made to the extreme ends of the coil. In the Colpitts circuit the filament of the tube is connected between two *condensers* and the plate and grid connections are made to the other condenser terminals. In one arrangement the tube gets its feedback inductively, in the other the capacitative voltage drops take care of the feedback.

The Hartley circuit has the tuning condenser across some of the turns both in the grid and in the plate part of the coil. When the condenser is entirely across plate turns, the circuit is a "tuned plate" circuit. When it is across the grid turns we have a "tuned grid" circuit.

Figure 1926-7 — A fairly revolutionary transmitter project had its frequency set by a piezoelectric quartz crystal. The extra stability came at a price — a separate crystal was required for each frequency.

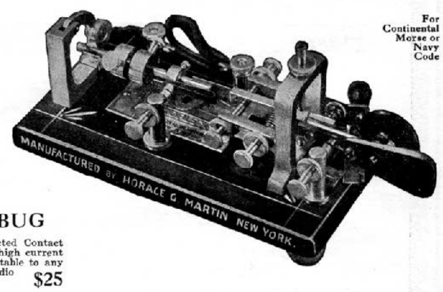
Learn to Send the *Easy* Way

Reg. Trade Marks
Vibroplex
Bug
Lightning Bug

With the Genuine Martin

VIBROPLEX

Improved Radio Transmitter



For Continental Morse or Navy Code

Japanned Base, ... $17
Nickel-Plated, ... 19
Carrying Case, ... 3

Improved Radio BUG

Equipped with Specially Constructed Contact Points 3/16" in diameter to break high current without the use of a relay. Adjustable to any desired speed. The choice of radio operators everywhere. $25

Simply Press the Lever—The Vibroplex Does the Rest

What Users Say

**From Station 4UA
Dundee, Fla.**

"I am a constant user of the Vibroplex, and my signals are always clear and readable at audibility R5 in England, France, Italy, Argentina and Alaska according to reports received on QSL. cards. Have had many a compliment on my sending 'good fist' but I attribute it to my faithful Vibroplex."

**From Station u2EV
New York City**

"I wouldn't be without a Vibroplex. I use it continuously at my station and on ships at sea and results have been more than I anticipated. Its speed and accuracy is marvelous, and makes one's sending far more readable than when using the ordinary key. What a blessing it would be if all amateurs used the Vibroplex thereby improving those 'bum fists' you hear so much."

No operator—no matter how skilled can send Continental or Morse code on an ordinary key with the *EASE* and *PERFECTION* of the Vibroplex.

Signals that will be heard and easily read thousands of miles away are transmitted at any desired speed, simply by pressing the lever—*the Vibroplex does the rest.*

More than 100,000 Wireless and Morse operators use the Vibroplex in preference to the key, because the sending is more uniform, the signals easier to read and the effort of sending is reduced to the minimum.

Learn to send the *EASY* way—with the Improved Vibroplex. It saves the arm, prevents cramp and enables you to send with the skill of an expert.

Insist on the Genuine Martin Vibroplex. See that the *VIBROPLEX Nameplate* is on the *BUG* you buy. Accept no substitute. When you buy a Vibroplex you buy complete satisfaction. Sent anywhere on receipt of price. Money order or registered mail. Liberal allowance on your old Vibroplex—any model.

Write for Catalog

THE VIBROPLEX COMPANY, Inc., 825 Broadway, *NEW YORK*
J. E. Albright, President
Telephones: Stuyvesant 6094, 4828, 4829

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Figure 1926-8 — This 1926 ad from the Vibroplex Corporation was similar to those shown for 75 years.

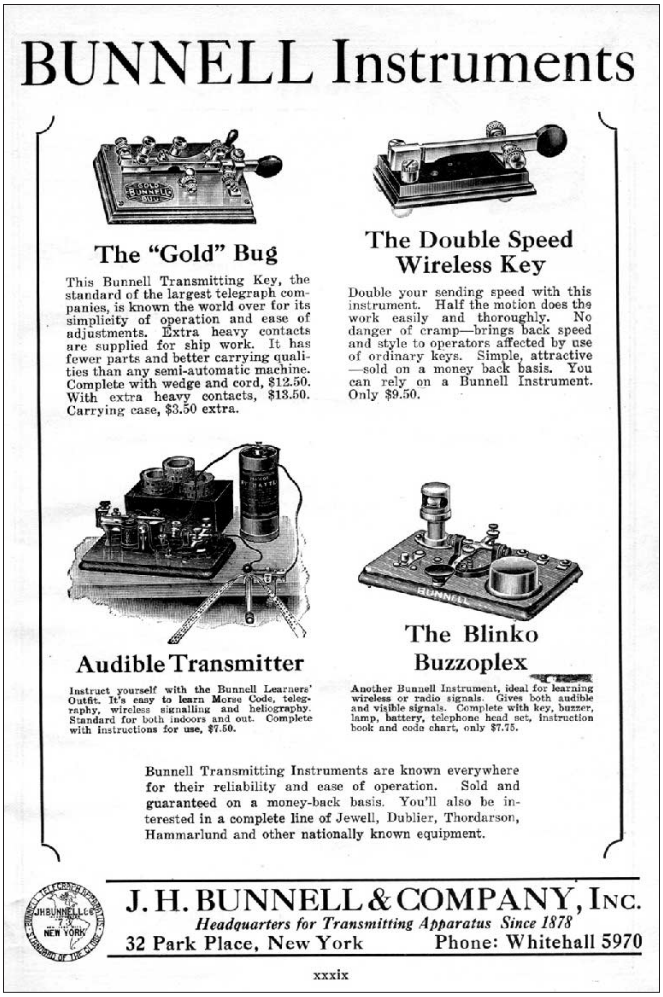


Figure 1926-9 — Bunnell, developer of the famous sideswiper key, also advertised in the 1926 edition.

Figure 1926-10 — National Radio, then making radio parts, with complete radio receivers some years away, had an ad in the first edition of the *Handbook.*

Figure 1926-11 — Even in this first edition, there was interest in promoting Amateur Radio as a path to a career.

The Beginning of the Next Decade — The 1930 Edition

It's not obvious that the plan of the ARRL for the production of *The Radio Amateur's Handbook* was to make it an annual affair. The edition released in 1930 was, in fact, the seventh edition (see Figure 1930-1) — not the fifth, as would be the case if there were one per year. While the edition's lead photo (see Figure 1930-2) showed equipment at the ARRL headquarters station that looked somewhat similar to that of the first edition, in fact, there were many significant changes in Amateur Radio between these editions.

The changes in the late 1920s were driven more by regulatory actions than by technology. In 1926, radio was rather loosely regulated by the US Department of Commerce. Most "regulations" were in the form of loose understandings between various commercial and amateur operating groups. This included frequency allocations (amateurs were then permitted to use any frequency above 1500 kilocycles [now kHz]) as well as technical standards, which were not yet well defined.

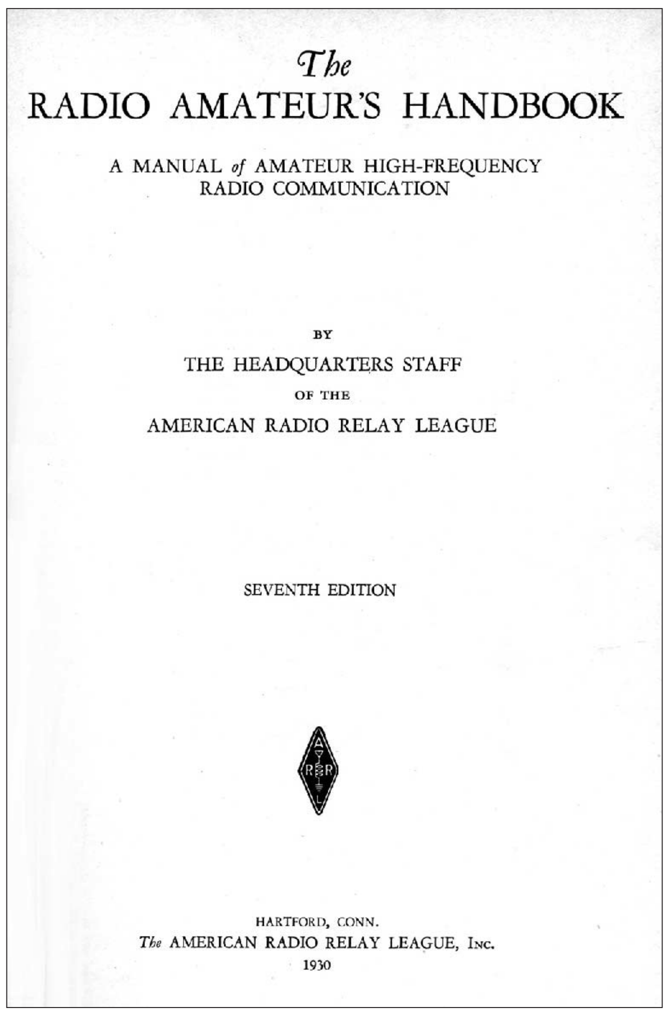
The US Federal Radio Commission (FRC), the forerunner of today's more general FCC, was established by congress and signed into law by President Calvin Coolidge on February 23, 1927. Over a few years, the FRC defined strict frequency allocations for different services, including the Amateur Radio Service. The new allocations established bands with a similarity to today's bands, except that they were just those harmonically related as shown in Table 1. The original order described the bands in terms of the actual wavelength, as well as

Table 1
Amateur Radio Bands Established by the FRC in 1928

Band (meters)	*Meters*	*Kilocycles (Frequency in KHz)*
160	150.0 to 200.0	2000 to 1500
80	75.0 to 85.7	4000 – 3500
40	37.5 to 42.8	8000 – 7000
20	18.7 to 21.4	16,000 – 14,000
10	9.99 to 10.71	30,000 – 28,000
5	4.69 to 5.35	64,000 – 56,000
0.75	0.7477 to 0.7496	400,000 – 401,000

Table 2
Amateur Radio Bands for Voice Established by the FRC in 1928

Band (meters)	*Meters*	*Kilocycles (Frequency in KHz)*
160	150.0 to 175.0	2000 to 1715
80	84.5 to 85.7	3500 – 3550
5	4.69 to 5.35	64,000 – 56,000


The
RADIO AMATEUR'S HANDBOOK

A MANUAL *of* AMATEUR HIGH-FREQUENCY
RADIO COMMUNICATION

BY
THE HEADQUARTERS STAFF
OF THE
AMERICAN RADIO RELAY LEAGUE

SEVENTH EDITION

HARTFORD, CONN.
The AMERICAN RADIO RELAY LEAGUE, INC.
1930

Figure 1930-1 — Title sheet of the seventh edition of *The Radio Amateur's Handbook*.

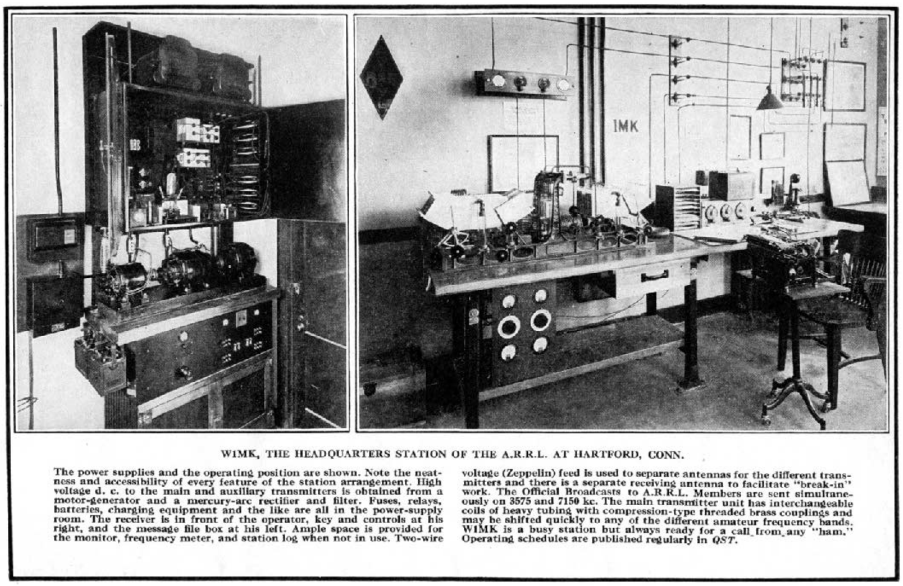


Figure 1930-2 — The headquarters station of the ARRL, then in Hartford, Connecticut, was shown on the cover page of the seventh edition.

Figure 1930-3 — The National Radio ad still shows a sample of their fine parts, but now ads a complete receiver, the SW-5.

the frequency (radios of the day were more likely to be calibrated in wavelength than frequency). I have also shown the usual band descriptor that we use today. Table 2 shows the frequencies on which radiotelephony was allowed — not very many, at least initially.[3]

In addition to the frequency allocations, the FRC 1928 announcement included new technical standards. These now required amateur stations to use "loose coupling to the antenna system," typically inductive rather than conductive coupling, to reduce harmonic output and "key impacts." Additionally, plate supply modulation (self rectifying circuits) and spark transmitters were no longer allowed (interestingly, some ship transmitters continued to use spark for many years).

The new regulations were reflected in the details of the *Handbook* construction projects, although a cursory look might not have revealed the difference, since most of the technology did not change a lot. Even the 1926 edition did not include any spark transmitters, since most amateurs now realized the benefits and additional efficiency of CW transmitters made with vacuum tubes.

Again, the ads in the back of the 1930 edition provided a glimpse of what amateurs were buying. By this time, National Radio had moved from being a parts supplier to being a manufacturer of receivers for amateur use, including the SW-5 "thrill box," highlighted in their ad (see Figure 1930-3).

[3]K. B. Warner, 1BHW, "Recent Changes in Radio Law and Regulations," *QST*, May 1928, pp 14-15.

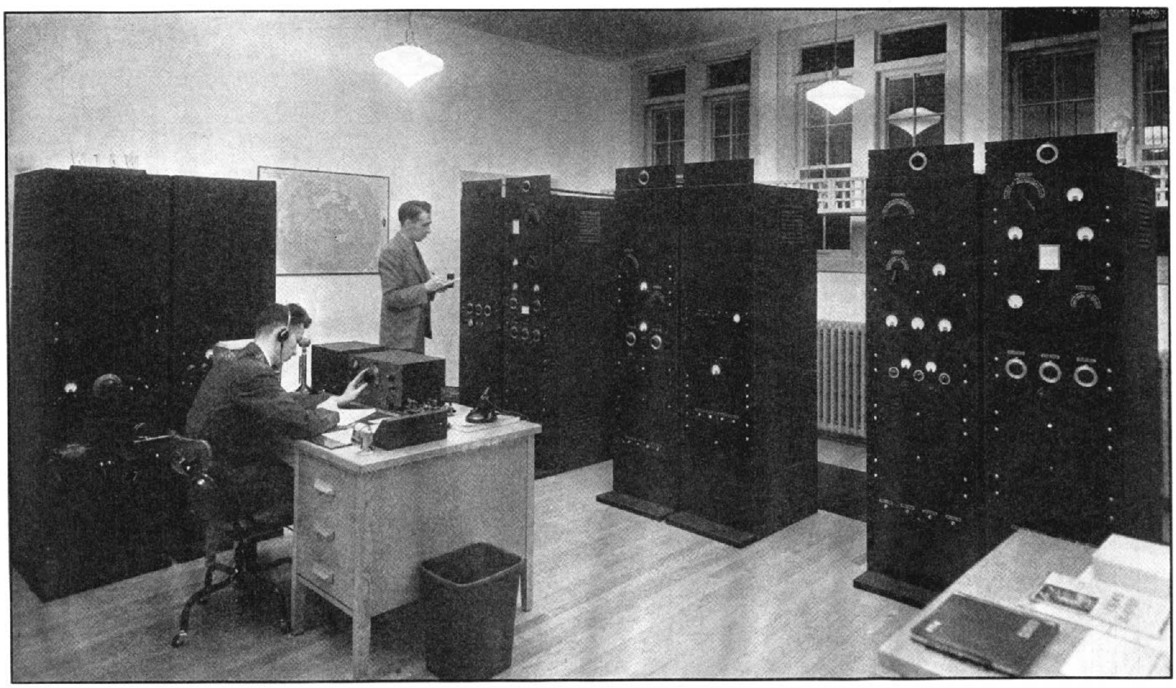
A Decade of Advancement — The 1940 Edition

Incremental advancement in technology occurred broadly in the decade preceding the 1940 edition. While the basic underlying physics remained the same, circuitry using vacuum tubes moved forward in large steps. By 1940, advanced amateur stations had moved from regenerative receivers on breadboards to bandswitching commercial superhets. Transmitters advanced from one or two tube self-excited transmitters on planks or breadboards to high power equipment in professional racks. This is perhaps best illustrated by comparing the cover leaf photos of the 1930 version of the ARRL headquarters station to that shown in the 1940 edition (see Figure 1940-1). This station, now the "Maxim Memorial Station, W1AW" was located at its present site in Newington, Connecticut, looking a lot like it would when I first visited it in 1956.

The cover page (Figure 1940-2) of the 1940 edition looks much like the previous ones, again, not identifying the publication year, but the edition — this one the 17th. Note that there was exactly one edition per year between 1930 and 1940, now firmly making the *Handbook* an annual affair.

By 1940, voice operation had been expanded into all HF bands, except 40 meters. Amateurs were allowed to operate on all frequencies above 110 Mc (MHz) and gravitated to the harmonics of lower frequency bands with operation on 2½ meters (112 MHz) and 1¼ meters (224 MHz).

Equipment projects were considerably



THE OPERATING ROOM AT THE MAXIM MEMORIAL STATION, W1AW, A.R.R.L HEADQUARTERS

Separate 1-kw. transmitters are installed for each band. Voice transmissions on 1806, 3950, 14,237 kc. and 28,600 follow simultaneous telegraph messages to all amateurs sent on 1762.5, 3825, 7280, 14,254 kc. and 28,600 kc. at 7.30 and 11 p.m. CST. Operators "Hal" Bubb (seated) and "Geo" Hart (standing) are always ready for a call from any amateur.

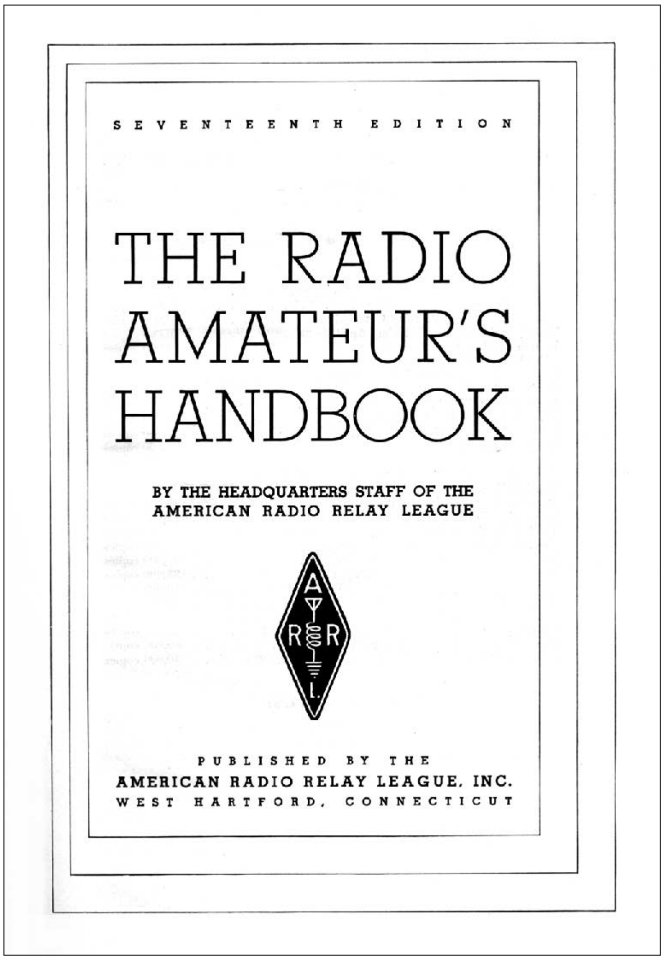
Figure 1940-1 — The ARRL headquarters Maxim Memorial Station, W1AW, was located at the site of the present ARRL headquarters (and station) in Newington, Connecticut. It is interesting to compare 1940's equipment to that of the 1930 headquarters station.

advanced over the decade. A snapshot of a receiver (see Figure 1940-3) shows a six-tube superhet that provides a significant improvement in performance over the regenerative receivers of the previous decade. As with most *Handbook* receivers, this set used plug-in coils, rather than bandswitching, in order to minimize construction complexity. While performance didn't suffer, operating convenience did. Most commercial superhet receivers described in the ad section (see Figure 1940-4) went a step beyond, with the exception of the famous National HRO (see Figure 1940-5), and provided single switch bandswitching.

HF transmitters moved forward in a similar manner, many making use of metal chassis and panels and crystal frequency control. Bandswitching was not yet feasible in transmitter power stages due to the large tank inductors employed. Some used switching in low-level stages, but for many the marginal benefit was not worth the complexity. Figures 1940-6 and -7 illustrate one transmitter project, a medium power HF rig, from this edition. The ad from Hallicrafters (Figure 1940-8) not only showed a commercial bandswitching receiver, but also a companion desktop transmitter.

With the additional VHF bands, operation on the (then called) "ultrahighs" gained in popularity. Early equipment for 2½ and 1¼ meters tended to be of the modulated oscillator variety and were described in their own chapter of the 1940 *Handbook* (see Figure 1940-9).

Ads from many manufacturers for complete radios, parts, instruction and accessories (see Figure 1940-10) continued to provide a window into what could be accomplished with enough resources.


SEVENTEENTH EDITION

THE RADIO AMATEUR'S HANDBOOK

BY THE HEADQUARTERS STAFF OF THE AMERICAN RADIO RELAY LEAGUE

PUBLISHED BY THE AMERICAN RADIO RELAY LEAGUE, INC.
WEST HARTFORD, CONNECTICUT

Figure 1940-2 — The cover page of the 1940 edition looks much like the previous ones, again, not identifying the publication year, but the edition — this one the 17th.

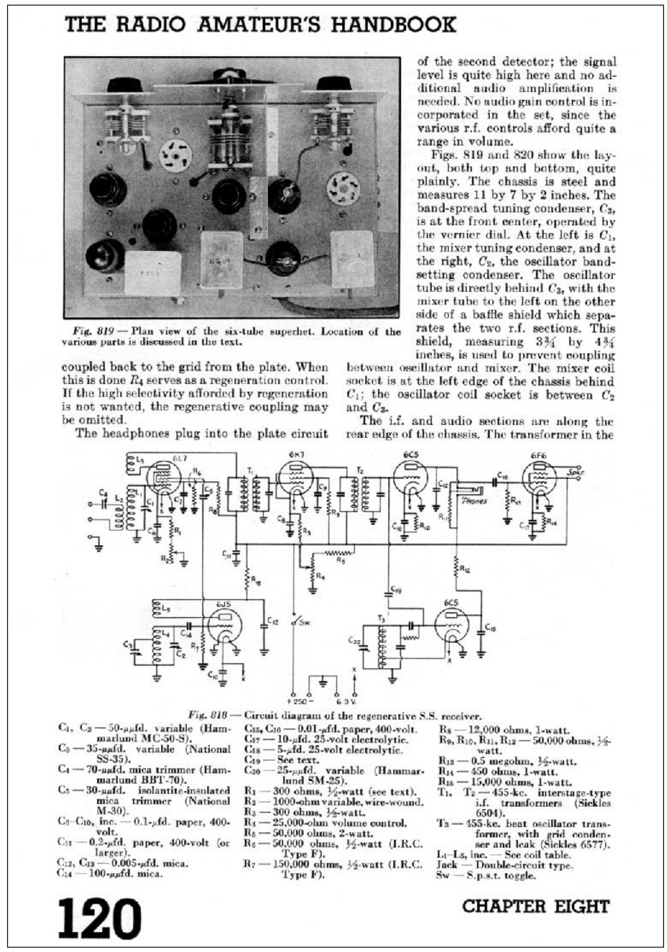

THE RADIO AMATEUR'S HANDBOOK

Fig. 819 — Plan view of the six-tube superhet. Location of the various parts is discussed in the text.

of the second detector; the signal level is quite high here and no additional audio amplification is needed. No audio gain control is incorporated in the set, since the various r.f. controls afford quite a range in volume.

Figs. 819 and 820 show the layout, both top and bottom, quite plainly. The chassis is steel and measures 11 by 7 by 2 inches. The band-spread tuning condenser, C_3, is at the front center, operated by the vernier dial. At the left is C_1, the mixer tuning condenser, and at the right, C_2, the oscillator band-setting condenser. The oscillator tube is directly behind C_3, with the mixer tube to the left on the other side of a baffle shield which separates the two r.f. sections. This shield, measuring 3¾ by 4¾ inches, is used to prevent coupling between oscillator and mixer. The mixer coil socket is at the left edge of the chassis behind C_1; the oscillator coil socket is between C_2 and C_3.

The i.f. and audio sections are along the rear edge of the chassis. The transformer in the

coupled back to the grid from the plate. When this is done R_4 serves as a regeneration control. If the high selectivity afforded by regeneration is not wanted, the regenerative coupling may be omitted.

The headphones plug into the plate circuit

Fig. 818 — Circuit diagram of the regenerative S.S. receiver.

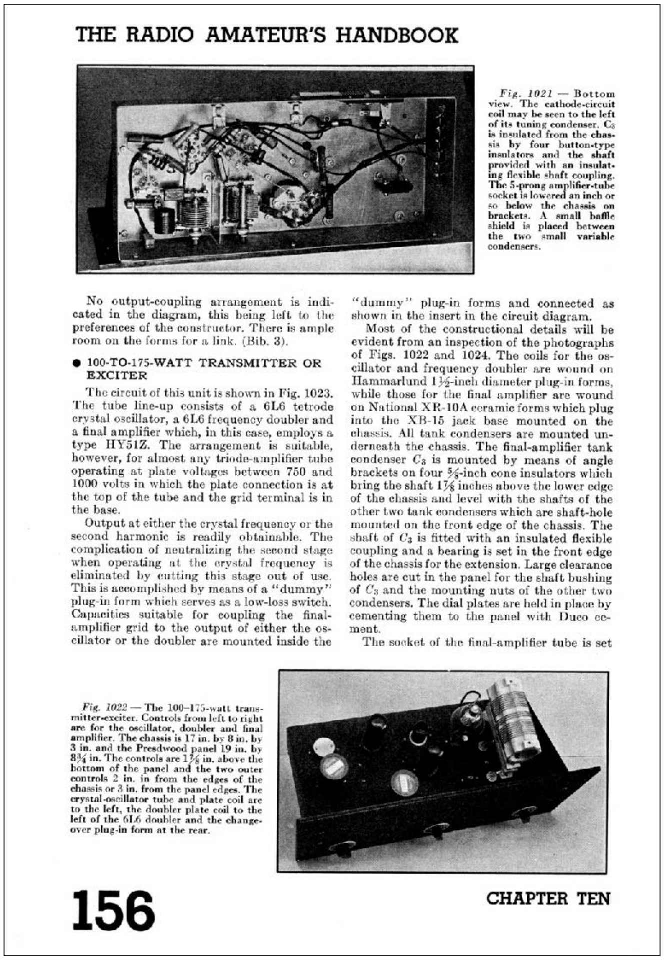
C_1, C_2 — 50-μμfd. variable (Hammarlund MC-50-S).
C_3 — 35-μμfd. variable (National SS-35).
C_4 — 70-μμfd. mica trimmer (Hammarlund BBT-70).
C_5 — 30-μμfd. isolantite-insulated mica trimmer (National M-30).
C_6–C_{10}, inc. — 0.1-μfd. paper, 400-volt.
C_{11} — 0.2-μfd. paper, 400-volt (or larger).
C_{12}, C_{13} — 0.005-μfd. mica.
C_{14} — 100-μμfd. mica.
C_{15}, C_{16} — 0.01-μfd. paper, 400-volt.
C_{17} — 10-μfd. 25-volt electrolytic.
C_{18} — 5-μfd. 25-volt electrolytic.
C_{19} — See text.
C_{20} — 25-μμfd. variable (Hammarlund SM-25).
R_1 — 300 ohms, ½-watt (see text).
R_2 — 1000-ohm variable, wire-wound.
R_3 — 300 ohms, ½-watt.
R_4 — 25,000-ohm volume control.
R_5 — 50,000 ohms, 2-watt.
R_6 — 50,000 ohms, ½-watt (I.R.C. Type F).
R_7 — 150,000 ohms, ½-watt (I.R.C. Type F).
R_8 — 12,000 ohms, 1-watt.
R_9, R_{10}, R_{11}, R_{12} — 50,000 ohms, ½-watt.
R_{13} — 0.5 megohm, ½-watt.
R_{14} — 450 ohms, 1-watt.
R_{15} — 15,000 ohms, 1-watt.
T_1, T_2 — 455-kc. interstage-type i.f. transformers (Sickles 6504).
T_3 — 455-kc. beat oscillator transformer, with grid condenser and leak (Sickles 6577).
L_1–L_5, inc. — See coil table.
Jack — Double-circuit type.
Sw — S.p.s.t. toggle.

120 CHAPTER EIGHT

Figure 1940-3 — This 1940 *Handbook* construction project resulted in a modern HF ham band superhet using plug-in coils to change bands.

Figure 1940-4 — These receivers, advertised by Hammarlund, set the standard for modern receiver technology of the day — the architecture remaining popular for decades to come.

Figure 1940-5 — National Radio had expanded its receiver line to include bandswitching and plug-in coil superhets, but still offered the popular SW-3 regenerative receiver from years past.



THE RADIO AMATEUR'S HANDBOOK

Fig. 1021 — Bottom view. The cathode-circuit coil may be seen to the left of its tuning condenser. C_3 is insulated from the chassis by four button-type insulators and the shaft provided with an insulating flexible shaft coupling. The 5-prong amplifier-tube socket is lowered an inch or so below the chassis on brackets. A small baffle shield is placed between the two small variable condensers.

No output-coupling arrangement is indicated in the diagram, this being left to the preferences of the constructor. There is ample room on the forms for a link. (Bib. 3).

● 100-TO-175-WATT TRANSMITTER OR EXCITER

The circuit of this unit is shown in Fig. 1023. The tube line-up consists of a 6L6 tetrode crystal oscillator, a 6L6 frequency doubler and a final amplifier which, in this case, employs a type HY51Z. The arrangement is suitable, however, for almost any triode-amplifier tube operating at plate voltages between 750 and 1000 volts in which the plate connection is at the top of the tube and the grid terminal is in the base.

Output at either the crystal frequency or the second harmonic is readily obtainable. The complication of neutralizing the second stage when operating at the crystal frequency is eliminated by cutting this stage out of use. This is accomplished by means of a "dummy" plug-in form which serves as a low-loss switch. Capacities suitable for coupling the final-amplifier grid to the output of either the oscillator or the doubler are mounted inside the "dummy" plug-in forms and connected as shown in the insert in the circuit diagram.

Most of the constructional details will be evident from an inspection of the photographs of Figs. 1022 and 1024. The coils for the oscillator and frequency doubler are wound on Hammarlund 1½-inch diameter plug-in forms, while those for the final amplifier are wound on National XR-10A ceramic forms which plug into the XB-15 jack base mounted on the chassis. All tank condensers are mounted underneath the chassis. The final-amplifier tank condenser C_3 is mounted by means of angle brackets on four ⅝-inch cone insulators which bring the shaft 1⅞ inches above the lower edge of the chassis and level with the shafts of the other two tank condensers which are shaft-hole mounted on the front edge of the chassis. The shaft of C_3 is fitted with an insulated flexible coupling and a bearing is set in the front edge of the chassis for the extension. Large clearance holes are cut in the panel for the shaft bushing of C_3 and the mounting nuts of the other two condensers. The dial plates are held in place by cementing them to the panel with Duco cement.

The socket of the final-amplifier tube is set

Fig. 1022 — The 100–175-watt transmitter-exciter. Controls from left to right are for the oscillator, doubler and final amplifier. The chassis is 17 in. by 8 in. by 3 in. and the Presdwood panel 19 in. by 8¾ in. The controls are 1⅞ in. above the bottom of the panel and the two outer controls 2 in. in from the edges of the chassis or 3 in. from the panel edges. The crystal-oscillator tube and plate coil are to the left, the doubler plate coil to the left of the 6L6 doubler and the change-over plug-in form at the rear.

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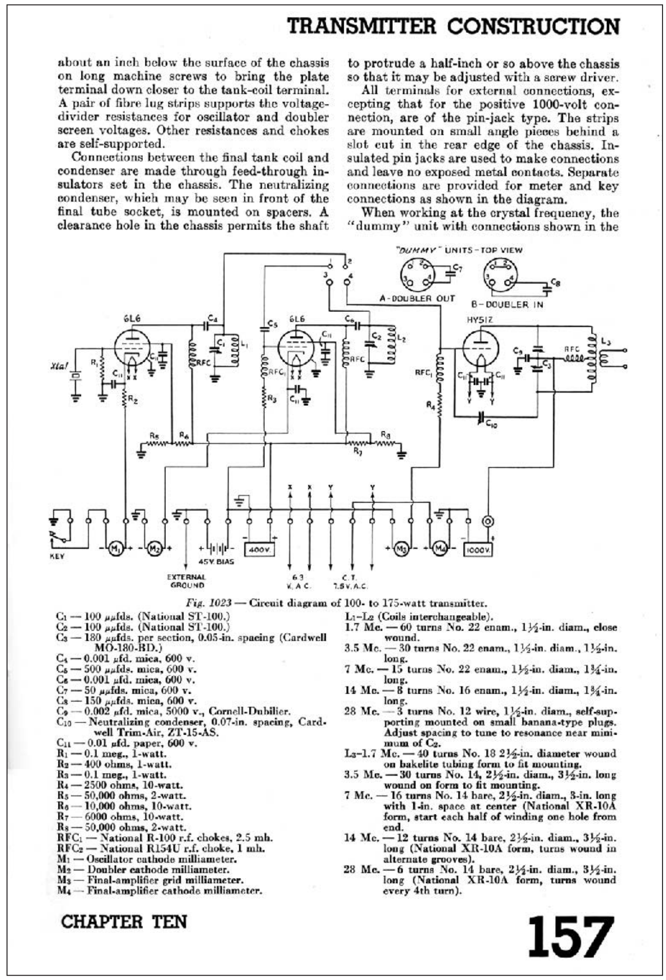
Figure 1940-6 — A 1940 edition medium power transmitter construction project.



TRANSMITTER CONSTRUCTION

about an inch below the surface of the chassis on long machine screws to bring the plate terminal down closer to the tank-coil terminal. A pair of fibre lug strips supports the voltage-divider resistances for oscillator and doubler screen voltages. Other resistances and chokes are self-supported.

Connections between the final tank coil and condenser are made through feed-through insulators set in the chassis. The neutralizing condenser, which may be seen in front of the final tube socket, is mounted on spacers. A clearance hole in the chassis permits the shaft to protrude a half-inch or so above the chassis so that it may be adjusted with a screw driver.

All terminals for external connections, excepting that for the positive 1000-volt connection, are of the pin-jack type. The strips are mounted on small angle pieces behind a slot cut in the rear edge of the chassis. Insulated pin jacks are used to make connections and leave no exposed metal contacts. Separate connections are provided for meter and key connections as shown in the diagram.

When working at the crystal frequency, the "dummy" unit with connections shown in the

Fig. 1023 — Circuit diagram of 100- to 175-watt transmitter.

C_1 — 100 μμfds. (National ST-100.)
C_2 — 100 μμfds. (National ST-100.)
C_3 — 180 μμfds. per section, 0.05-in. spacing (Cardwell MO-180-BD.)
C_4 — 0.001 μfd. mica, 600 v.
C_5 — 500 μμfds. mica, 600 v.
C_6 — 0.001 μfd. mica, 600 v.
C_7 — 50 μμfds. mica, 600 v.
C_8 — 150 μμfds. mica, 600 v.
C_9 — 0.002 μfd. mica, 5000 v., Cornell-Dubilier.
C_{10} — Neutralizing condenser, 0.07-in. spacing, Cardwell Trim-Air, ZT-15-AS.
C_{11} — 0.01 μfd. paper, 600 v.
R_1 — 0.1 meg., 1-watt.
R_2 — 400 ohms, 1-watt.
R_3 — 0.1 meg., 1-watt.
R_4 — 2500 ohms, 10-watt.
R_5 — 50,000 ohms, 2-watt.
R_6 — 10,000 ohms, 10-watt.
R_7 — 6000 ohms, 10-watt.
R_8 — 50,000 ohms, 2-watt.
RFC_1 — National R-100 r.f. chokes, 2.5 mh.
RFC_2 — National R154U r.f. choke, 1 mh.
M_1 — Oscillator cathode milliameter.
M_2 — Doubler cathode milliameter.
M_3 — Final-amplifier grid milliameter.
M_4 — Final-amplifier cathode milliameter.

L_1–L_2 (Coils interchangeable).
1.7 Mc. — 60 turns No. 22 enam., 1½-in. diam., close wound.
3.5 Mc. — 30 turns No. 22 enam., 1½-in. diam., 1½-in. long.
7 Mc. — 15 turns No. 22 enam., 1½-in. diam., 1¾-in. long.
14 Mc. — 8 turns No. 16 enam., 1½-in. diam., 1¾-in. long.
28 Mc. — 3 turns No. 12 wire, 1½-in. diam., self-supporting mounted on small banana-type plugs. Adjust spacing to tune to resonance near minimum of C_2.
L_3-1.7 Mc. — 40 turns No. 18 2½-in. diameter wound on bakelite tubing form to fit mounting.
3.5 Mc. — 30 turns No. 14, 2½-in. diam., 3½-in. long wound on form to fit mounting.
7 Mc. — 16 turns No. 14 bare, 2½-in. diam., 3-in. long with 1-in. space at center (National XR-10A form, start each half of winding one hole from end.
14 Mc. — 12 turns No. 14 bare, 2½-in. diam., 3½-in. long (National XR-10A form, turns wound in alternate grooves).
28 Mc. — 6 turns No. 14 bare, 2½-in. diam., 3½-in. long (National XR-10A form, turns wound every 4th turn).

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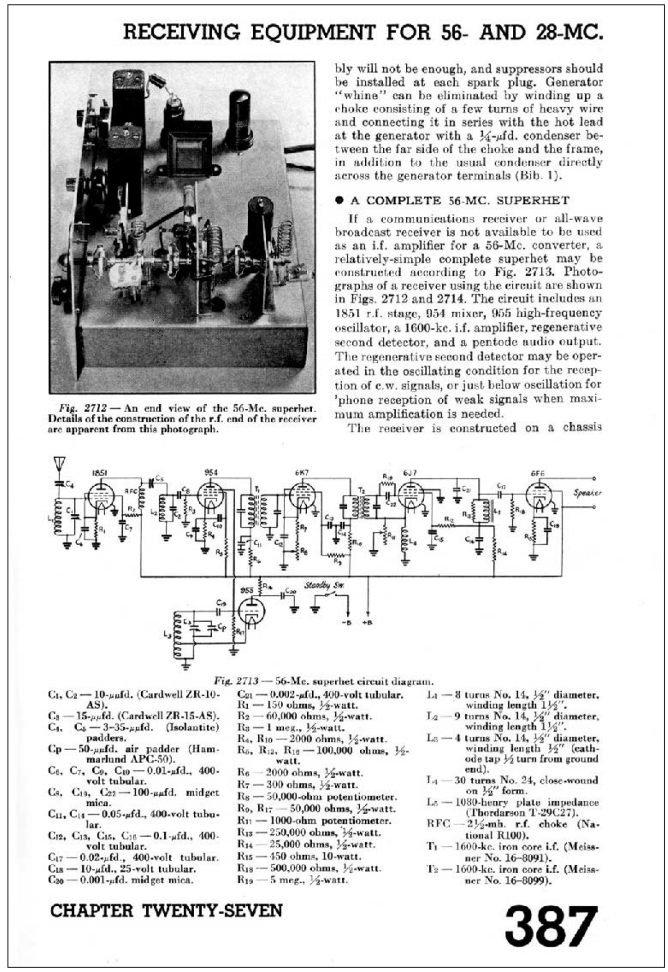
Figure 1940-7 — The second page of the project in Figure 1940-6, showing the schematic diagram.

Figure 1940-8 — Hallicrafters not only provided receivers, but also had a matching desktop transmitter.



RECEIVING EQUIPMENT FOR 56- AND 28-MC.

Fig. 2712 — An end view of the 56-Mc. superhet. Details of the construction of the r.f. end of the receiver are apparent from this photograph.

bly will not be enough, and suppressors should be installed at each spark plug. Generator "whine" can be eliminated by winding up a choke consisting of a few turns of heavy wire and connecting it in series with the hot lead at the generator with a ¼-μfd. condenser between the far side of the choke and the frame, in addition to the usual condenser directly across the generator terminals (Bib. 1).

● A COMPLETE 56-MC. SUPERHET

If a communications receiver or all-wave broadcast receiver is not available to be used as an i.f. amplifier for a 56-Mc. converter, a relatively-simple complete superhet may be constructed according to Fig. 2713. Photographs of a receiver using the circuit are shown in Figs. 2712 and 2714. The circuit includes an 1851 r.f. stage, 954 mixer, 955 high-frequency oscillator, a 1600-kc. i.f. amplifier, regenerative second detector, and a pentode audio output. The regenerative second detector may be operated in the oscillating condition for the reception of c.w. signals, or just below oscillation for 'phone reception of weak signals when maximum amplification is needed.

The receiver is constructed on a chassis

Fig. 2713 — 56-Mc. superhet circuit diagram.

C_1, C_2 — 10-μμfd. (Cardwell ZR-10-AS).
C_3 — 15-μμfd. (Cardwell ZR-15-AS).
C_4, C_5 — 3–35-μμfd. (Isolantite) padders.
Cp — 50-μμfd. air padder (Hammarlund APC-50).
C_6, C_7, C_9, C_{10} — 0.01-μfd., 400-volt tubular.
C_8, C_{19}, C_{22} — 100-μμfd. midget mica.
C_{11}, C_{14} — 0.05-μfd., 400-volt tubular.
C_{12}, C_{13}, C_{15}, C_{16} — 0.1-μfd., 400-volt tubular.
C_{17} — 0.02-μfd., 400-volt tubular.
C_{18} — 10-μfd., 25-volt tubular.
C_{20} — 0.001-μfd. midget mica.
C_{21} — 0.002-μfd., 400-volt tubular.
R_1 — 150 ohms, ½-watt.
R_2 — 60,000 ohms, ½-watt.
R_3 — 1 meg., ½-watt.
R_4, R_{10} — 2000 ohms, ½-watt.
R_5, R_{12}, R_{16} — 100,000 ohms, ½-watt.
R_6 — 2000 ohms, ½-watt.
R_7 — 300 ohms, ½-watt.
R_8 — 50,000-ohm potentiometer.
R_9, R_{17} — 50,000 ohms, ½-watt.
R_{11} — 1000-ohm potentiometer.
R_{13} — 250,000 ohms, ½-watt.
R_{14} — 25,000 ohms, ½-watt.
R_{15} — 450 ohms, 10-watt.
R_{18} — 500,000 ohms, ½-watt.
R_{19} — 5 meg., ½-watt.
L_1 — 8 turns No. 14, ½" diameter, winding length 1½".
L_2 — 9 turns No. 14, ½" diameter, winding length 1½".
L_3 — 4 turns No. 14, ½" diameter, winding length ½" (cathode tap ½ turn from ground end).
L_4 — 30 turns No. 24, close-wound on ½" form.
L_5 — 1080-henry plate impedance (Thordarson T-29C27).
RFC — 2½-mh. r.f. choke (National R100).
T_1 — 1600-kc. iron core i.f. (Meissner No. 16–8091).
T_2 — 1600-kc. iron core i.f. (Meissner No. 16–8099).

CHAPTER TWENTY-SEVEN 387

Figure 1940-9 — The 1940 edition described VHF construction projects as well as those for HF.


HANDBOOK
534
CATALOG SECTION

SUPERIOR KEYS FOR SUPERIOR WORK

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The new "CHAMPION" is an inexpensive key having exceptional sending qualities—clarity . . . speed . . . sending ease, which will appeal alike to amateurs and professional operators. Chrome and cadmium plated and mounted on black base. Standard size and equipped with Standard contact points same as the more expensive models. Practically rust-proof. This model is not equipped with circuit closer or cord and wedge. If your dealer cannot supply you write us for full particulars.

IMPROVED ORIGINAL VIBROPLEX $13.75

Needs no introduction being known the world over for its smooth, easy, rhythmic sending. In high favor with experienced operators everywhere. Polished finish bright parts.

A Winner "LIGHTNING BUG" $13.75

This is the same Great New Easy-action Vibroplex which formerly sold for $17.00 — the same fine instrument that is preferred for its ease of handling, fine quality signal and all 'round superior performance. Polished finish bright parts.

CARRYING CASE $3.00

Handsome black morocco. Reinforced corners. Flexible leather handle. Keeps bug free of dust, dirt and moisture. Patent lock and key.

Approved by Over 100,000 Operators

Experienced operators — over 100,000 of them, have put their stamp of approval on VIBROPLEX keys for clarity, speed and sending ease. They have learned from actual experience that the Vibroplex really does make sending a lot easier and better, and that it develops a higher degree of sending skill than the average hand sender can hope to attain.

The BUG trade mark identifies the Genuine Vibroplex

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If you can send on the regulation key — you can send better, faster and with half the effort with a Vibroplex. Its simplicity, mechanical perfection, machine speed and sending ease enables any operator with a little practice, to send with the skill of an expert. Simply press lever — Vibroplex does the rest. Heed the advice of experienced operators and demand the Genuine Vibroplex. Accept no substitute. Only the Genuine has "THE BUG" trade mark. Look for it on the bug you buy. You will always be glad you did. Money order or registered mail. Write for FREE illustrated catalog.

THE VIBROPLEX CO., Inc.
832 Broadway New York, N. Y.
J. E. Albright, President

Figure 1940-10 — Vibroplex continued to advertise its popular "Bugs."

A Decade of Turmoil and Recovery — The 1950 Edition

The big news between the 1940 and 1950 editions was, of course, World War II, which was declared on December 7, 1941. All Amateur Radio operation was suspended "until further notice." While there were some exceptions for specific amateurs operating in support of local security and Civil Defense, including a special War Emergency Radio Service that mainly used the 2½ meter band, hams were essentially off the air until bands were gradually brought back starting after the end of hostilities.

One might have expected that this would have resulted in a suspension of *Handbook* publication, but that was not the case. *QST* and *The Radio Amateur's Handbook* continued unabated throughout the period, in fact there was even an extra edition published in 1942 for the war effort. This "Special Defense Edition" (see Figure 1950-1) was designed as a training manual for use by various military technical schools. At 288 pages, it was about one third the size of the

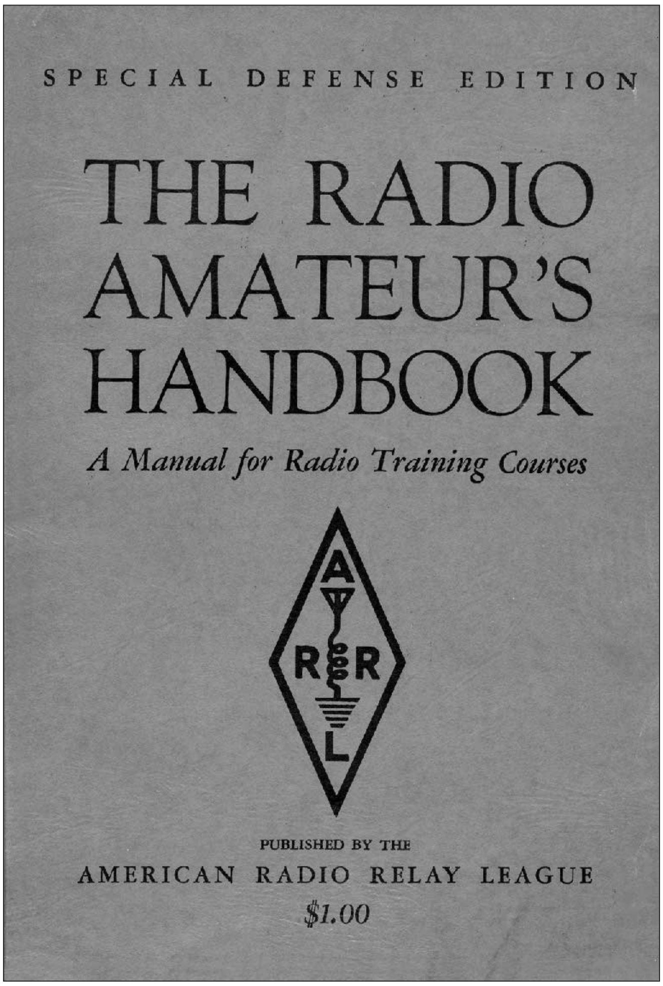


Figure 1950-1 — The cover of the 1942 Special Defense Edition of The Radio Amateur's *Handbook*.

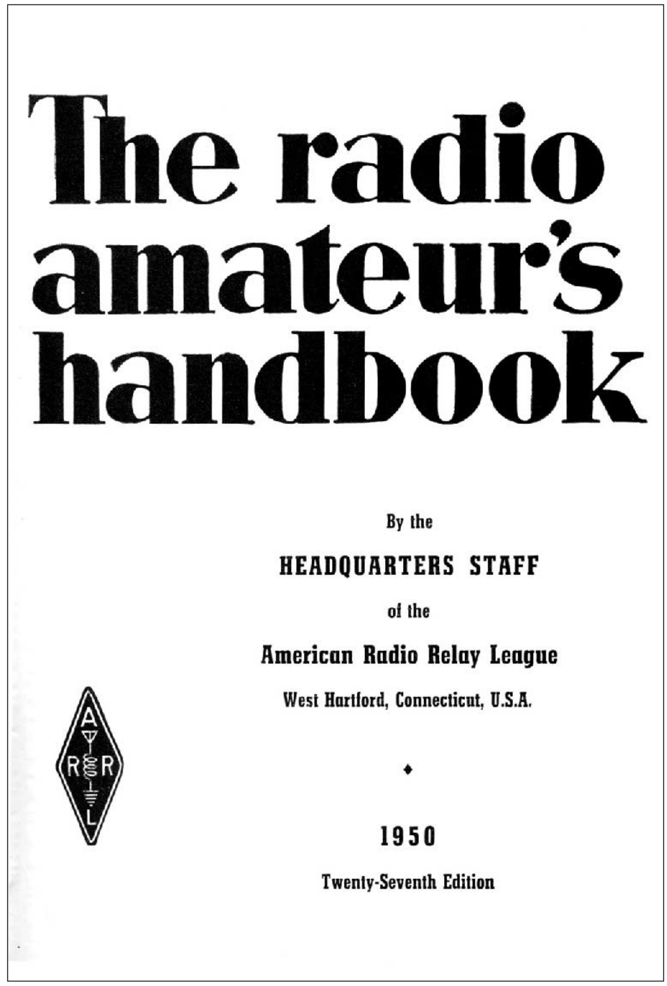


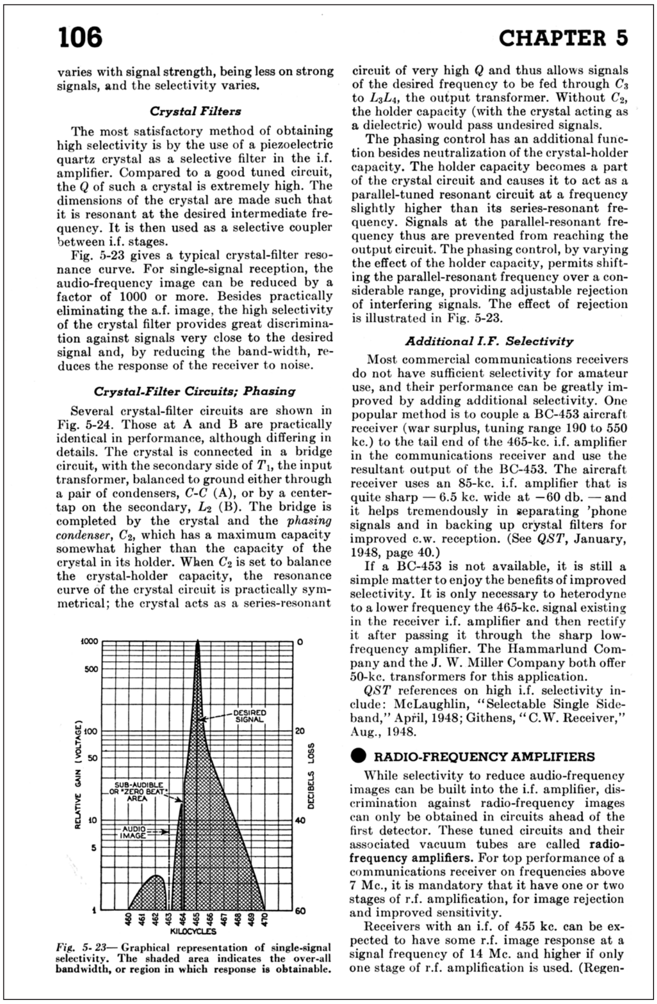
Figure 1950-2 — The cover page of the 1950 edition looks much like the previous ones, but a bit more modern and note that the year is explicitly shown.

regular editions, accomplished by eliminating most construction projects, the advertising section and material very specific to Amateur Radio.

The latter half of the 1940s found the amateur bands gradually returned to amateur use, but with some changes. Perhaps the most significant was the change in VHF allocations to accommodate the newly defined VHF television service. The 2½ and 5 meter bands were within the TV allocation, resulting in the shift to our current 2 and 6 meter bands.

The 1950 edition cover page (see Figure 1950-2) sported a new more modern look and now firmly indicated the year of publication, in addition to the edition identifier. Changes in the approach to technology employed reflected two different changes in the environment:

◊ The rapid development of radio science during the war years was reflected in Amateur Radio. The single signal effect, described by Lamb in the previous decade, has been improved by coupling it with the high selectivity of single crystal IF filters as shown in Figure 1950-3, a figure that will remain in *Handbooks* for decades. In addition to the adaptation of technology, the years following the war included an



106 CHAPTER 5

varies with signal strength, being less on strong signals, and the selectivity varies.

Crystal Filters

The most satisfactory method of obtaining high selectivity is by the use of a piezoelectric quartz crystal as a selective filter in the i.f. amplifier. Compared to a good tuned circuit, the Q of such a crystal is extremely high. The dimensions of the crystal are made such that it is resonant at the desired intermediate frequency. It is then used as a selective coupler between i.f. stages.

Fig. 5-23 gives a typical crystal-filter resonance curve. For single-signal reception, the audio-frequency image can be reduced by a factor of 1000 or more. Besides practically eliminating the a.f. image, the high selectivity of the crystal filter provides great discrimination against signals very close to the desired signal and, by reducing the band-width, reduces the response of the receiver to noise.

Crystal-Filter Circuits; Phasing

Several crystal-filter circuits are shown in Fig. 5-24. Those at A and B are practically identical in performance, although differing in details. The crystal is connected in a bridge circuit, with the secondary side of T_1, the input transformer, balanced to ground either through a pair of condensers, C-C (A), or by a center-tap on the secondary, L_2 (B). The bridge is completed by the crystal and the *phasing condenser*, C_2, which has a maximum capacity somewhat higher than the capacity of the crystal in its holder. When C_2 is set to balance the crystal-holder capacity, the resonance curve of the crystal circuit is practically symmetrical; the crystal acts as a series-resonant circuit of very high Q and thus allows signals of the desired frequency to be fed through C_3 to L_3L_4, the output transformer. Without C_2, the holder capacity (with the crystal acting as a dielectric) would pass undesired signals.

The phasing control has an additional function besides neutralization of the crystal-holder capacity. The holder capacity becomes a part of the crystal circuit and causes it to act as a parallel-tuned resonant circuit at a frequency slightly higher than its series-resonant frequency. Signals at the parallel-resonant frequency thus are prevented from reaching the output circuit. The phasing control, by varying the effect of the holder capacity, permits shifting the parallel-resonant frequency over a considerable range, providing adjustable rejection of interfering signals. The effect of rejection is illustrated in Fig. 5-23.

Additional I.F. Selectivity

Most commercial communications receivers do not have sufficient selectivity for amateur use, and their performance can be greatly improved by adding additional selectivity. One popular method is to couple a BC-453 aircraft receiver (war surplus, tuning range 190 to 550 kc.) to the tail end of the 465-kc. i.f. amplifier in the communications receiver and use the resultant output of the BC-453. The aircraft receiver uses an 85-kc. i.f. amplifier that is quite sharp — 6.5 kc. wide at −60 db. — and it helps tremendously in separating 'phone signals and in backing up crystal filters for improved c.w. reception. (See *QST*, January, 1948, page 40.)

If a BC-453 is not available, it is still a simple matter to enjoy the benefits of improved selectivity. It is only necessary to heterodyne to a lower frequency the 465-kc. signal existing in the receiver i.f. amplifier and then rectify it after passing it through the sharp low-frequency amplifier. The Hammarlund Company and the J. W. Miller Company both offer 50-kc. transformers for this application.

QST references on high i.f. selectivity include: McLaughlin, "Selectable Single Sideband," April, 1948; Githens, "C.W. Receiver," Aug., 1948.

● **RADIO-FREQUENCY AMPLIFIERS**

While selectivity to reduce audio-frequency images can be built into the i.f. amplifier, discrimination against radio-frequency images can only be obtained in circuits ahead of the first detector. These tuned circuits and their associated vacuum tubes are called **radio-frequency amplifiers.** For top performance of a communications receiver on frequencies above 7 Mc., it is mandatory that it have one or two stages of r.f. amplification, for image rejection and improved sensitivity.

Receivers with an i.f. of 455 kc. can be expected to have some r.f. image response at a signal frequency of 14 Mc. and higher if only one stage of r.f. amplification is used. (Regen-

Fig. 5-23— Graphical representation of single-signal selectivity. The shaded area indicates the over-all bandwidth, or region in which response is obtainable.

Figure 1950-3 — The single signal effect, described by Lamb in the previous decade, has been improved by coupling it with the high selectivity of single crystal IF filters.

118 CHAPTER 5

An Amateur-Band Eight-Tube Superheterodyne

An advanced type of amateur receiver incorporating one r.f. amplifier stage, variable i.f. selectivity and audio noise limiting is shown in Figs. 5-33, 5-35 and 5-36. As can be seen from the circuit in Fig. 5-34, a 6SG7 pentode is used for the tuned r.f. stage ahead of the 6K8 converter. An antenna compensator, C_4, controlled from the panel, allows one to trim up the r.f. stage when using different antennas that might modify the tracking. The cathode bias resistor of the r.f. stage is made as low as possible consistent with the tube ratings, to keep the gain and hence the signal-to-noise ratio of the stage high. The oscillator portion of the 6K8 mixer is tuned to the high-frequency side of the signal except on the 28-Mc. band, the usual custom nowadays in communications receivers. The oscillator tuning condenser, C_{17}, is of higher capacity than the r.f. and mixer tuning condensers, in the interest of better oscillator stability.

The i.f. amplifier is tuned to 455 kc., and the first stage is made regenerative by soldering a short length of wire to the plate terminal of the socket and running it near the grid terminal, as indicated by C_{C1} in the diagram. Regeneration is controlled by reducing the gain of the tube, and R_{12}, a variable cathode-bias control, serves this function. The second i.f. stage uses a 6K7, selected because high gain is not necessary at this point.

Manual gain-control voltage is applied to the r.f. and second i.f. stages. It is not applied to the mixer because it might pull the oscillator frequency, and it is not tied in with the first i.f. amplifier because it would interlock with the regeneration control used for controlling the selectivity. However, the a.v.c. voltage is applied to the r.f. and both i.f. stages, with the result that the selectivity of the regenerative stage decreases with loud signals and gives a measure of automatic selectivity control. Using a negative-voltage power supply for the manual gain control is more expensive than the familiar cathode control, but it allows a wide range of control with less dissipation in the components. The a.v.c. is of the delayed type, the a.v.c. diode being biased about 1½ volts by the cathode resistor of the diode-triode detector-audio stage.

The second-detector-and-first-audio is the usual diode-triode combination and uses a 6SQ7. A 1N34 crystal diode is used as a noise limiter, and is left in the circuit all of the time. As is common with this type of circuit, it has little or no effect when the b.f.o. is on, but it is of considerable help to 'phone reception on the bands where automobile ignition is a factor. The constructor can satisfy himself on its operation when first building the receiver and working on it out of the case. By leaving one end of the 1N34 floating and touching it to the proper point in the circuit, a marked drop in ignition noise will be noted.

The b.f.o. is capacity-coupled to the detector by soldering one end of an insulated wire to the a.v.c. diode plate and wrapping several turns of the wire around the b.f.o. grid lead. This capacity is designated C_{C2} in the diagram. The wire was connected to the a.v.c. diode plate lead only for wiring convenience — the a.v.c. coupling condenser, C_{32}, passing the b.f.o. voltage without introducing appreciable attenuation.

Headphone output is obtained from the plate circuit of the 6SQ7 at J_1, and loudspeaker output is available from the 6F6 audio-amplifier stage. High-impedance or crystal headphones are recommended for maximum headphone output.

♦

Fig. 5-33 — An amateur-band eight-tube receiver. The knobs on the left control audio volume (upper) and b.f.o. pitch, and the two on the right handle r.f. and i.f. gain (upper) and i.f. regeneration. The knob to the left of the large tuning knob is fastened to the *MAN.-A.V.C.-B.F.O* switch, and the one on the right is for the antenna trimmer. The toggle switch under the dial throws high negative bias on the r.f. stage during transmission periods.

♦

Figure 1950-4 — This receiver construction project, see schematic in Figure 1950-5, is based on the same architecture as the receiver shown in Figure 1940-3. While an additional RF and IF stage were added, there's not much new here.

abundance of low cost surplus radio equipment that could be put to use with varying levels of effort. In many cases this equipment made the decision to buy new commercial gear, or to build your own difficult. Still, the *Handbook* described receiver construction projects (see Figures 1950-4 and 5) that, while elegant looking, arguably were not very different from those shown in the 1940 edition.

◊ The introduction and increasing popularity of broadcast television service as the decade drew to a close had a major impact on Amateur Radio, as it would for decades to come. Harmonic and spurious radiation in the VHF range that had been largely unnoticed for years suddenly resulted in non-amateurs becoming very aware of ham radio in a negative way. This gave rise to major changes in transmitter design and construction methods, including shielding, bypassing, filtering and the use of coaxial cable — available as surplus following the war. This can be seen in Figure 1950-6, a transmitter not very different from those of the previous decade, but with attention paid to shielding and bypassing to "reduce the generation and transmission of harmonics."

Other developments were shown in the 1950 edition, including an early description of single-sideband suppressed-carrier transmission (see Figure 1950-7). This was to become known as "SSB" in a few years

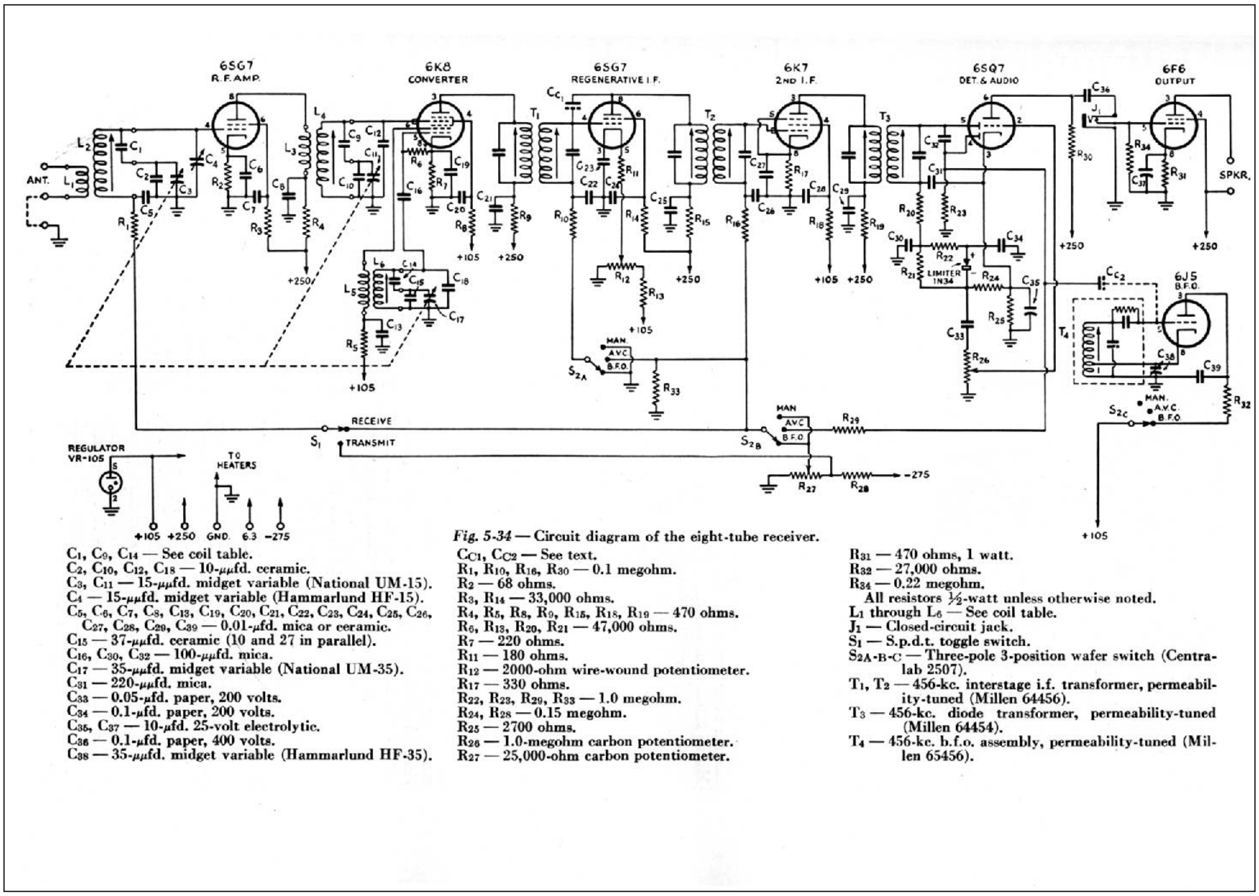
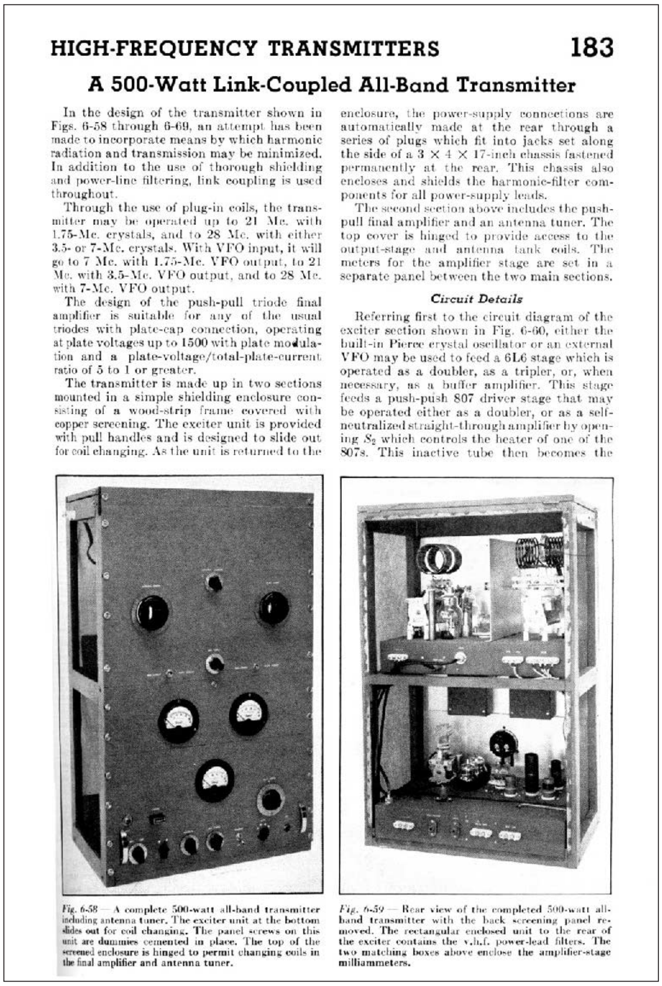


Figure 1950-5 — Schematic diagram of the receiver project shown in Figure 1950-4.

and, while the most popular HF voice mode today, took some years to displace (double-sideband full-carrier) AM from predominance in *Handbook* projects.

The ad section featured the newest of the "postwar" communication equipment. While perhaps shinier and prettier, these radios (see Figures 1950-8 and -9) were not terribly different from those of the previous generation — with the exception of the introduction of the Collins 75A-1 (see Figure 1950-10) receiver. The 75A-1 featured down conversion to a tunable first IF stage, an architecture that would define the best of the SSB equipment of the upcoming generation. Vibroplex (see Figure 1950-11) continued to offer the same bugs as in previous decades, although the ad has a more modern look. Interestingly, the prices that dipped significantly between 1926 and 1940, returned to around their 1926 levels.

In 1939, the *Handbook* editors had concluded that there was enough material about antennas available that the *Handbook* could not do it justice. Thus a new book, *The ARRL Antenna Book*, was launched. Figure 1950-12 shows the cover of the first edition while Figure 1950-13 shows the cover of subsequent editions which maintained the familiar appearance for decades.



HIGH-FREQUENCY TRANSMITTERS 183

A 500-Watt Link-Coupled All-Band Transmitter

In the design of the transmitter shown in Figs. 6-58 through 6-69, an attempt has been made to incorporate means by which harmonic radiation and transmission may be minimized. In addition to the use of thorough shielding and power-line filtering, link coupling is used throughout.

Through the use of plug-in coils, the transmitter may be operated up to 21 Mc. with 1.75-Mc. crystals, and to 28 Mc. with either 3.5- or 7-Mc. crystals. With VFO input, it will go to 7 Mc. with 1.75-Mc. VFO output, to 21 Mc. with 3.5-Mc. VFO output, and to 28 Mc. with 7-Mc. VFO output.

The design of the push-pull triode final amplifier is suitable for any of the usual triodes with plate-cap connection, operating at plate voltages up to 1500 with plate modulation and a plate-voltage/total-plate-current ratio of 5 to 1 or greater.

The transmitter is made up in two sections mounted in a simple shielding enclosure consisting of a wood-strip frame covered with copper screening. The exciter unit is provided with pull handles and is designed to slide out for coil changing. As the unit is returned to the enclosure, the power-supply connections are automatically made at the rear through a series of plugs which fit into jacks set along the side of a 3 × 4 × 17-inch chassis fastened permanently at the rear. This chassis also encloses and shields the harmonic-filter components for all power-supply leads.

The second section above includes the push-pull final amplifier and an antenna tuner. The top cover is hinged to provide access to the output-stage and antenna tank coils. The meters for the amplifier stage are set in a separate panel between the two main sections.

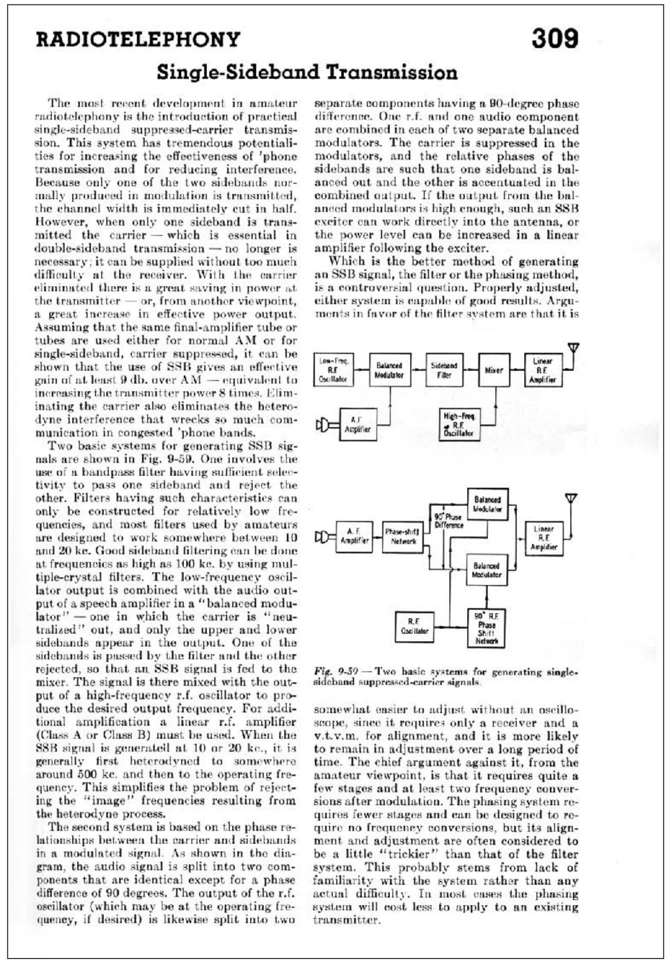
Circuit Details

Referring first to the circuit diagram of the exciter section shown in Fig. 6-60, either the built-in Pierce crystal oscillator or an external VFO may be used to feed a 6L6 stage which is operated as a doubler, as a tripler, or, when necessary, as a buffer amplifier. This stage feeds a push-push 807 driver stage that may be operated either as a doubler, or as a self-neutralized straight-through amplifier by opening S_2 which controls the heater of one of the 807s. This inactive tube then becomes the

Fig. 6-58 — A complete 500-watt all-band transmitter including antenna tuner. The exciter unit at the bottom slides out for coil changing. The panel screws on this unit are dummies cemented in place. The top of the screened enclosure is hinged to permit changing coils in the final amplifier and antenna tuner.

Fig. 6-59 — Rear view of the completed 500-watt all-band transmitter with the back screening panel removed. The rectangular enclosed unit to the rear of the exciter contains the v.h.f. power-lead filters. The two matching boxes above enclose the amplifier-stage milliammeters.

Figure 1950-6 — This 1950 edition medium power transmitter construction project includes shielding and filtering to reduce dreaded TVI.



RADIOTELEPHONY 309

Single-Sideband Transmission

The most recent development in amateur radiotelephony is the introduction of practical single-sideband suppressed-carrier transmission. This system has tremendous potentialities for increasing the effectiveness of 'phone transmission and for reducing interference. Because only one of the two sidebands normally produced in modulation is transmitted, the channel width is immediately cut in half. However, when only one sideband is transmitted the carrier — which is essential in double-sideband transmission — no longer is necessary; it can be supplied without too much difficulty at the receiver. With the carrier eliminated there is a great saving in power at the transmitter — or, from another viewpoint, a great increase in effective power output. Assuming that the same final-amplifier tube or tubes are used either for normal AM or for single-sideband, carrier suppressed, it can be shown that the use of SSB gives an effective gain of at least 9 db. over AM — equivalent to increasing the transmitter power 8 times. Eliminating the carrier also eliminates the heterodyne interference that wrecks so much communication in congested 'phone bands.

Two basic systems for generating SSB signals are shown in Fig. 9-59. One involves the use of a bandpass filter having sufficient selectivity to pass one sideband and reject the other. Filters having such characteristics can only be constructed for relatively low frequencies, and most filters used by amateurs are designed to work somewhere between 10 and 20 kc. Good sideband filtering can be done at frequencies as high as 100 kc. by using multiple-crystal filters. The low-frequency oscillator output is combined with the audio output of a speech amplifier in a "balanced modulator" — one in which the carrier is "neutralized" out, and only the upper and lower sidebands appear in the output. One of the sidebands is passed by the filter and the other rejected, so that an SSB signal is fed to the mixer. The signal is there mixed with the output of a high-frequency r.f. oscillator to produce the desired output frequency. For additional amplification a linear r.f. amplifier (Class A or Class B) must be used. When the SSB signal is generated at 10 or 20 kc., it is generally first heterodyned to somewhere around 500 kc. and then to the operating frequency. This simplifies the problem of rejecting the "image" frequencies resulting from the heterodyne process.

The second system is based on the phase relationships between the carrier and sidebands in a modulated signal. As shown in the diagram, the audio signal is split into two components that are identical except for a phase difference of 90 degrees. The output of the r.f. oscillator (which may be at the operating frequency, if desired) is likewise split into two separate components having a 90-degree phase difference. One r.f. and one audio component are combined in each of two separate balanced modulators. The carrier is suppressed in the modulators, and the relative phases of the sidebands are such that one sideband is balanced out and the other is accentuated in the combined output. If the output from the balanced modulators is high enough, such an SSB exciter can work directly into the antenna, or the power level can be increased in a linear amplifier following the exciter.

Which is the better method of generating an SSB signal, the filter or the phasing method, is a controversial question. Properly adjusted, either system is capable of good results. Arguments in favor of the filter system are that it is somewhat easier to adjust without an oscilloscope, since it requires only a receiver and a v.t.v.m. for alignment, and it is more likely to remain in adjustment over a long period of time. The chief argument against it, from the amateur viewpoint, is that it requires quite a few stages and at least two frequency conversions after modulation. The phasing system requires fewer stages and can be designed to require no frequency conversions, but its alignment and adjustment are often considered to be a little "trickier" than that of the filter system. This probably stems from lack of familiarity with the system rather than any actual difficulty. In most cases the phasing system will cost less to apply to an existing transmitter.

Fig. 9-59 — Two basic systems for generating single-sideband suppressed-carrier signals.

Figure 1950-7 — Single sideband transmission rated a few pages, but it would be some years before it would become mainstream for amateur use.

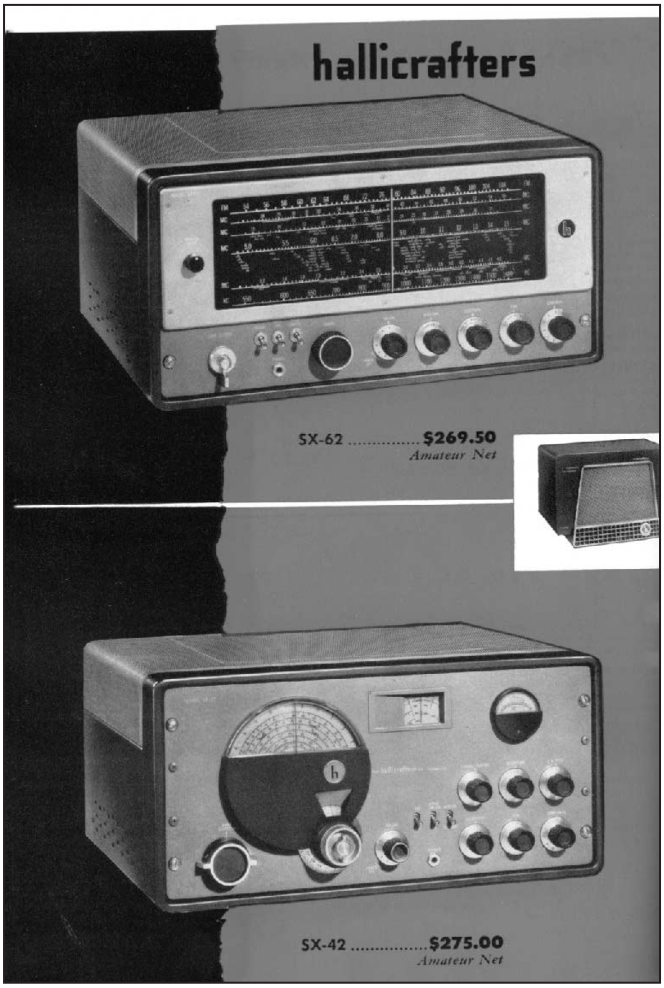


Figure 1950-8 — Hallicrafters receivers in 1950 had a definite postwar look. These receivers covered not only HF, but also VHF through 6 meters and the new FM broadcast band at 3 meters.

Figure 1950-9 — National Radio's premier postwar offering was the HRO-50 — an evolution of the prewar HRO that included miniature tubes, an internal power supply, push-pull (hi-fi) audio and a direct reading frequency scale. These were nice features, but it was now a two-person lift!

1950 Parade of Collins Stars

COLLINS 75A-1 AMATEUR RECEIVER

The well known and highly regarded 75A-1 receiver was designed specifically to give the radio amateur the best possible performance in the 80, 40, 20, 15, 11 and 10 meter bands.

Double conversion and crystal filter controls, with a high frequency first i-f and a low frequency second i-f, provide at least 50 db image rejection in all bands. The received bandwidth is variable in 5 steps from 4 kc to 200 cycles at 6 db down from the peak of the resonant frequency. The 6AK5 r-f stage makes possible a threshold sensitivity far better than can be realized in normal installations.

Very high accuracy and stability result from the use of precision quartz crystals in the first conversion circuit, the extreme accuracy and stability of the v.f.o. in the second conversion circuit, and linearity and absence of backlash in the tuning mechanism. The bandlighted slide rule dial indicates frequency in megacylces, while the vernier dial provides a direct reading in kilocycles. Panel controls include tuning, bandswitch, r-f gain, audio gain, c-w pitch, on-off-standby, crystal selectivity, crystal phasing, avc-manual-c-w, and noise limiter switch.

Dimensions: 21⅛" wide, 12$^{7}/_{16}$" high, 13⅞" deep.
Power source: 115 volts 50/60 cycles a-c.
Shipping weight: 93 pounds including speaker.
Net domestic price, complete with 13 tubes and rectifier, speaker and cabinet assembly, and instruction book (exclusive of state tax but including excise tax) $375.00

Coming! Collins KW-1

The New One Kilowatt Transmitter . . . Available Early Summer, 1950

Engineered by Collins expressly for radio amateurs. One kilowatt input, both AM phone and c-w. Designed to avoid TVI. Bandswitching throughout. Usual excellent Collins audio.

Tentative specifications: Exciter, single control tuning. Dial similar to the new Collins 51J-1 receiver. Output 50 to 75 ohms; single ended pi followed by L section. Tubes: P. A., two type 4-250A; modulator, two type 810.

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Figure 1950-10 — This ad by Collins radio doesn't really highlight the fact that the 75A-1 architecture was radical for its time, and would set the stage for the Collins SSB radios that would appear in the next decade.

THE EASIEST SEMI-AUTOMATIC KEY IN THE WORLD TO OPERATE!

VIBROPLEX

Reg. Trade Marks: Vibroplex, Lightning Bug, Bug

AMAZING NEW VIBROPLEX Super De Luxe The "PRESENTATION"
The only key with Super-Speed Control Main Spring and Other Great Operating Features

- Touch Control . . . instant adjustment to personal touch
- Super-Speed Control Main Spring . . . lets you send slower or faster than has before been possible
- Jewel Movement . . . smoother, easier operation, longer life
- Extra Large Contacts . . . die cut for perfect alignment and clearer signals
- Sure-Grip Finger and Thumb Piece . . . valuable aids in developing operating skill
- Finger-Tip Circuit Closer . . . eliminates lost motion
- Vacuum-Controlled Cushion Feet . . . smoother operation and firmer stance on table

The Operator's Greatest Asset

24-K Gold-Plated Base Top

Illustrated above is the New, Vibroplex Model Super DeLuxe "PRESENTATION", the smoothest operating key ever built $27.50

VIBROPLEX brings to all c.w. keying operations the simplicity and precision which makes high class operating possible. The ability to send perfect signals is further aided by the ease with which these keys can be operated. Perfect balance, simple operation and smooth, positive action encourage users to make the most of their skill. These worthwhile features are important not only to the experienced operator, but to anyone desiring to develop a pleasing sending style.

Vibroplex Model ORIGINAL — An exceptionally efficient and popular, all-purpose key combining all the features for a high class keying performance. Famous the world over for its operating case and signal quality. Black crystal base, polished chromium machine parts, $15.95; DeLuxe finish — polished chromium base and machine parts, jewel movement, $19.50

Vibroplex Model CHAMPION — A full size, dependable key at low cost. For radio use only. Modelled after the Lightning Bug and combining much of the smoothness and operating ease of that popular key. Less circuit closer, cord and wedge. $9.95.

Vibroplex Model BLUE RACER — Small in size, BIG in performance. Weight 2 lbs. 8 oz. Patterned after the Original with the same operating case and signal quality for which that key is internationally famous. Sturdy construction. Black crystal base, polished chromium machine parts, $15.95; DeLuxe finish — polished chromium base and machine parts, jewel movement, $19.50

Vibroplex CARRYING CASE — Finished in handsome simulated black morocco. Plush-lined. Reinforced corners. Flexible leather handle. Insures safe-keeping when not in use. Keeps key like new. Lock and key, $5.50.

Vibroplex Model, LIGHTNING BUG — A beautifully built, moderately-priced key. Has many advanced features contributing to the highest degree of operating skill with less effort, including an improved flat vibrating lever, adjustable dot contact spring and many others. Black crystal base, polished chromium machine parts, $13.95; DeLuxe finish-polished chromium base and machine parts, jewel movement, $17.50

All Vibroplex keys are available for left hand operation, $1.00 more. Choose from the world's finest semi-automatic keys. If your dealer cannot supply you ORDER DIRECT.

FREE descriptive literature

To get the genuine Vibroplex key, look for the "BUG" trade mark stamped on nameplate.

THE VIBROPLEX CO., INC., 833 Broadway, NEW YORK 3, N. Y.
W. W. Albright, President

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Figure 1950-11 — Vibroplex continued to advertise its popular "Bugs." This ad has a more modern layout than earlier ones, and the prices are back to 1926 levels.

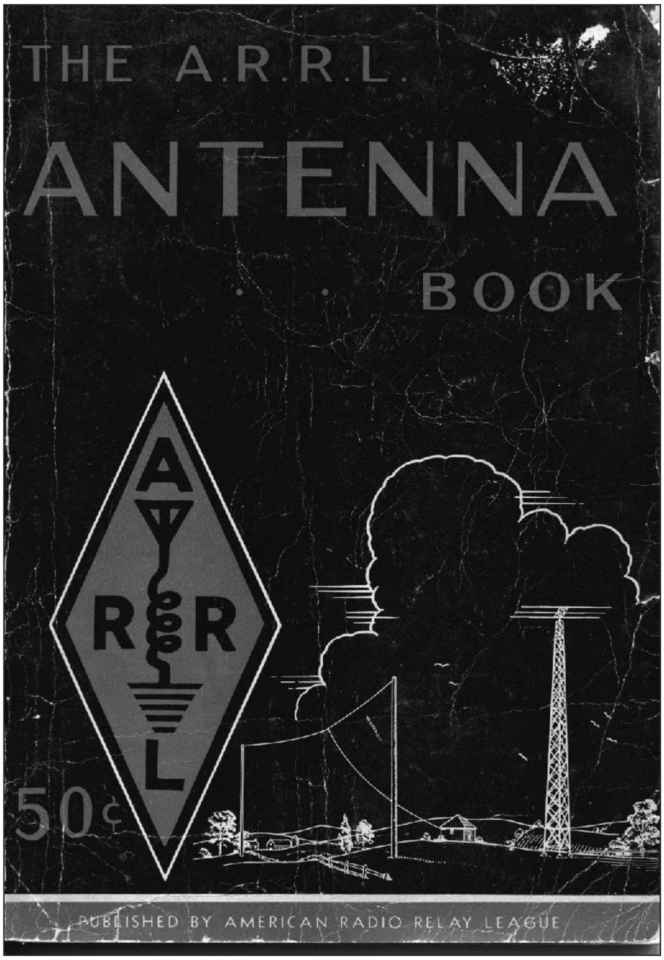


Figure 1950-12 — In 1939, the *Handbook* editors concluded that there was enough material about antennas available that a new reference text was needed, creating the *ARRL Antenna Book*.

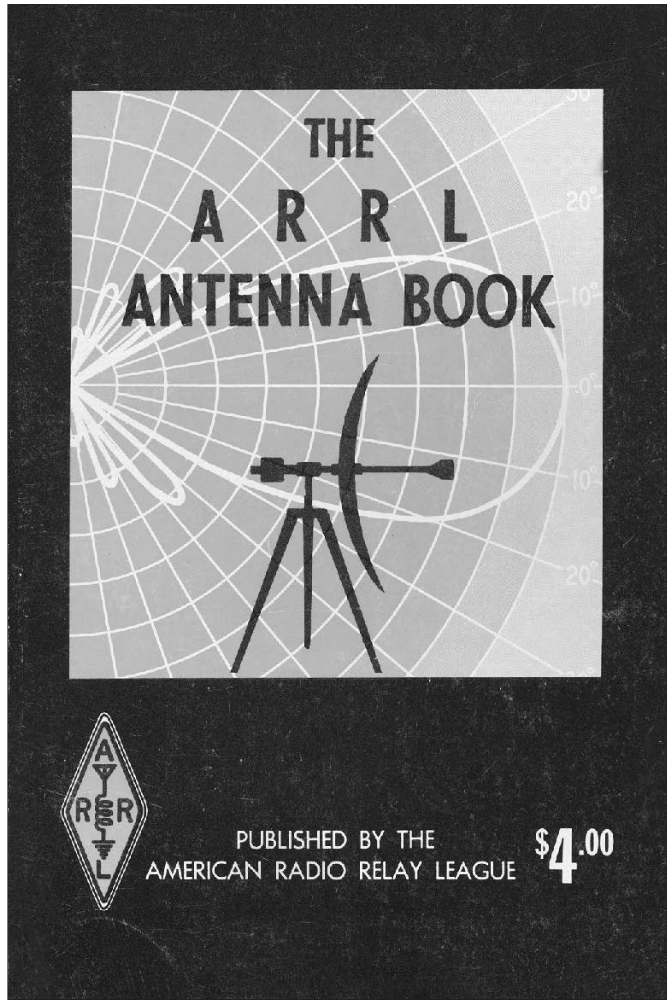
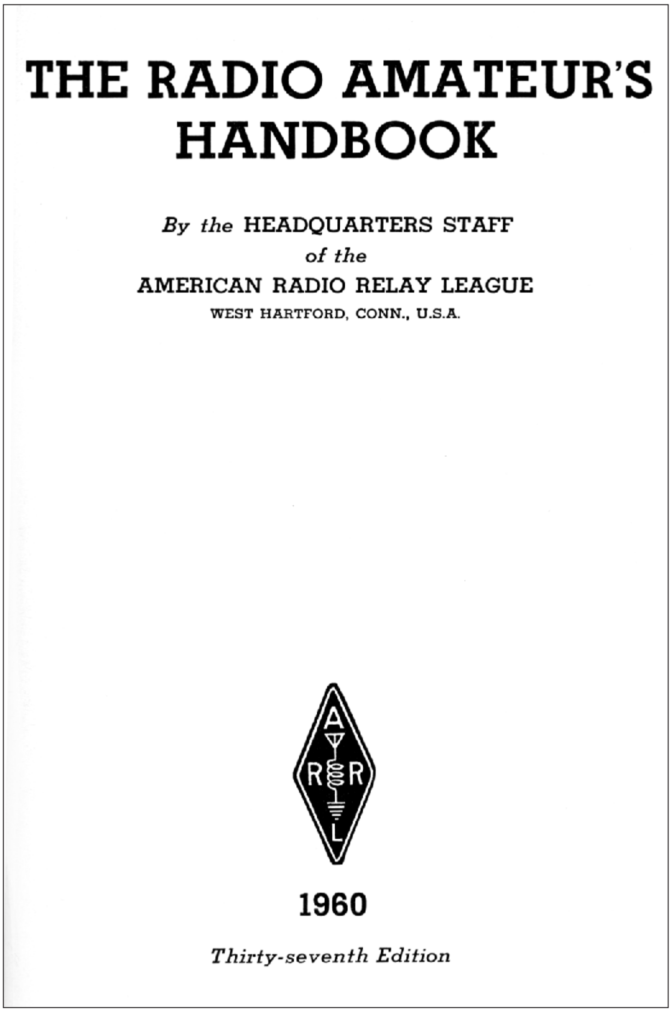


Figure 1950-13 — By 1949, the amount of material in the *Antenna Book* had increased substantially and the cover assumed the familiar look that subsequent editions maintained for decades.

A Decade of Advancement and Change — The 1960 Edition

The advancements in technology and engineering that were starting to emerge in the 1950s were solidified in the period building toward 1960, although not evident in the cover plate (see Figure 1960-1). While complete solid state equipment is some years away, transistor circuitry was showing up in projects where it was readily applied (see Figure 1960-2). In this figure, the mostly vacuum tube receiver includes a two transistor 100 kHz calibrator. Also note the two crystal IF band-pass filter. This arrangement was chosen with an ear toward SSB reception, in preference to the sharper single crystal filters of earlier year designs.

Figures 1960-3 and -4 illustrate a *Handbook* transmitter project that, while superficially similar to earlier CW transmitter projects, is of a significantly different design. In place of the plug-in link-coupled transmitter coils of earlier generations, this transmitter uses a pi-network output circuit that allows bandswitching with a single switch section on the output circuit. It is now possible to have a tightly RF-sealed transmitter that provides instant bandswitching across the HF



THE RADIO AMATEUR'S HANDBOOK

By the HEADQUARTERS STAFF *of the* AMERICAN RADIO RELAY LEAGUE

WEST HARTFORD, CONN., U.S.A.

1960

Thirty-seventh Edition

Figure 1960-1 — The cover plate of the 1960 *Handbook* offers no clues to the changes over the past decade.

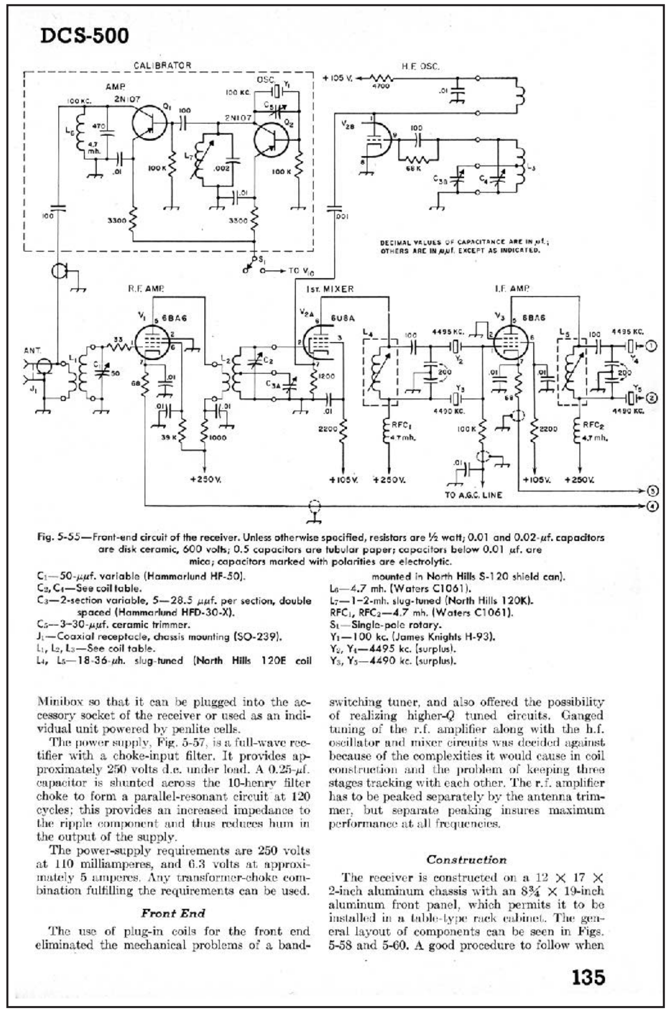


Fig. 5-55—Front-end circuit of the receiver. Unless otherwise specified, resistors are ½ watt; 0.01 and 0.02-μf. capacitors are disk ceramic, 600 volts; 0.5 capacitors are tubular paper; capacitors below 0.01 μf. are mica; capacitors marked with polarities are electrolytic.

C_1—50-μμf. variable (Hammarlund HF-50).
C_2, C_4—See coil table.
C_3—2-section variable, 5—28.5 μμf. per section, double spaced (Hammarlund HFD-30-X).
C_5—3-30-μμf. ceramic trimmer.
J_1—Coaxial receptacle, chassis mounting (SO-239).
L_1, L_2, L_3—See coil table.
L_4, L_5—18-36-μh. slug-tuned (North Hills 120E coil mounted in North Hills S-120 shield can).
L_6—4.7 mh. (Waters C1061).
L_7—1-2-mh. slug-tuned (North Hills 120K).
RFC_1, RFC_2—4.7 mh. (Waters C1061).
S_1—Single-pole rotary.
Y_1—100 kc. (James Knights H-93).
Y_2, Y_4—4495 kc. (surplus).
Y_3, Y_5—4490 kc. (surplus).

Minibox so that it can be plugged into the accessory socket of the receiver or used as an individual unit powered by penlite cells.

The power supply, Fig. 5-57, is a full-wave rectifier with a choke-input filter. It provides approximately 250 volts d.c. under load. A 0.25-μf. capacitor is shunted across the 10-henry filter choke to form a parallel-resonant circuit at 120 cycles; this provides an increased impedance to the ripple component and thus reduces hum in the output of the supply.

The power-supply requirements are 250 volts at 110 milliamperes, and 6.3 volts at approximately 5 amperes. Any transformer-choke combination fulfilling the requirements can be used.

Front End

The use of plug-in coils for the front end eliminated the mechanical problems of a bandswitching tuner, and also offered the possibility of realizing higher-*Q* tuned circuits. Ganged tuning of the r.f. amplifier along with the h.f. oscillator and mixer circuits was decided against because of the complexities it would cause in coil construction and the problem of keeping three stages tracking with each other. The r.f. amplifier has to be peaked separately by the antenna trimmer, but separate peaking insures maximum performance at all frequencies.

Construction

The receiver is constructed on a 12 × 17 × 2-inch aluminum chassis with an 8¾ × 19-inch aluminum front panel, which permits it to be installed in a table-type rack cabinet. The general layout of components can be seen in Figs. 5-58 and 5-60. A good procedure to follow when

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Figure 1960-2 — Schematic of a 1960 *Handbook* receiver project that makes use of transistors in the calibrator circuit. It also features a band-pass crystal filter appropriate for SSB reception.

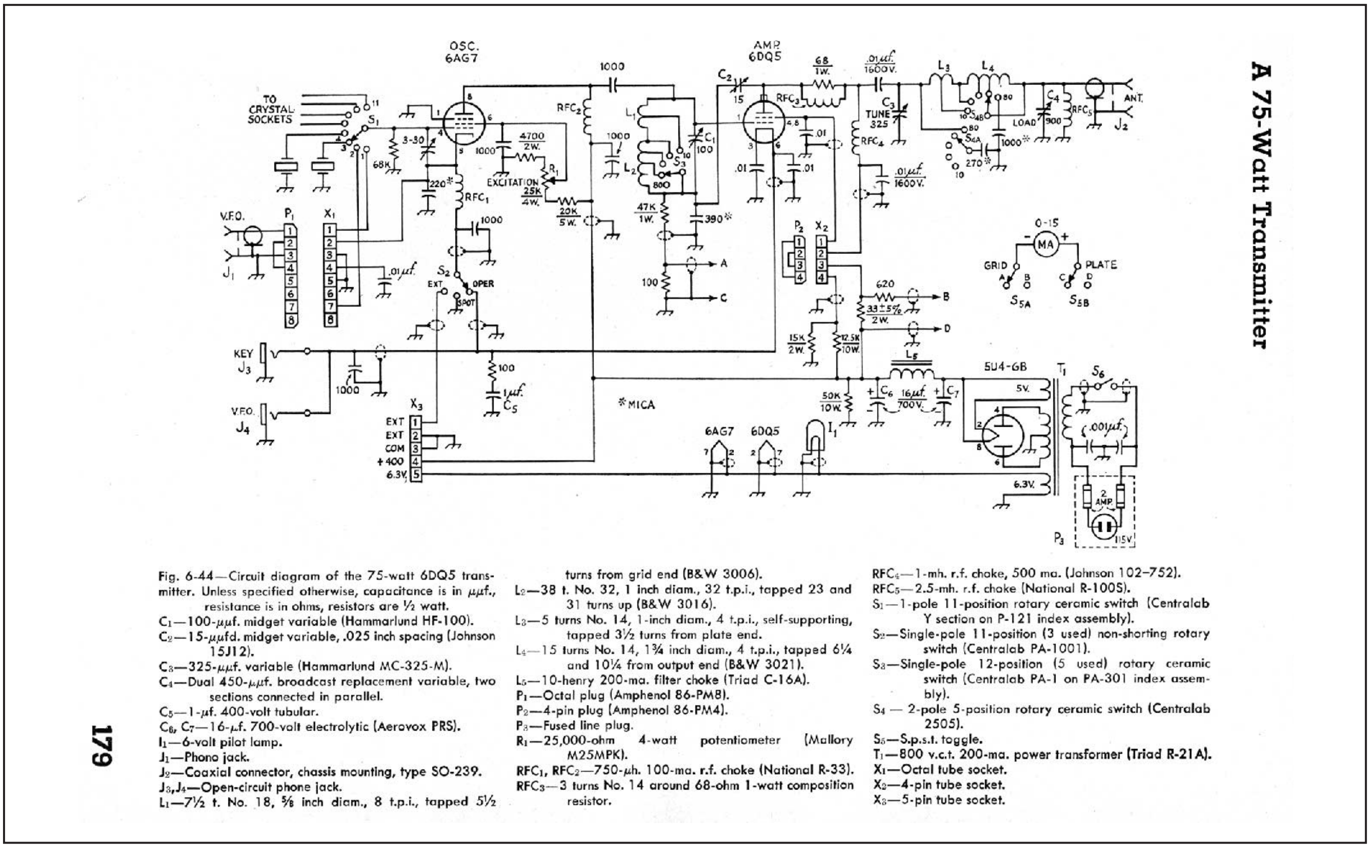


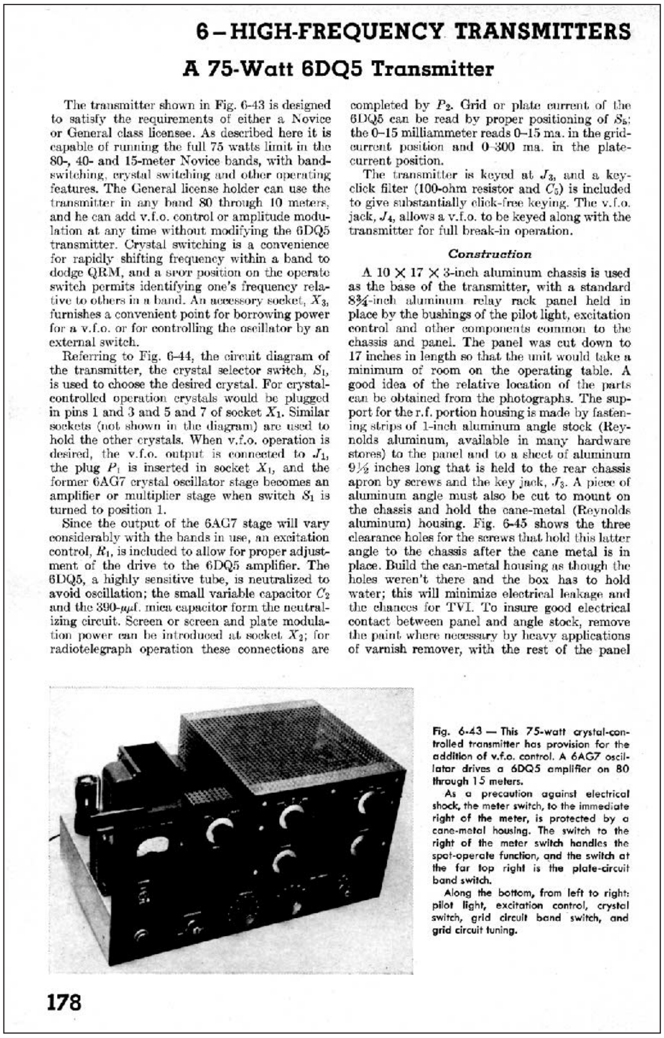
Figure 1960-3 — Schematic of a 1960 *Handbook* transmitter project that features a pi-network output circuit that allows band-switching and helps with harmonic reduction.

spectrum. The pi-network has other advantages — it is naturally low pass in response and it is unbalanced, and so it was a perfect fit to coax-fed antenna systems. Both features tended to reduce harmonic radiation and TVI.

The advertising section illustrated the diversity of technology available during the period. Collins Radio was at the head of the pack with its compact 100 W PEP HF SSB transceiver that could be used in a mobile setup, as shown in Figure 1960-5. This transceiver made use of the architectural design of the 75A-1 receiver shown in Figure 1950-10.

Other equipment manufacturers offered a mix of technologies. The Heath Company (see Figure 1960-6) offered AM transmitters, such as their TX-1 Apache with an optional phasing type SSB exciter. Their companion multimode receiver, the RX-1 would be announced soon. E. F. Johnson offered a wide range of high quality AM and CW transmitters (see Figure 1960-7), including an SSB adapter similar to the one provided by Heath. Hallicrafters offered a modern heterodyning transmitter, the HT-32, along with an SSB oriented receiver, the SX-101, and high power linear amplifier as shown in Figure 1960-8.

National Radio was still offering a full line of receivers, including a further update to the venerable HRO. Added to the line was an amateur band only receiver, the NC-300, a direct competitor to the Hallicrafters SX-101. A careful look at the Vibroplex ad (see Figure 1960-10) will reveal an entirely new product — the Vibrokeyer, "paddles" for an electronic keyer — a competitor to their mechanical bug.



6 – HIGH-FREQUENCY TRANSMITTERS

A 75-Watt 6DQ5 Transmitter

The transmitter shown in Fig. 6-43 is designed to satisfy the requirements of either a Novice or General class licensee. As described here it is capable of running the full 75 watts limit in the 80-, 40- and 15-meter Novice bands, with bandswitching, crystal switching and other operating features. The General license holder can use the transmitter in any band 80 through 10 meters, and he can add v.f.o. control or amplitude modulation at any time without modifying the 6DQ5 transmitter. Crystal switching is a convenience for rapidly shifting frequency within a band to dodge QRM, and a spot position on the operate switch permits identifying one's frequency relative to others in a band. An accessory socket, X_3, furnishes a convenient point for borrowing power for a v.f.o. or for controlling the oscillator by an external switch.

Referring to Fig. 6-44, the circuit diagram of the transmitter, the crystal selector switch, S_1, is used to choose the desired crystal. For crystal-controlled operation crystals would be plugged in pins 1 and 3 and 5 and 7 of socket X_1. Similar sockets (not shown in the diagram) are used to hold the other crystals. When v.f.o. operation is desired, the v.f.o. output is connected to J_1, the plug P_1 is inserted in socket X_1, and the former 6AG7 crystal oscillator stage becomes an amplifier or multiplier stage when switch S_1 is turned to position 1.

Since the output of the 6AG7 stage will vary considerably with the bands in use, an excitation control, R_1, is included to allow for proper adjustment of the drive to the 6DQ5 amplifier. The 6DQ5, a highly sensitive tube, is neutralized to avoid oscillation; the small variable capacitor C_2 and the 390-$\mu\mu$f. mica capacitor form the neutralizing circuit. Screen or screen and plate modulation power can be introduced at socket X_2; for radiotelegraph operation these connections are completed by P_2. Grid or plate current of the 6DQ5 can be read by proper positioning of S_5; the 0–15 milliammeter reads 0–15 ma. in the grid-current position and 0–300 ma. in the plate-current position.

The transmitter is keyed at J_3, and a key-click filter (100-ohm resistor and C_5) is included to give substantially click-free keying. The v.f.o. jack, J_4, allows a v.f.o. to be keyed along with the transmitter for full break-in operation.

Construction

A 10 × 17 × 3-inch aluminum chassis is used as the base of the transmitter, with a standard 8¾-inch aluminum relay rack panel held in place by the bushings of the pilot light, excitation control and other components common to the chassis and panel. The panel was cut down to 17 inches in length so that the unit would take a minimum of room on the operating table. A good idea of the relative location of the parts can be obtained from the photographs. The support for the r.f. portion housing is made by fastening strips of 1-inch aluminum angle stock (Reynolds aluminum, available in many hardware stores) to the panel and to a sheet of aluminum 9½ inches long that is held to the rear chassis apron by screws and the key jack, J_3. A piece of aluminum angle must also be cut to mount on the chassis and hold the cane-metal (Reynolds aluminum) housing. Fig. 6-45 shows the three clearance holes for the screws that hold this latter angle to the chassis after the cane metal is in place. Build the can-metal housing as though the holes weren't there and the box has to hold water; this will minimize electrical leakage and the chances for TVI. To insure good electrical contact between panel and angle stock, remove the paint where necessary by heavy applications of varnish remover, with the rest of the panel

Fig. 6-43 — This 75-watt crystal-controlled transmitter has provision for the addition of v.f.o. control. A 6AG7 oscillator drives a 6DQ5 amplifier on 80 through 15 meters.

As a precaution against electrical shock, the meter switch, to the immediate right of the meter, is protected by a cane-metal housing. The switch to the right of the meter switch handles the spot-operate function, and the switch at the far top right is the plate-circuit band switch.

Along the bottom, from left to right: pilot light, excitation control, crystal switch, grid circuit band switch, and grid circuit tuning.

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Figure 1960-4 — Front panel view of the 1960 *Handbook* transmitter project shown in Figure 1960-3. This tight design is fully enclosed and features front panel bandswitching.

Figure 1960-5 — This Collins Radio ad featuring their KWM-2 SSB transceiver was at the leading edge of Amateur Radio technology. The architecture closely followed that of the 75A-1 receiver shown in Figure 1950-10.

Figure 1960-6 — The Heath Company offered AM transmitters, such as their TX-1 Apache with an optional phasing type SSB exciter.

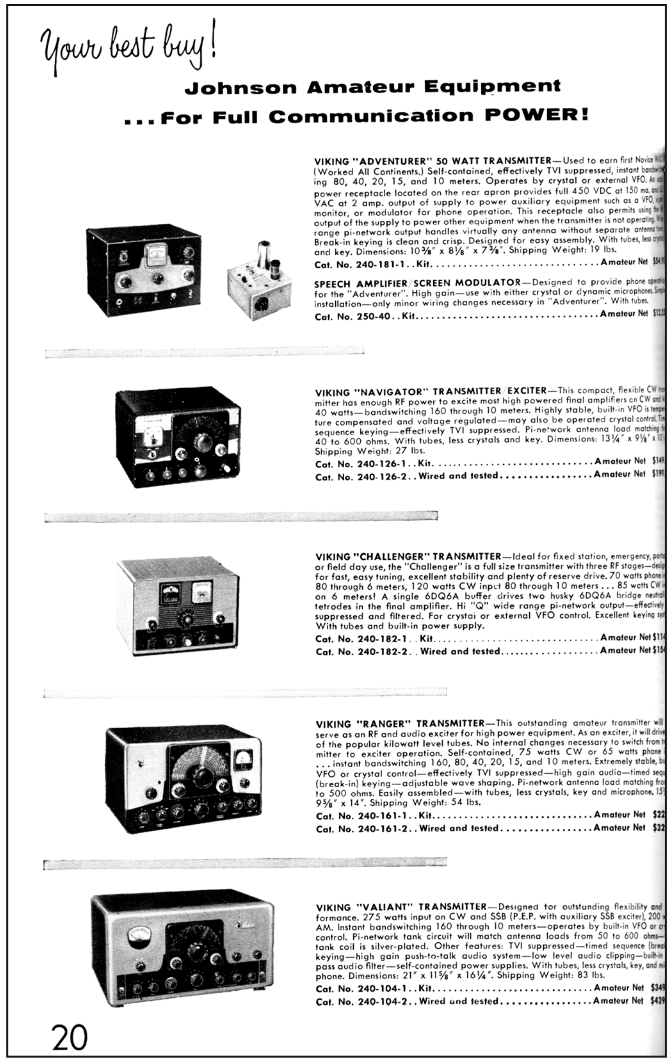


Figure 1960-7 — E. F. Johnson offered a wide range of high quality AM and CW transmitters, including an SSB adapter similar to the one provided by Heath.

Figure 1960-8 — Hallicrafters offered a modern heterodyning transmitter, the HT-32, along with an SSB oriented receiver, the SX-101, and the HT-33 high power linear amplifier.

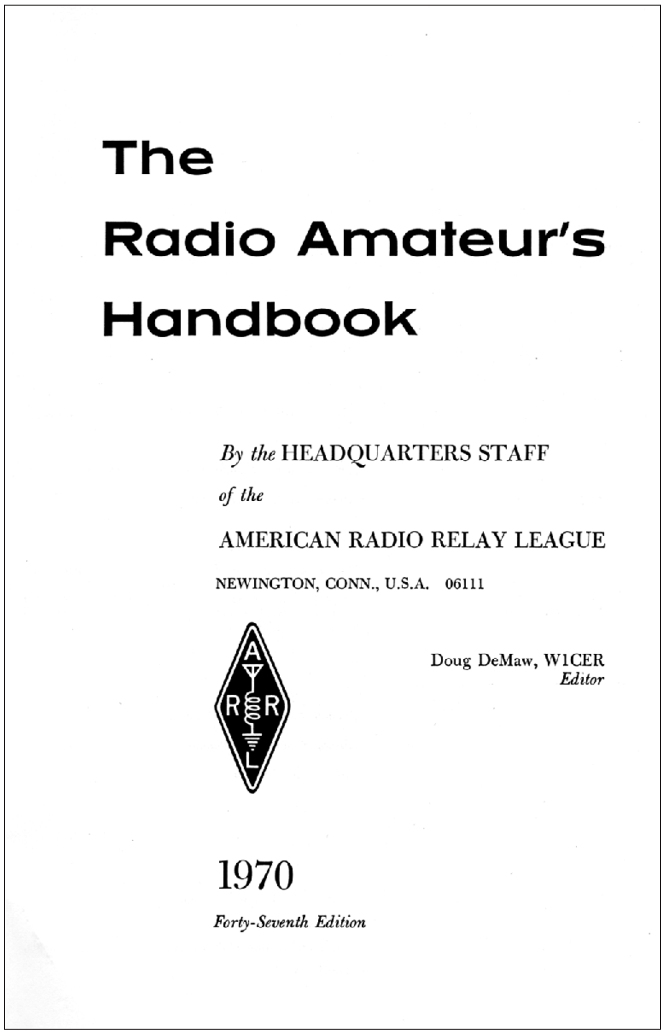
Figure 1960-9 — National Radio still offered the latest of the HRO series, the HRO-60 featuring double conversion, but they also would supply an amateur band only receiver designed for SSB. The new NC-300 was similar to the SX-101 from Hallicrafters.

Figure 1960-10 — The Vibroplex ad featured a new product — the Vibrokeyer, designed to be used with the newly popular electronic keyers.

The Decade of Solid State and the SSB Transceiver — The 1970 Edition

Between the 1960 and 1970 Handbooks (see Figure 1970-1), two major game changers went from being interesting technology to becoming mainstream Amateur Radio. The first was the acceptance of solid state devices as appropriate for most sections of radio equipment — although RF power stages would remain largely in the domain of vacuum tubes for some time. This trend can be seen in a solid state receiver project (see Figure 1970-2) and a hybrid (solid state except for the transmit driver and power amplifier stages) SSB transmitter (see Figure 1970-3). There were still tube projects galore, since many amateurs felt most comfortable with the earlier technology. The beginner transmitter shown in Figure 1970-4 could have appeared in much earlier editions.

The second advance was the emergence of single sideband telephony, and especially SSB transceivers, as the primary HF voice mode and equipment configuration. While SSB was introduced in a general way in past


The
Radio Amateur's
Handbook

By the HEADQUARTERS STAFF
of the
AMERICAN RADIO RELAY LEAGUE
NEWINGTON, CONN., U.S.A. 06111

Doug DeMaw, W1CER
Editor

1970
Forty-Seventh Edition

Figure 1970-1 — The front matter on the 1970 *Handbook* had a more modern look than in the past.

decades, it was the emergence of the one box transceiver as shown previously in Figure 1960-5, that made the big difference. During this decade, the benefits of a transceiver, not only for SSB, but for CW as well, became apparent. Companies such as Collins Radio (see Figure 1970-5), the Heath Company (see Figure 1970-6), R.L. Drake (see Figure 1970-7) and others provided their versions of both transceivers and separate transmitters and receivers that could be locked together as if they were transceivers.

Not everything changed. The Vibroplex ad (Figure 1970-8) maintained its consistency over yet another decade. In recognition of the amount of operating, in contrast to technical information available, or needed by operators, *The Radio Amateur's Operating Manual* (see Figure 1970-9) was introduced in 1966 as something of a spinoff from the *Handbook*.

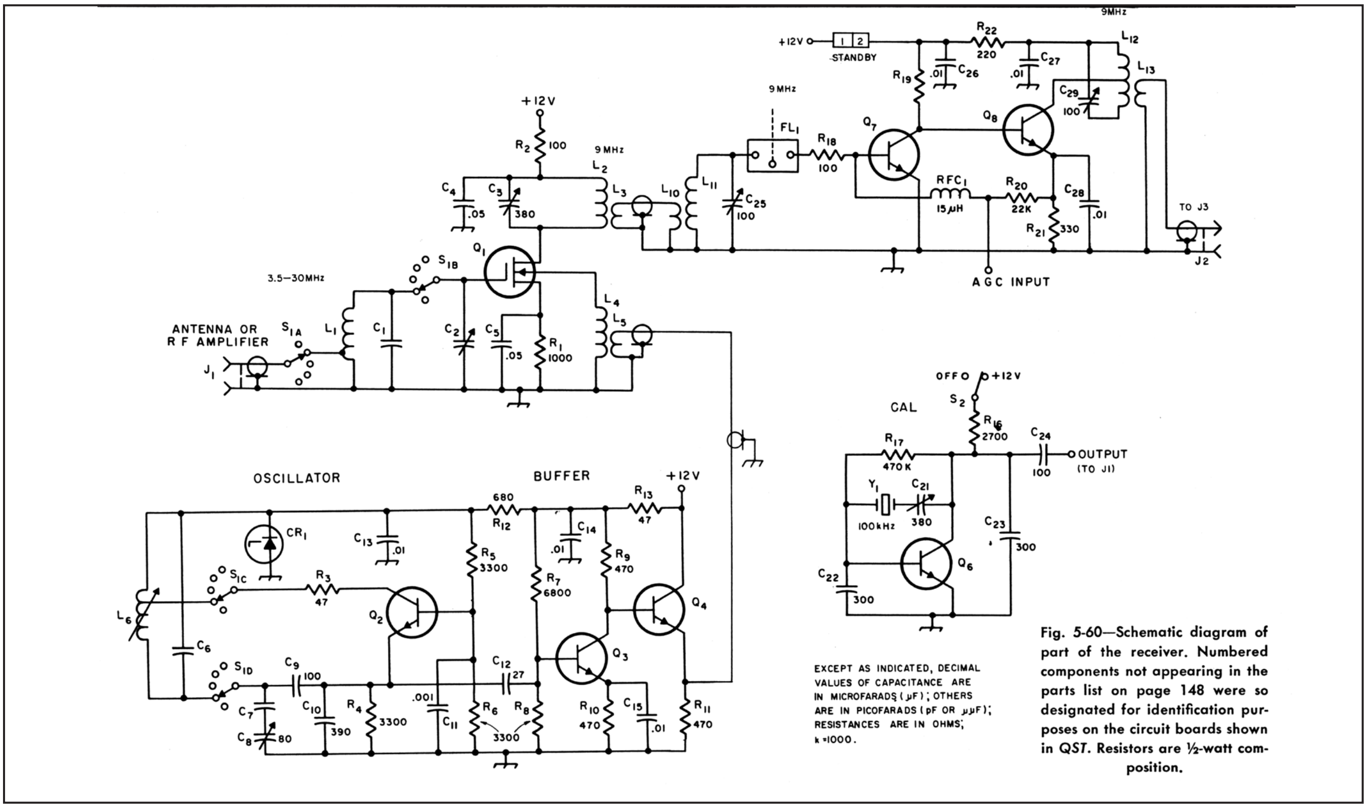


Fig. 5-60—Schematic diagram of part of the receiver. Numbered components not appearing in the parts list on page 148 were so designated for identification purposes on the circuit boards shown in *QST*. Resistors are ½-watt composition.

Figure 1970-2 — This 1970 *Handbook* receiver project is entirely solid state.

A 175-WATT MECHANICAL-FILTER EXCITER

This 3.5 to 4.0-MHz. s.s.b./c.w. transmitter can be used by itself, or it can be used to drive any of the amplifiers described in Chapter 6. It will drive most commercially-built amplifiers also. The power output from this unit, while maintaining an acceptable IMD level (intermodulation distortion) is 100 watts, p.e.p.

Block diagrams have been added to each schematic illustration to help the reader understand how the circuit operates. The power supply, "A 650-Volt General-Purpose Supply," is shown in Chapter 12. Information on building the modular solid-state v.f.o. is given in Chapter 5 ("A General-Purpose V.F.O."). This transmitter was designed to be used with these two units.

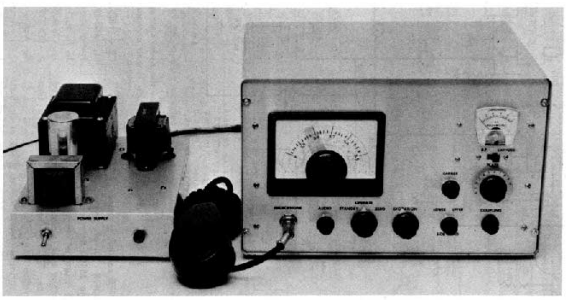
This exciter has effective a.l.c., which helps to maintain a high average talk-power level. Grid-block keying is used for c.w. The keying is shaped to provide a clean, clickless note. If low-power a.m. operation is desired, carrier can be inserted for this purpose. The power input to the p.a. must be limited to approximately 25 watts if this is done, and the output signal will be *single-sideband* a.m.

Circuit Information

In the circuit of Fig. 9-31, output from a hi-impedance microphone is amplified by V_1 and fed to a twin-triode balanced-modulator, V_2. The 455-kHz. carrier is generated by V_{3A} and routed to V_2. The double-sideband suppressed-carrier a.m. signal from V_2 is next passed through FL_1 where it becomes a s.s.b. suppressed-carrier signal; the sideband (upper or lower) depends upon the crystal selected at V_{3A}. Output from FL_1 is amplified by V_4, whose actual gain at a given instant is dependent upon the level of the minus-polarity a.l.c. voltage supplied to its grid; the lower the a.l.c. voltage, the higher will be the gain of V_4. V_{3B} is used as a cathode-follower to supply carrier (455 kHz.) to V_5 for tuneup, c.w., or a.m. operation, thus bypassing the mechanical filter and balanced-modulator with some of the signal. The carrier-insertion level is controlled by R_3. S_2, a part of R_3, opens that branch of the circuit during s.s.b. operation to minimize carrier leak-through from V_{3B} to V_5.

A transistorized v.f.o. is used to beat a 3045 to 3545-kHz. signal against the 455-kHz. s.s.b. signal at V_5. The *sum* frequency from the mixer provides the desired 3.5 to 4.0-MHz. transmitter output frequency. Output from the v.f.o. is filtered by L_4, L_5, and their related network capacitors. The filtering keeps spurious output from the v.f.o. from reaching the balanced mixer and generating unwanted frequencies. A vacuum-tube buffer stage, V_8, is used between the v.f.o. and V_5 to reduce "pulling" and to transform the v.f.o.'s low output impedance to a higher impedance for feeding the grid of the balanced mixer. L_6 is broadbanded (no parallel capacitor) to assure fairly constant mixer injection across the entire tuning range of the v.f.o.

The mixer tuned circuit, L_1-C_{2A}, is connected to the grid of the driver stage, V_6. The plate cir-



The exciter is housed in a home-made cabinet. Several commercial cabinets are available to the builder, many of which are similar in size and style to this one. An LMB type W-2J would be a good choice, and could be ventilated. Black decals are used for identifying the controls on the satin-finish aluminum panel. The panel was soaked in a lye bath to get the dull finish, then sprayed with clear lacquer.

Figure 1970-3 — The 1970 *Handbook* featured this compact 75 meter, 175 W SSB exciter/transmitter. This was a "hybrid " design, similar to some commercial equipment of the day — transistors were used in low level stages, while tubes remained in the transmitter power driver and output sections.

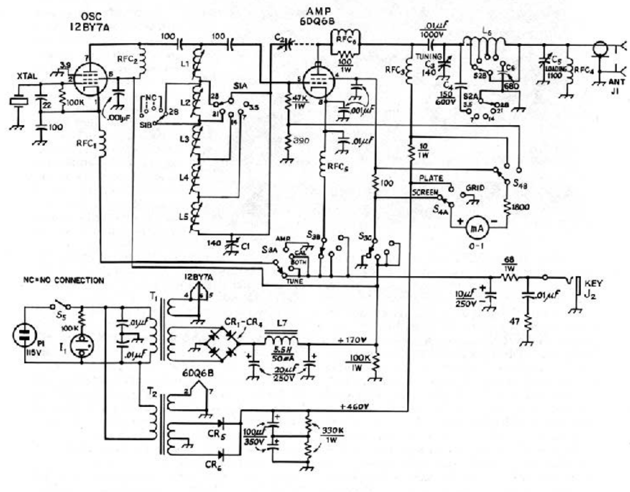


Fig. 6-42—Circuit diagram of the five-band 50 watter. Unless indicated otherwise, capacitances are in pf. and resistances are in ohms, ½-watt. Capacitors marked with polarity are electrolytic; capacitors with decimal value of µf. are disc ceramic.

C_1—140-pf. variable (Hammarlund APC-140).
C_2—One-inch wide aluminum strip. See Fig. 6-43.
C_3—140-pf. variable (Hammarlund) HFA-140-A).
C_4—150-pf. zero-temp.-coefficient (Centralab type TCZ).
C_5—1100-pf. variable. 3-section, 365 pf. per section, stator sections connected in parallel, trimmers removed (Allied Radio 43A3522).
C_6—680 pf., 500 volts, dipped mica.
CR_1-CR_4—400 p.i.v. 750-ma. silicon diode.
CR_5, CR_6—1000 p.i.v. 400-ma. silicon diode (1N3563).
I_1—Neon indicator (Drake R-117-603).
J_1—Coaxial receptacle SO-239.
J_2—Open-circuit phone jack.
L_1—.68–1.25 µh. adjustable (Miller 21A106RBI).
L_2—.68–1.25 µh. adjustable (Miller 21A106RBI).
L_3—1.35-2.75 µh. adjustable (Miller 21A226RBI).
L_4—9.4-15.0 µh. adjustable (Miller 21A155RBI).
L_5—27.5-58 µh. adjustable (Miller 21A475RBI).
L_6—31½ turns No. 16, 8 t.p.i., 1¼ inch diameter (B&W 3018) tapped from C_3 end: 2¾, 6¾, 10¾, 22¾ turns.
L_7—5.5-henry 50-ma. choke (Allied Radio 54A2135).
M_1—0-1 milliammeter (Lafayette 99G5040).
P_1—Fused plug, 1½-amp. fuses.
RFC_1-RFC_5—1-mh. 125-ma. r.f. choke (Miller 4662).
RFC_6—7 turns No. 18 space-wound on 100-ohm 1-watt composition resistor.
S_1—2-pole 6-position (5 used) rotary switch (Mallory 3226J).
S_2—2-pole 6-position (4 used) rotary switch (Centralab PA-2003).
S_3—3-pole 4-position rotary switch (Mallory 3234J).
S_4—2-pole 6-position (1, 3, 5, used) rotary switch (Mallory 3226J).
S_5—S.p.s.t. toggle.
T_1—125-volt 50-ma., 6.3-volt 2-amp. transformer (Knight 54A1411).
T_2—700 v.c.t. 90-ma., 6.3-volt 3.5-amp. transformer (Knight 54A1429).
(Knight products handled by Allied Radio, Chicago.)

Figure 1970-4 — Not all projects were modernized — this beginner transmitter looks a lot like Novice transmitters from previous decades.

Figure 1970-5 — Collins Radio's 1970 ad features a full complement of gear built in the image of its successful KWM-2 showcased in Figure 1960-5.

Figure 1970-6 — The Heath Company took hold of the Collins idea and offered kits to build similar looking compact SSB gear.

Figure 1970-7 — The R. L. Drake Company, a relative newcomer to the scene, offered a line of similar and highly regarded transceivers and separate units.

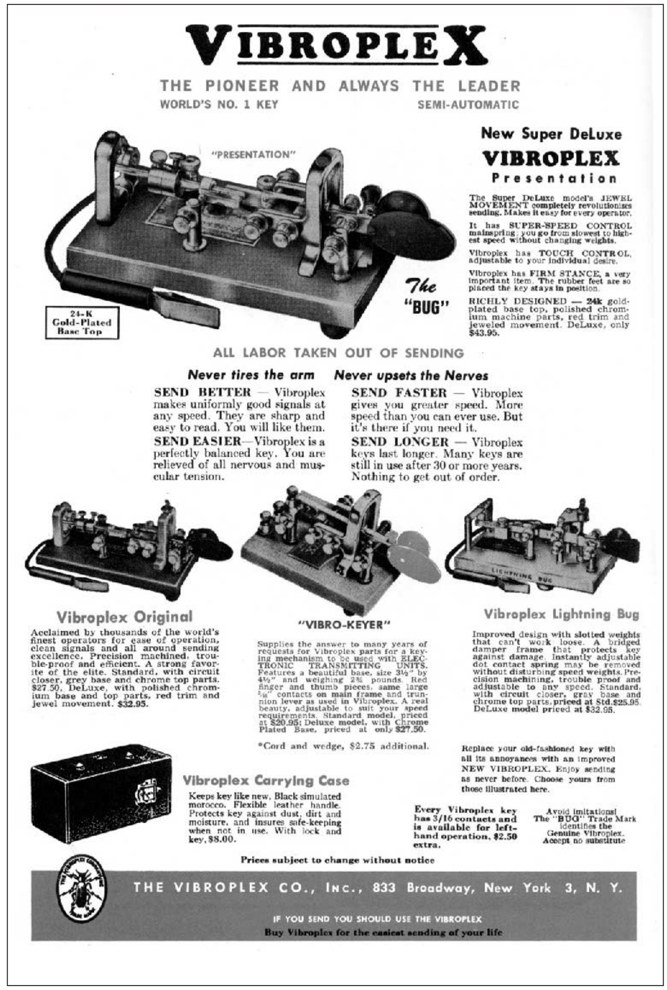


Figure 1970-8 — Vibroplex continued to produce their fine line of semi-automatic keys and paddles.

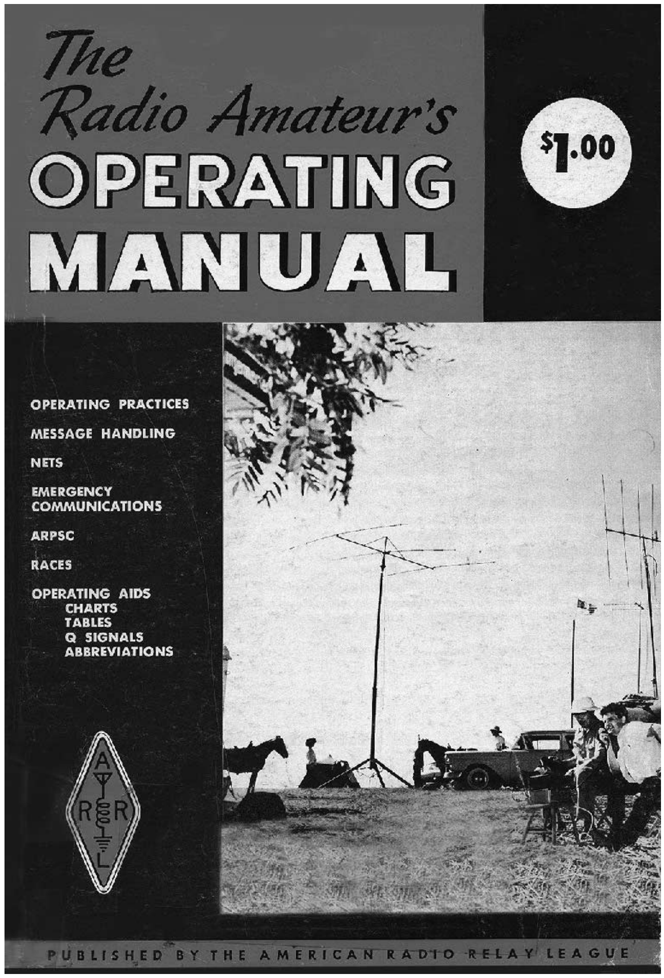


Figure 1970-9 — *The Radio Amateur's Operating Manual* was introduced in 1966.

FM Becomes the Mode on VHF — The 1980 Edition

The decade leading toward the 1980 *Handbook* saw a structural change — there was no longer an advertising section at the rear! Readers would need to look through the pages of *QST* to keep up with the advance of "Bug" technology from Vibroplex. The cover page (see Figure 1980-1) continued with an updated look.

During the decade between the 1970 and 1980 *Handbooks*, there were continued advancements in the application of solid state to mainstream projects as shown in a high performance miniature solid state receiver (see Figures 1980-2 and -3) and an all solid state transmitter (see Figure 1980-4). While low power transmitters were headed toward solid state, a lack of available devices for typical HF power levels (100 W and higher) would keep vacuum tubes in the picture for a while longer.

One big change in the decade was the emergence of FM as the mode of choice for local voice communications. The genesis of this resulted from a change in bandwidth requirements for commercial and government public service VHF users that resulted in a large amount of surplus equipment becoming available. By the 1970s, this equipment had been supplemented by equipment designed especially for amateurs, generally providing more channel choices than in the modified commercial gear. This was all accompanied by a new "FM and Repeaters" section in the *Handbooks* of the period.

The Radio Amateur's Handbook

By the HEADQUARTERS STAFF
of the
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1980
Fifty-Seventh Edition

Figure 1980-1 — The front matter in the 1980 *Handbook* had a more modern look than in the past.

Fig. 58 — Photograph of the miniature 5-band superheterodyne receiver. This layout arrangement was developed by WAØUZO of Circuit Board Specialists.

part of the tuned circuit at 50Ω and is a center-tapped broadband transformer.

Mixer and Filter

Two 40673 or 3N211 MOSFETs are used as a singly balanced active mixer (Q1 and Q2). Local-oscillator injection is applied to the paralleled gates no. 2 of Q1 and Q2. Output from the mixer is by means of T2, a broadband trifilar-wound pot-core transformer. A 10-kΩ resistor is bridged across the mixer drains to limit the signal swing — an aid to mixer IMD. FL2 filters the LO voltage to keep harmonic energy to the mixer at a low level. The 68-pF capacitor between FL2 and the mixer gates can be changed in value to obtain the 3-volt pk-pk LO voltage which is specified.

An MPF102 or 2N4416 JFET is used as a post-mixer amplifier (Q3). The drain load resistor is chosen to match the filter impedance. A 2-kΩ value is specified for use with the Collins F455FD-04 filter at FL1. If a different filter is used, such as anssb type, the drain load resistor may have to be changed to match the impedance of the filter. Also, the end resonating capacitors at FL1 may need to be a different value (see manufacturer's data sheets).

I-F Amplifier

A two-stage CA3028A i-f amplifier is used following the i-f filter, FL1. Series regulation is applied to the operating voltage of this circuit in order to provide 9.1 volts. Automated gain control is developed by the agc strip and supplied to pin 4 of the CA3028As through Q7. Maximum gain occurs when the agc voltage is +9. Minimum gain is at the +2-volt agc level.

Product Detector and Audio Channel

A singly balanced product detector is fed from the low-Z secondary winding of T4. BFO injection is supplied by Q5, which is shown with a 454.3-kHz crystal for use with the Collins cw filter specified for FL1. If a Collins ssb i-f filter is used at FL1, the BFO crystal will have to be of a frequency that falls 20 dB down on the filter curve, upper or lower sideband. The manufacturer specifies which frequencies are correct for the filter being used. For upper and lower sideband operation it will be necessary to use two BFO crystals. Thus, a selector switch will be needed between the gate of Q5 and the two crystals.

RC filtering is used at the output of the product detector to keep the BFO and i-f leakage from reaching the audio preamplifier, Q4. Any JFET will suffice at Q4, such as a 2N4416.

Q17 functions as an audio muting switch during transmit. It is actuated via J2 by grounding the Q17 base line through an external set of relay contacts or bipolar-transistor dc switch.

U4 amplifies the audio to speaker level. LC filtering is used at the output of U4 to suppress unwanted hf oscillations which could interfere with overall receiver performance (spurious responses). The MC1306P IC is designed for low-voltage operation. Therefore, the 3-terminal regulator, U5, has been included in the circuit.

AGC System

Audio-derived agc is used in this receiver. Output is sampled from the product detector, then amplified by means of U3. D3 and D4 rectify the amplified audio and drive a cascaded dc amplifier consisting of Q6 and Q7. The agc time constant is set by a 1-μF capacitor in parallel with a 1M-Ω resistor. The time constant can be varied to suit the operator by changing the value of the charging capacitor in that network. Values of less than 1 μF will shorten the discharge time and vice versa. D5 serves as a gating diode to prevent loss of the agc drive voltage through the i-f gain control, R3.

The agc strip drives the S meter, M1, through Q7. Agc voltage for U1 and U2 is obtained at the emitter of Q7. R2 should be set so that maximum receiver input signal provides +9 volts at pin 4 or U1 and U2.

Local Oscillator

Q13 operates as a highly stable series-tuned Colpitts oscillator. Polystyrene fixed-value capacitors are used to ensure stability and offer drift compensation which corrects for the positive drift of the core material in L12. Silver-mica capacitors can be substituted with a possible degradation in long-term stability. C2 is the main-tuning capacitor. C4 is optional. If it is used it should be panel-mounted to permit dial calibration from band to band. This will be necessary because the converter crystals may not be precisely on the specified frequencies.

Q14 serves as a source-follower buffer stage. The signal level is built up by means of Q15, a Class A broadband amplifier. Sufficient LO output is available at 50Ω to swing the no. 2 gates of the balanced mixer to 3 volts pk-pk. The added power developed by Q15 is necessary to provide the required injection voltage across the 50-Ω load presented by harmonic filter FL2. A 40673 can be used in place of the 3N211 specified at Q13. Similarly, a 2N4416 will be satisfactory at Q14.

Front-End Converters

The same circuit-board pattern is used for the 40, 20 and 15 meter converters. In order to obtain a 200-kHz bandwidth on 80 meters, FL3 is used. Also, no rf amplifier stage is necessary on 80 meters. Therefore, the pc-board pattern is different from that for the other hf bands.

The converters of Fig. 60 are designed for a broadband i-f output of 1.8 to 2.0 MHz. They are selected for the desired operating band by means of S1. When this switch is placed in the 160-meter position the converters are bypassed to permit routing the antenna directly to the mixer of the main frame for reception on 160 meters.

Q8 performs as a low-gain, common-gate rf amplifier. The source tuned circuit is peaked for the center of the band segment of interest. It is broad enough in response to require no additional tuning.

Receiving Systems 8-36

Figure 1980-2 — This 1980 *Handbook* miniature receiver project is entirely solid state, but also incorporates features designed to limit IMD and improve dynamic range — issues with some early solid state receivers.

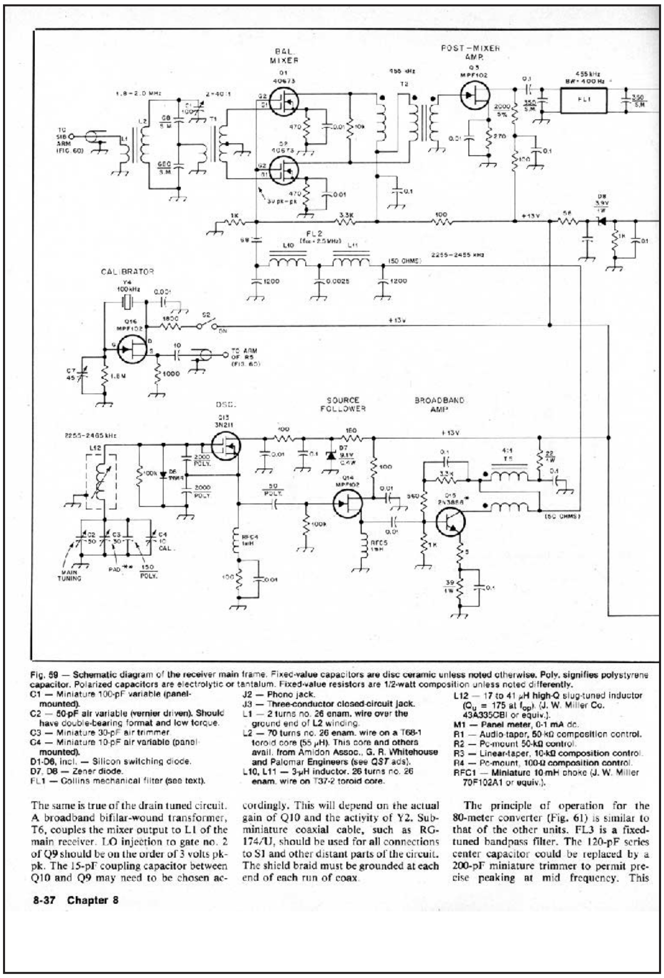


Fig. 59 — Schematic diagram of the receiver main frame. Fixed-value capacitors are disc ceramic unless noted otherwise. Poly. signifies polystyrene capacitor. Polarized capacitors are electrolytic or tantalum. Fixed-value resistors are 1/2-watt composition unless noted differently.

C1 — Miniature 100-pF variable (panel-mounted).
C2 — 50-pF air variable (vernier driven). Should have double-bearing format and low torque.
C3 — Miniature 30-pF air trimmer.
C4 — Miniature 10-pF air variable (panel-mounted).
D1-D6, incl. — Silicon switching diode.
D7, D8 — Zener diode.
FL1 — Collins mechanical filter (see text).
J2 — Phono jack.
J3 — Three-conductor closed-circuit jack.
L1 — 2 turns no. 26 enam. wire over the ground end of L2 winding.
L2 — 70 turns no. 26 enam. wire on a T68-1 toroid core (55 μH). This core and others avail. from Amidon Assoc., G. R. Whitehouse and Palomar Engineers (see *QST* ads).
L10, L11 — 3-μH inductor. 26 turns no. 26 enam. wire on T37-2 toroid core.
L12 — 17 to 41 μH high-Q slug-tuned inductor (Q_u = 175 at f_{op}). (J. W. Miller Co. 43A335CBI or equiv.).
M1 — Panel meter, 0-1 mA dc.
R1 — Audio-taper, 50-kΩ composition control.
R2 — Pc-mount 50-kΩ control.
R3 — Linear-taper, 10-kΩ composition control.
R4 — Pc-mount, 100-Ω composition control.
RFC1 — Miniature 10-mH choke (J. W. Miller 70F102A1 or equiv.).

The same is true of the drain tuned circuit. A broadband bifilar-wound transformer, T6, couples the mixer output to L1 of the main receiver. LO injection to gate no. 2 of Q9 should be on the order of 3 volts pk-pk. The 15-pF coupling capacitor between Q10 and Q9 may need to be chosen accordingly. This will depend on the actual gain of Q10 and the activity of Y2. Subminiature coaxial cable, such as RG-174/U, should be used for all connections to S1 and other distant parts of the circuit. The shield braid must be grounded at each end of each run of coax.

The principle of operation for the 80-meter converter (Fig. 61) is similar to that of the other units. FL3 is a fixed-tuned bandpass filter. The 120-pF series center capacitor could be replaced by a 200-pF miniature trimmer to permit precise peaking at mid frequency. This

8-37 Chapter 8

Figure 1980-3 — The schematic of part of the receiver of Figure 1980-2 shows the modern mixer and IF post mixer amplifier.

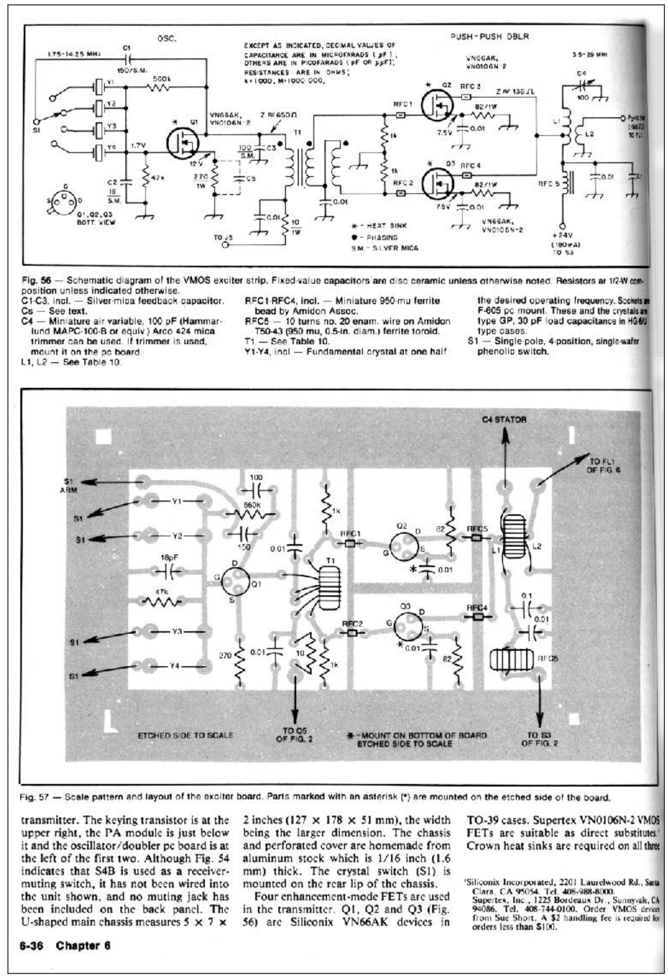


Fig. 56 — Schematic diagram of the VMOS exciter strip. Fixed-value capacitors are disc ceramic unless otherwise noted. Resistors ar 1/2-W composition unless indicated otherwise.

C1-C3, incl. — Silver-mica feedback capacitor.
Cs — See text.
C4 — Miniature air variable, 100 pF (Hammarlund MAPC-100-B or equiv.) Arco 424 mica trimmer can be used. If trimmer is used, mount it on the pc board.
L1, L2 — See Table 10.
RFC1-RFC4, incl. — Miniature 950-mu ferrite bead by Amidon Assoc.
RFC5 — 10 turns no. 20 enam. wire on Amidon T50-43 (950 mu, 0.5-in. diam.) ferrite toroid.
T1 — See Table 10.
Y1-Y4, incl — Fundamental crystal at one half the desired operating frequency. Sockets are F-605 pc mount. These and the crystals are type GP, 30 pF load capacitance in HG6/U type cases.
S1 — Single-pole, 4-position, single-wafer phenolic switch.

Fig. 57 — Scale pattern and layout of the exciter board. Parts marked with an asterisk (*) are mounted on the etched side of the board.

transmitter. The keying transistor is at the upper right, the PA module is just below it and the oscillator/doubler pc board is at the left of the first two. Although Fig. 54 indicates that S4B is used as a receiver-muting switch, it has not been wired into the unit shown, and no muting jack has been included on the back panel. The U-shaped main chassis measures 5 × 7 × 2 inches (127 × 178 × 51 mm), the width being the larger dimension. The chassis and perforated cover are homemade from aluminum stock which is 1/16 inch (1.6 mm) thick. The crystal switch (S1) is mounted on the rear lip of the chassis.

Four enhancement-mode FETs are used in the transmitter. Q1, Q2 and Q3 (Fig. 56) are Siliconix VN66AK devices in TO-39 cases. Supertex VN0106N-2 VMOS FETs are suitable as direct substitutes.[1] Crown heat sinks are required on all three

[1]Siliconix Incorporated, 2201 Laurelwood Rd., Santa Clara, CA 95054. Tel. 408-988-8000. Supertex, Inc., 1225 Bordeaux Dr., Sunnyvale, CA 94086. Tel. 408-744-0100. Order VMOS devices from Sue Short. A $2 handling fee is required for orders less than $100.

6-36 Chapter 6

Figure 1980-4 — This MOSFET transmitter puts out 0.5 W. While low power transmitters have moved to solid state, the typical 100 W HF transceiver still uses tubes in its final stages.

We Embrace Computers and Space Communications — The 1990 Edition

During the 1980s, the *Handbook* quietly assumed a subtly different name. Instead of the longstanding title *The Radio Amateur's Handbook*, it was now *The ARRL Handbook for the Radio Amateur*. It also increased dramatically in page count and number of chapters and took on a different cover appearance, as shown in Figures 1990-1 and 1990-2.

The 1980s saw the beginning of the popularity of personal computers throughout the developed world. Amateur Radio was quick to embrace the new technology — first in off-line applications such as log keeping and contest scoring — then in radio system control and finally in signal processing in various forms.

Projects now added large numbers of integrated circuits to the mix, as well as digital logic and their families of integrated circuits.

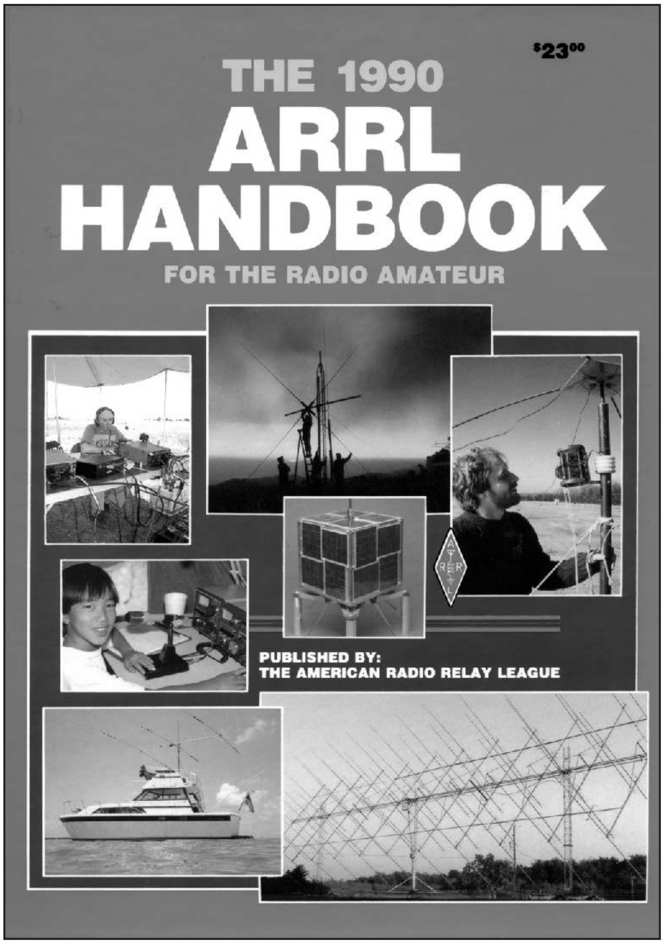
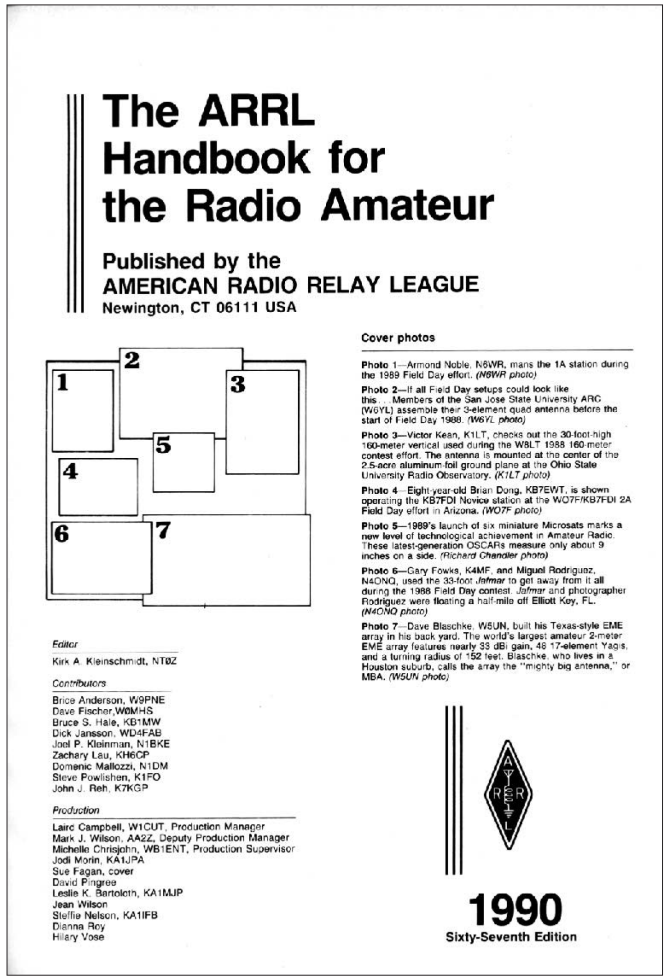


Figure 1990-1 — The cover of the 1990 *Handbook* has a completely different look than in the past. In addition, during the past decade, the size changed to approximately 8½ × 11 and the title has been slightly revised.



The ARRL Handbook for the Radio Amateur

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Newington, CT 06111 USA

Cover photos

Photo 1—Armond Noble, N6WR, mans the 1A station during the 1989 Field Day effort. *(N6WR photo)*

Photo 2—If all Field Day setups could look like this. . .Members of the San Jose State University ARC (W6YL) assemble their 3-element quad antenna before the start of Field Day 1988. *(W6YL photo)*

Photo 3—Victor Kean, K1LT, checks out the 30-foot-high 160-meter vertical used during the W8LT 1988 160-meter contest effort. The antenna is mounted at the center of the 2.5-acre aluminum-foil ground plane at the Ohio State University Radio Observatory. *(K1LT photo)*

Photo 4—Eight-year-old Brian Dong, KB7EWT, is shown operating the KB7FDI Novice station at the WO7F/KB7FDI 2A Field Day effort in Arizona. *(WO7F photo)*

Photo 5—1989's launch of six miniature Microsats marks a new level of technological achievement in Amateur Radio. These latest-generation OSCARs measure only about 9 inches on a side. *(Richard Chandler photo)*

Photo 6—Gary Fowks, K4MF, and Miguel Rodriguez, N4ONQ, used the 33-foot *Jafmar* to get away from it all during the 1988 Field Day contest. *Jafmar* and photographer Rodriguez were floating a half-mile off Elliott Key, FL. *(N4ONQ photo)*

Photo 7—Dave Blaschke, W5UN, built his Texas-style EME array in his back yard. The world's largest amateur 2-meter EME array features nearly 33 dBi gain, 48 17-element Yagis, and a turning radius of 152 feet. Blaschke, who lives in a Houston suburb, calls the array the "mighty big antenna," or MBA. *(W5UN photo)*

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1990
Sixty-Seventh Edition

Figure 1990-2 — The 1990 cover has so much going on that it takes a navigation screen inside to keep track of it all.

The End of a Century — The 2000 Edition

During the 1990s, the *Handbook* continued the successful cover appearance, as shown in Figures 2000-1 and 2000-2.

The 1990s saw the expansion of the applications of integrated circuits. PC boards were being designed and produced using computer software and Amateur Radio was quick to embrace and integrate the technology of the ubiquitous Internet. The *Handbook* was becoming as much a reference book for electronic and radio engineering theory, as well as a source for projects, usually with much more design information than in previous generations.

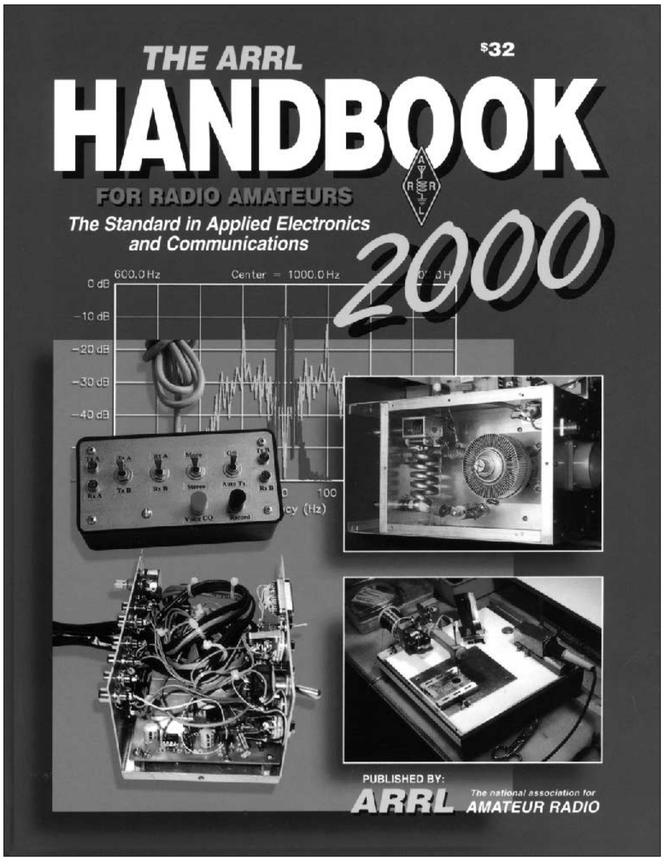
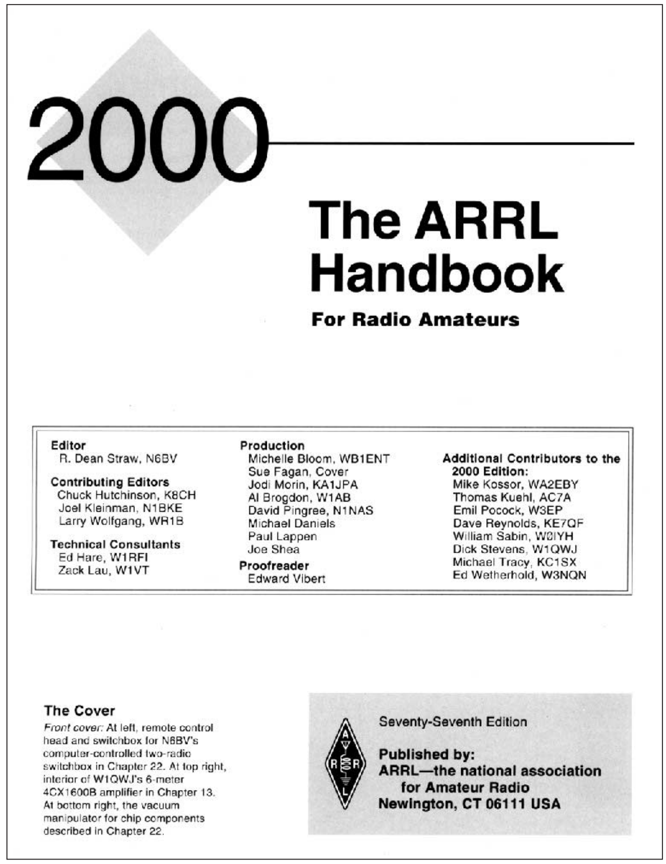


Figure 2000-1 — The cover of the 2000 *Handbook* builds on the look over the past decade.



2000

The ARRL Handbook

For Radio Amateurs

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The Cover
Front cover: At left, remote control head and switchbox for N6BV's computer-controlled two-radio switchbox in Chapter 22. At top right, interior of W1QWJ's 6-meter 4CX1600B amplifier in Chapter 13. At bottom right, the vacuum manipulator for chip components described in Chapter 22.

Seventy-Seventh Edition

Published by:
ARRL—the national association for Amateur Radio
Newington, CT 06111 USA

Figure 2000-2 — The 2000 cover can be described in a short paragraph — perhaps an improvement over 1990.

The Beginning of the Current Century — The 2010 Edition

During the 2000s, the *Handbook* continued the successful cover appearance, as shown in Figures 2010-1 and 2010-2. Note the subtle shift to a new name, now it is *The ARRL Handbook for Radio Communications*. This is perhaps in recognition of the fact we've known for a long time — the *Handbook* is not just for hams. Visit the office of a radio or telecommunications engineer and it's an even bet that a copy of the *Handbook* will be found on a bookshelf there. This is as true today as it was when I started my career as a radar engineer in 1969!

The 1990s saw the expansion of the applications of integrated circuits. PC boards were being designed and produced using computer software and Amateur Radio was quick to embrace and integrate the technology of the ubiquitous Internet.

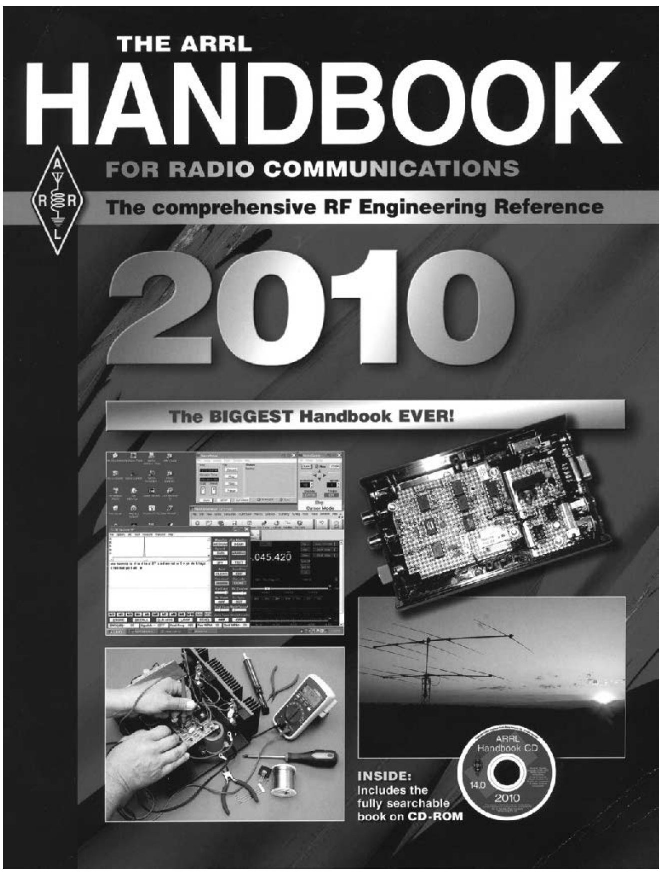
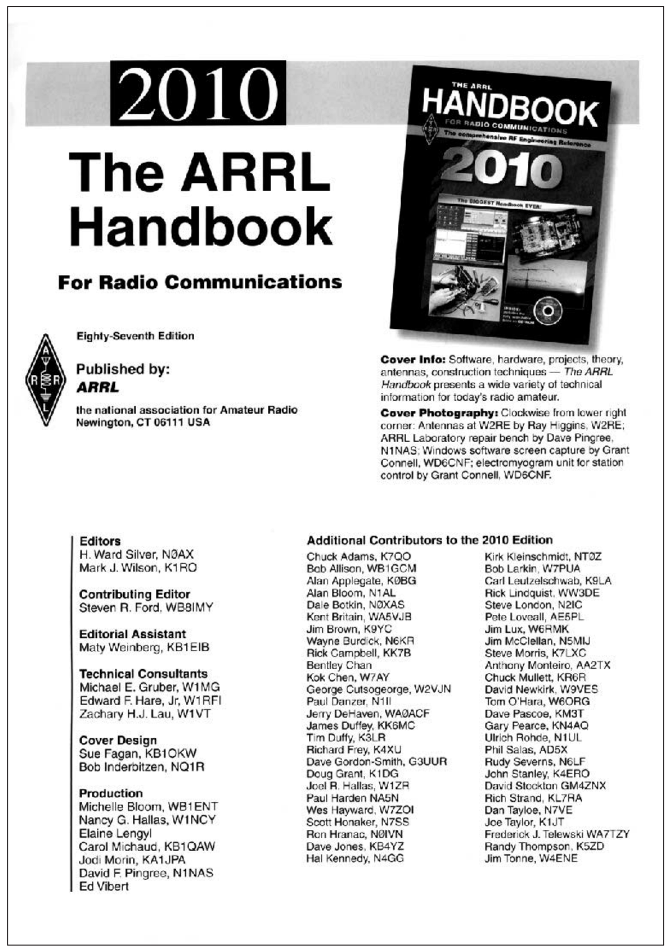


Figure 2010-1 — The cover of the 2010 *Handbook* builds on the look over the past decade. Note the change to a more general title — the *Handbook* isn't just for hams anymore — of course it never was.



2010

The ARRL Handbook

For Radio Communications

Eighty-Seventh Edition

Published by:
ARRL
the national association for Amateur Radio
Newington, CT 06111 USA

Cover Info: Software, hardware, projects, theory, antennas, construction techniques — *The ARRL Handbook* presents a wide variety of technical information for today's radio amateur.

Cover Photography: Clockwise from lower right corner: Antennas at W2RE by Ray Higgins, W2RE; ARRL Laboratory repair bench by Dave Pingree, N1NAS; Windows software screen capture by Grant Connell, WD6CNF; electromyogram unit for station control by Grant Connell, WD6CNF.

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Figure 2010-2 — Look at the list of contributors to the 2010 edition — quite a difference from the single name on the inside of the 1926 edition! This major new edition featured lot of material by a lot of contributors — W1ZR is even on the list!