

FULL-SIZE BLUE PRINTS SUPPLEMENT

RADIO NEWS

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OCT 25 1938

Short-Wave Manual

BY EMINENT SHORT-WAVE EXPERTS



PRICE 50¢

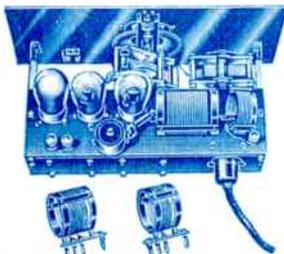
THE LATEST DEVELOPMENTS IN SHORT-WAVE RECEIVERS AND HOW TO CONSTRUCT SAME

Aero Short Wave Receivers

AERO PRODUCTS

The Aero Kits for the receivers shown on this page are supplied in a new and unique form. The subpanel has all the parts which normally mount on it already mounted and wired, so that when the builder is ready to complete the receiver, all that is necessary is to mount the condensers, dial, rheostat and volume control on the front panel and connect seven wires which are left as loose ends from the base panel. Nothing whatever is required to assemble this set except a screw driver and a soldering iron, as all connections are complete and the wires are all attached.

Aero Short Wave Transmitters



International Short Wave Receiver

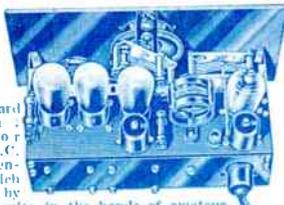
This is the first receiver designed exclusively for short wave broadcast reception. Broadcast programs on short waves are remarkably clear and free from static. You can receive them on the Aero International

There is only one tuning control and the set is extremely easy to operate. The complete kit includes everything necessary to put the set together without spending another cent. Full size pictorial wiring diagram make assembly easy.
List Price, Kit No. 8.....\$55.30

Aero International S.W. Converter

The Aero "International" Converter for D.C. receivers embodies one stage of radio frequency amplification utilizing a shield grid tube and a regenerative detector. Only one tuning control, one volume control, and a filament rheostat. A wonderful little unit, only 7 in. x 10 in. x 6 in., which will give your broadcast set a range of thousands of miles. Kit is complete. Nothing more need be purchased.
List Price Aero Kit No. 9.....\$38.90

Standard Short Wave Receiver



The Aero Standard Three-tube Short Wave Receiver for either A.C. or D.C. tubes utilizes a regenerative circuit which has been proven by years of excellent results in the hands of amateur operators. The same special audio amplifier is supplied as is used in the Aero "Chronophone" and other high grade broadcast receivers, so that excellent quality can be assured when receiving far-distant stations. Kit is complete with nothing else to purchase.
List Price, Kit No. 10 or 11.....\$49.95

Standard Short Wave Converter

You can receive short wave programs on your present broadcast receiver by merely plugging the Aero International Short Wave Converter into the detector socket. It will add thousands of miles to the range of your receiver. Kit is complete and pictorial diagrams make wiring easy.
List Price, Kit No. 12 or 14.....\$32.00



Aero 1929 New Coils Kit LWT. 13 \$12.50

The new bands are narrower - To cut QRM now, only the most selective receivers can be used. Selectivity and low losses in the tuning circuits are synonymous. Almost every condenser has negligible losses, but where can you find even an approach to the low losses of Aerocoils?

In keeping with past performance, the adoption of the new bands finds Aero Products ready with new coil kits. The same low loss construction, with consequent selectivity even more important than ever before, is still adopted, but the new coils spread the new bands over the major portion of the dial while still leaving sufficient space on each end to assure against lap over. Designed especially for the new amateur bands, they are the most efficient coils which can be used. A new and better sound primary is also provided, and the same base, with the isolated grid terminal, is employed.
Amateur Special Kit No. LWT 13 covering new 20, 10 and 80 meter bands with .00003 condenser. *Including plug-in base with new design of adjustable space-wound primary. List price.....\$12.50
Additional Coil INT-A0 range 8.2 to 12.5 meters.....\$4.00

BROKEN KIT PRICES

- Coil No. INT-A1—range 19.1 to 27.3 meters.....\$4.00
- Coil No. INT-A2—range 31.1 to 38.6 meters.....\$4.00
- Coil No. INT-A3—range 41.6 to 50.2 meters.....\$4.00
- Plug-in Base—with new space-wound primary. Type LWT 100-P.....\$3.00
- * Aero AE 912 Variable Condenser, .00003, each.....\$1.50

International Short Wave Coils Type LWT-12



Newest style, small diameter inductances. Have restricted fields, tune very sharp. Consist of space wound coils supported by bakelite frames. A minimum of dielectric in field. No eddy currents or feedbacks. Kit consists of a variable primary and three plug-in secondary coils, covering all waves between 16.5 and 89.5 meters. Mounting base included. Shifting effected in two seconds. With a 3 to 7 plate S.P.F. condenser these coils will tune in stations in all parts of the world. Ship. wt., 1 1/2 lbs.
LWT-12—Complete Kit. List price.....\$12.50

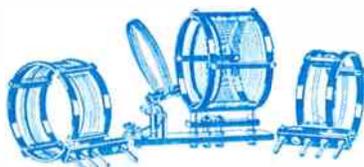


Aero Shield Grid Coils

Kit consists of three coils and mounting base. Aperiodically coupled, no primary needed. Set of three coils covers all waves from 16 to 90 meters. Same diameter and low loss construction as International coils listed above. Each unit consists of two coils, a secondary and a smaller diameter tickler which is mounted inside.
Kit LWT-11 of three coils. List price.....\$11.50
Kit for use with foundation units containing plug-in mount for replacing large diameter short wave coils. Same three coils as supplied last year, but of the newer type. Smaller diameter.
Kit LWT-10 of three coils. List price.....\$10.50

SINGLE COILS, Secondary and Tickler

- INT-101—16.5 to 32 meters. List price.....\$4.00 net
 - INT-102—26.2 to 48.7 meters. List price.....4.00 net
 - INT-103—46.7 to 89.5 meters. List price.....4.00 net
 - INT-104—87 to 155 meters. List price.....4.00 net
 - 100-P—Base with space wound primary coil. List price.....\$3.00
 - 100-W—Base without primary coil. List price.....\$1.50
- Shipping weight, single coil, 8 oz.

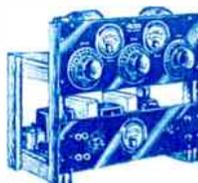


Aero S.W. Receiving Coil

Coils are 3 inches in diameter, ninety-five per cent air dielectric and completely interchangeable. The kit includes three coils and base mounting, with variable primary, covering all wavelengths between 15 and 130 meters. Ship. wt. lbs. 1 1/2.
Complete Kit LWT-125. List price.....\$12.50

- The range of the above kit may be widened by adding any of the extra coils listed below.
- INT-0—13 to 29 meters. List price.....\$1.00
 - INT-4—127 to 250 meters. List price.....\$1.00
 - INT-5—250 to 570 meters. List price.....\$1.00
 - Or any of the three coils in the kit may be purchased separately. Ship. wt., 8 oz.
 - INT-1—15 to 33.5 meters. List price.....\$1.00
 - INT-2—31 to 68 meters. List price.....\$1.00
 - INT-3—37 to 120 meters. List price.....\$1.00
 - LWT—Mounting base with primary coil. List price.....\$3.00

Aero Radiophone Transmitters



Neat little transmitters that have a world wide code range and several hundred mile range on phone. The ideal set for the "dial-in-the-wool" "ham" or the man who has just obtained his license and is ready to relay messages of his own. Set uses the tuned plate, tuned grid circuit. All tuning done by means of three variable condensers. Antenna ammeter, plate milliammeter and filament voltmeter show exactly what is happening. Mounted on impregnated wooden frame with bakelite panels. All parts readily accessible. Plug in coils for rapid shifting of wavelength.
Kit No. 50—Complete Radiophone Transmitter for phone or CW operation on 110 volt, 60 cycle AC. Includes Inductances, chokes, rectifier, filter and transformer. Uses 210 or 250 tubes with a pair of 2B1's for rectifiers. Coils included for the radiophone band. Ship. wt. 80 lbs. List price.....\$148.75
Kit No. 51—Code Transmitter for CW operation. Looks like the upper panel only. No power supply included. Kit consists of inductances, condensers, meters, and all necessary small parts of the oscillator circuit. Will run from batteries or a large power pack. Ship. wt. 35 lbs. List price.....\$74.85.
Prices of other high-powered kits on application



Short Wave Transmitting Coils

Coils for use in the low and medium powered transmitter. Wound with large diameter enameled wire in bakelite frames. 95% of the insulation is air. Kit consists of an antenna coil mounted on a base, a plate coil, and a separate grid coil with mounting base. For use in the tuned plate, tuned grid circuit.
2040-K—16 to 52 meter kit. List price.....\$12.00
4080-K—36 to 90 meter kit. List price.....\$12.00
9018-K—90 to 180 meter kit. List price.....\$12.00

INDIVIDUAL COILS

- 2040-C—16 to 52 meters. List price.....\$1.00
- 4080-C—36 to 90 meters. List price.....\$1.00
- 9018-C—72 to 180 meters. List price.....\$1.00
- GRID-100—Grid Mounting Base. List price.....\$1.00
- PRI-300—Antenna coil and Base. List price.....\$3.00
- 24-C—16.5 to 52 meter coil. List price.....\$5.50
- 48-C—36 to 90 meter coil. List price.....\$5.50
- 98-C 72 to 180 meter coil. List price.....\$5.50

New Aero High-Power Transmitting Coils for UX852, UX860, 250 Watt and 500 Watt



The new Aero high-power Transmitting Coils, designed to be as closely as possible in accord with "1929 practice" as outlined in recent issues of Q & T. For the first time "plug-in" coils can be used for high power. New by design plugs will carry up to 15 amperes with safety. Heavy aluminum rod is used for the completely self-supporting coil. A new material with asbestos basing, superior in electrical characteristics to glass, without its fragility, is used for the spacing bar. Porcelain insulators assure the user against leakage and electrostatic shields and other points of design previously limited in use to variable condensers have been incorporated in these coils. Coils are designed for use with 110 MMFD Condenser.

PRICES

- Kits of Two Coils, complete with plug-in mounts.....\$15.00
- TEL 24K 15.5 to 45 meters.....\$15.00
- TEL 48K 39 to 88 meters.....\$15.00

SINGLE COILS

- 24C—15.5 to 45 Meters.....\$7.50
- 48C—39 to 88 meters.....\$7.50
- Plug-in mounts only, per pair.....\$7.50
- Plugs only, with nuts, per pair.....\$2.00

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Aero Products, Inc., 4611 E. Ravenswood Ave.
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Please send me a copy of your 25c Aero Green Book showing 64 pages of newest modern circuits for short wave and broadcast receivers, transmitters, coils and kits.

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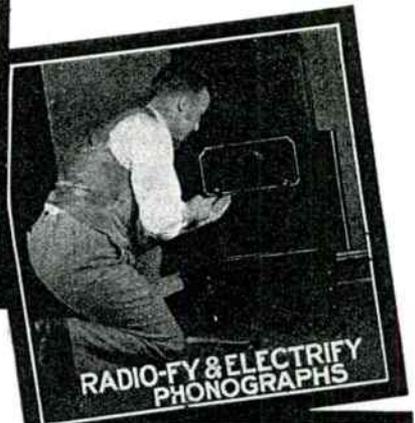
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FREE Radio
Idea Book**



5 Easy Ways to Make \$3.00 an hour in Your Spare Time in RADIO

Each of these plans, developed by the Radio Association of America, is a big money-maker. Set owners everywhere want to get rid of static, to have their sets operate from the electric light socket, the tone improved, and the volume increased, and transformed into single-dial controls. Phonograph owners want their machines electrified and radiofied. If you learn to render these services, you can easily make \$3.00 an hour for your spare time, to say nothing of the money you can make installing, servicing, repairing, building radio sets, and selling supplies.

Over \$600,000,000 is being spent yearly for sets, supplies, service. You can get your share of this business and, at the same time, fit yourself for the big-pay opportunities in Radio by joining the Association.

Join the Radio Association of America

A membership in the Association offers you the easiest way into Radio. It will enable you to earn \$3.00 an hour upwards in your spare time—train you to install, repair and build all kinds of sets—start you in business without capital or finance an invention—train you for the \$3,000 to \$10,000 big-pay radio positions—help secure a better position at

bigger pay for you. *A membership need not cost you a cent!*
The Association will give you a comprehensive, practical, and theoretical training and the benefit of its Employment Service. You earn while you learn. Our cooperative plan will make it possible for you to establish a radio store. You have the privilege of buying radio supplies at wholesale from the very first.

ACT NOW—If You Wish the No-Cost Membership Plan

To a limited number of ambitious men, we will give Special Memberships that may not—need not—cost you a cent. To secure one, write today. We will send you details and also our book filled with dollars-and-cents radio ideas. It will open your eyes to the money-making possibilities of Radio.

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Frank J. Deutsch, Penn.: "I have made over \$500 out of Radio in my spare time. Yours is a great plan for ambitious men."

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Claude DeGraves, Canada: "I knew nothing about Radio when I joined the Association a year ago. I am now a member of the engineering staff of the DeForest Company and my income is 225% greater than at the time I joined."

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Dept. SWM-1, 4513 Ravenswood Ave., Chicago, Ill.

Gentlemen: Please send me by return mail full details of your Special Membership Plan, and also copy of your Radio Idea Book.

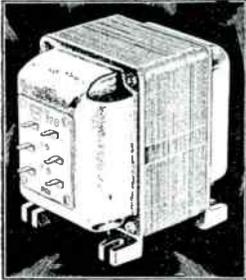
Name.....

Address.....

City..... State.....



Here's 750 Volts PURE D. C. For S. W. Transmission



New S-M 324 Power Transformer

Seven hundred and fifty volts D. C.—perfectly rectified and filtered, free from hum and suitable for plate supply for transmission or for reception—is made available at low cost by the new S-M 324 power transformer. A big, husky sixteen-pound transformer. Two 750-volt, 150-milliampere secondaries (center-tapped 1500-volt winding), used with two 281 type rectifier tubes, will supply up to 150 milliamperes at over 700 volts. Price, \$25.00.

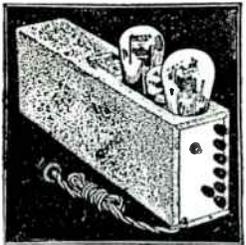


S-M 331 Unichokes

For use as filter choke in such a rectifier, the S-M 331 Un'choke is absolutely ideal. It utilizes the Clough resonance principle (under which it is licensed) to eliminate effectively the 120-cycle ripple—doing this more effectively with only 7 mfd. of condenser than do ordinary chokes with 8 to 12 mfd. Inductance at 110 milliamperes load, primary 2 henries, secondary 30 henries. Price, mounted in standard S-M case, \$8.00; open mounted (331-U) \$7.00.

Issue No. 7 of "The Radiobuilder" gives details of a circuit especially designed for economical production of pure D. C. at 750 volts. There are a few copies left—send for one right away if you haven't it. Use the coupon.

The S-M 678PD Is the Ideal Separate Audio Amplifier for All Short-Wave Tuners



The new 2-stage S-M 678PD Phonograph Amplifier is priced so low that, while particularly adapted for dance halls and small theaters, it is ideal for the home also. Used with any 110 volt D.C. dynamic speaker, it takes input from any magnetic phonograph pickup, or from the detector tube of a broadcast or short-wave receiver, and, by means of its S-M Clough-system audio transformers, supplies to the speaker undistorted the full power output of its 250-type tube. All input power is taken from the 110 volt A.C. house-lighting mains. Price, wired, \$73.00; complete kit, \$65.00.

Or you can get 250-tube power right in your present set by inserting a 250 tube (with an adapter) in the last socket of the set, and using the S-M 675ABC Power Supply—which furnishes ABC power for the 250, and B power to the entire set (or full ABC power to A.C. tube sets). Price, 675ABC kit, \$54.00, or factory-wired, \$58.00.

S-M Tube-Socket Plug-In Coils



The new "130 Series" S-M Midget Plug-in Coils are wound on extremely accurate bakelite forms, and are very compact, economical and highly uniform. Their winding space is 1 1/2" long by 1 1/2" in diameter, with a slot 1/4" wide and 1/8" deep at the bottom for primary or tickler windings. All forms are equipped with five pins to fit any 5-prong tube socket (as S-M 512). Overall size, 2 1/2" long over finger flange, 1 3/4" diameter.

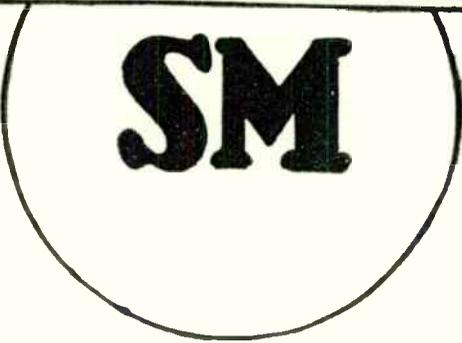
| S-M Catalog No. | NO. OF TURNS | | Meters Range (.00014 Condenser) | Price |
|-----------------|--------------------------------------------------------|---------|---------------------------------|--------|
| | Secondary | Primary | | |
| 131T | 6 1/2 | 5 1/2 | 17.4-32.1 | \$1.25 |
| 131U | 13 1/2 | 5 1/2 | 31- 58 | 1.25 |
| 131V | 25 1/2 | 9 1/2 | 57-110 | 1.25 |
| 131W | 49 1/2 | 15 1/2 | 104-204 | 1.25 |
| 131X | 82 1/2 | 19 1/2 | 190-358 | 1.25 |
| 131Y | 155 | 30 1/2 | 344-647 | 1.50 |
| 130P | Plain Coil Form with Contact Pins..... | | | .65 |
| 130T | Threaded Coil Form (98 threads) with Contact Pins..... | | | .65 |

Silver-Marshall, Inc.
882 W. Jackson Blvd., Chicago, U. S. A.
...Please send me, free, the complete S-M Catalog; also Radiobuilder No. 7.
For enclosed in stamps, send me the following:
..... 50c Next 12 issues of The Radiobuilder
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S-M DATA SHEETS as follows, at 2c each:
..... No. 1. 670B, 670ABC Reservoir Power Units
..... No. 2. 685 Public Address Unipac
..... No. 3. 730, 731, 732 "Round-the-World" Short Wave Sets
..... No. 4. 223, 225, 226, 256, 251 Audio Transformers
..... No. 5. 720 Screen Grid Six Receiver
..... No. 6. 740 "Coast-to-Coast" Screen Grid Four
..... No. 7. 675ABC High-Voltage Power Supply and 676 Dynamic Speaker Amplifier
..... No. 8. Sargent-Rayment Seven
..... No. 9. 678PD Phonograph Amplifier
..... Name
..... Address

Are you getting The **RADIOBUILDER** regularly? No. 7 (Nov. 1928) described in detail, with complete circuits, a 750-volt rectifying system using the new S-M 324 transformer illustrated above. Copies may be had without charge as long as they last; use the coupon.

If you build professionally, by all means ask for information on the S-M Authorized Service Station proposition; its money-making opportunities are greater than ever.

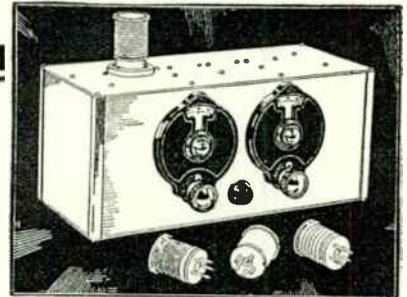
SILVER-MARSHALL, Inc.
882 West Jackson Blvd., Chicago, U. S. A.



Build the Set That Brings Them In from All Nations

Own a S.W. Set You Can Rely On

The S-M 730 "Round-the-World Four"



RADIO STATION CFBO
 SAINT JOHN, N. B.
 CANADA
 CONTROLLED AND OPERATED BY
 C. A. MUNRO, LTD.,
 BROADCASTING STUDIO
 IMPERIAL THEATRE

Silver Marshall Inc.
 Chicago Ill.

Dear Sirs :-

About two months ago I purchased one of your Round the World Four Short Wave Kites.

I put same together and took same out to the country to test.

The first day I had it was on a Sunday and from 12 Noon our time until 12 Midnight I never was without music. This set brought in K D KA, WGY, 5 S W Chelmsford England and P C C J Holland all with Loud Speaker Volume and good modulation.

Since then I have used same in St. John here for rebroadcasting thru our station C F B O.

As I am writing this only to-day I have been able to bring the first two Worlds Series Baseball games and rebroadcast them complete from start to finish.

Please remember that we do not get any daylight reception here at all from either U.S. or Canadian Stations on the B C.L. band, 200 to 600 Meters.

In closing I can only say that I built over twelve different short wave sets and yet to find the equal of the Round the World Four.

5 S W coores in every evening and 50% of the time with Loud speaker volume.

Yours very truly

J. O. Thorne

Supt. C. F B O

YOUR television experiments and short wave reception—do you depend on a receiver which is itself of "experimental" construction and requires excessive attention to insure reliability and time to change wave lengths? If you do, you'll enjoy, all the more, getting acquainted with the S-M "Round-the-World" Four—a snappy little receiver that can be built up in 3 hours time, and sets a new record of performance.

If you own an S-M "Round-the-World" Receiver, in its neat aluminum shielding cabinet, with its screen grid r.f. stage and quick-action plug-in coils, you can rest assured your reception—whether code, voice, or pictures—interstate or international—will be topnotch *all the time*.

COMPLETE KIT

Everything necessary to build the complete four tube r.f. regenerative (non-radiating) short-wave set, including aluminum cabinet and two S-M Clough audio transformers.

730 Complete Kit.....\$51.00
 730 Set, Wired 66.00

ADAPTER KIT

Complete with aluminum cabinet, less the two audio stages. Used with an adapter plug, it converts any broadcast receiver for short-wave use. Ideal for Television.

731 Adapter Kit.....\$36.00
 731 Adapter, Wired..... 46.00

ESSENTIAL KIT

Contains the two tuning and tickler condensers, four wound plug-in coils, coil socket, and three r.f. chokes, with full instructions for building a 1, 2, 3, or 4 tube set.

732 Essential Kit.....\$16.50

WE OWN AND OPERATE THE FOLLOWING AMATEUR STATIONS IN WHICH WE USE THE S-M 730 RECEIVER EXCLUSIVELY:

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RADIO NEWS

SHORT-WAVE MANUAL

The Season's Best Short
Wave Receivers for The
Television Experimenter, The
Short-Wave Broadcast Fan
and The Transmitting
Amateur

LISTING:

| | |
|-----------------------------------|-----------------------------------|
| The R.F. Short-Wave Receiver | The 18-1500 Meter Receiver |
| The "S.M." Round-the-World-Four | The "Junk-Box" Receiver |
| The National Screen-Grid Receiver | Short-Wave Operation |
| The Hammarlund "Transoceanic Two" | Short-Wave Stations of the World. |

EDITED

BY

H. M. BAYER

Technical Editor, "Radio News"

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1929

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An R. F. Short-Wave Broadcast Receiver

Incorporating an Optional R. F. Stage, Interchangeable Coils for the 10-725-meter Bands, and Push-Pull Amplification

By W. Francis Goodreau

WAVELENGTHS below 200 meters are rapidly becoming established as channels for the broadcasting of radio entertainment. The recent announcements of the decision of a number of popular broadcast stations to operate special transmitters on these waves proves that the industry's growing faith in transmission on high frequencies is beginning to be manifest in a concrete form. On the other hand, the interest of the general public in the construction of short-wave receivers shows that the special programs which are being transmitted on waves outside the broadcast band are being appreciated.

Short waves have many advantages, from the viewpoints of both the broadcaster and the listener. In the first place, they seem to be more efficient, as the programs of low-power stations are frequently heard half-way around the world. Secondly, there is less congestion, as more individual channels are available; and, as a result, a listener may often receive the program from the short-wave transmitter of a station with less interference than would be experienced in receiving the same program broadcast on the regular waves.

ENORMOUSLY GREATER RANGE

Not only in the United States, but in a

number of other countries (including England, France, Germany, Holland, etc.) many stations are broadcasting on waves between 30 and 200 meters. A majority of these programs, even those originating on the

HERE is a receiver which should find favor both with the broadcast listener who desires to enter the short wave field, and the short wave amateur who finds time occasionally to listen to some music.

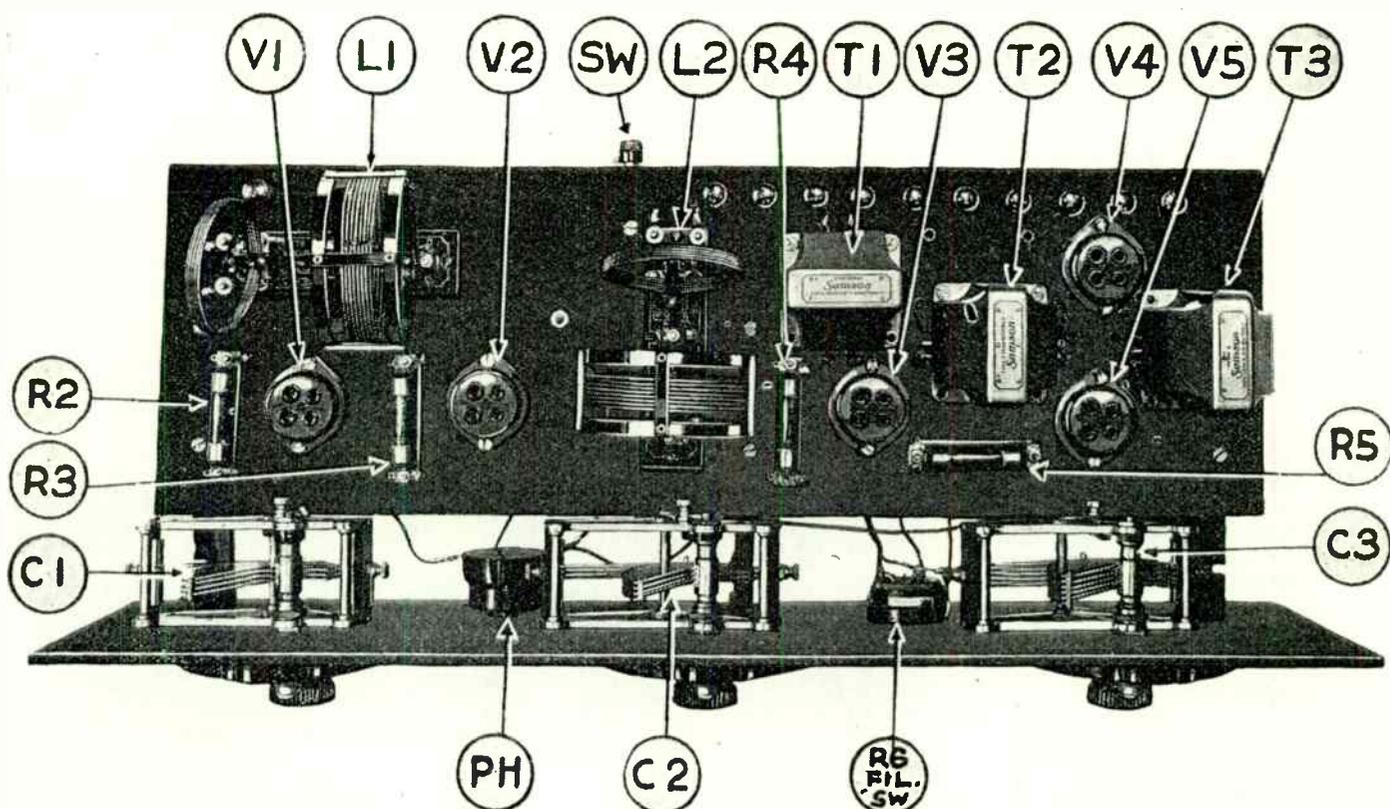
A commendable feature of this set is that no efficiency is sacrificed either on the short or broadcast waves; in fact, the type of audio amplification employed in this receiver is capable of above-average reproduction. For the code fan who desires reliable short wave work, quality broadcast reception, and 600 meter ship traffic, this receiver is ideal.—EDITOR.

other side of the Atlantic, are available to the owner of an efficient short-wave receiver. A number of these stations are broadcasting on regular schedules, while a great num-

ber are "on the air" quite frequently, especially when unusual programs are being offered. Practically all of the short-wave stations in this country broadcast the same program simultaneously on their broadcast and short-wave transmitters.

Because of their musical excellence, these programs are interesting to every listener, and especially to the DX fan who, having received practically all of the American and Canadian stations, is looking for new worlds to conquer. Unfortunately, until recently it was not possible to hear the short-wave broadcasts with any degree of satisfaction, because of the lack of suitable receivers. The sets that were used were mostly designed for code reception and, although they were very efficient, they were not designed to give the quality of reception demanded of broadcast receivers today.

Recently, however, articles have appeared in a number of radio magazines describing the construction of sets designed for quality of tone reception on short waves. Most strictly-short-wave receivers use condensers of very small maximum capacity in order to turn to the short wavelengths. When receivers of this type are used for the reception of waves above 200 meters, it is



This picture shows the location of practically all parts used in the construction of this short-wave receiver; the symbols correspond to those used in the wiring diagrams and the list of parts. L1 and L2, R.F. coils; T1, T2 and T3, audio transformers; V1, V2, V3, V4 and V5, tube sockets; C1, C2 tuning condensers; C3, regeneration condenser; R2, R3, R4 and R5, filament ballasts; R6, volume control; PH, oscillation control; Sw, switch controlling R.F. amplifier stage.

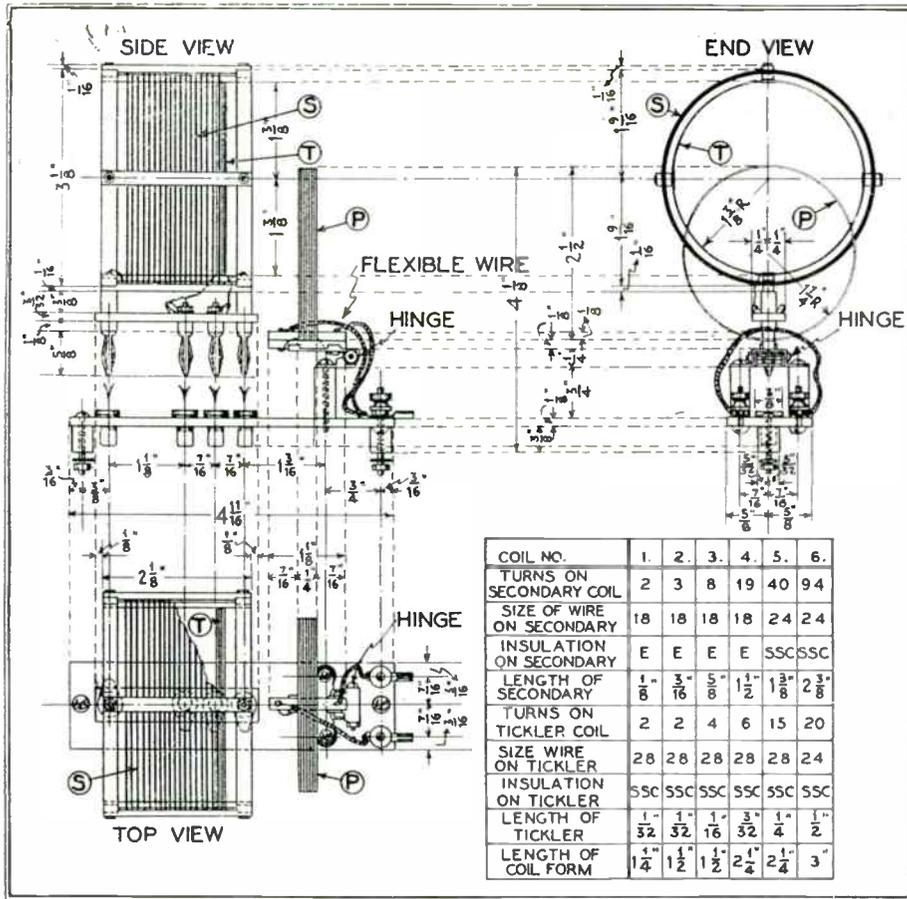


Diagram gives complete details for building the six sets of coils required in order to give this set a wavelength range from 10 to 725 meters. The primary coil consists of 10 turns of No. 24 S.S.C. wire wound on a form 2½ inches in diameter with whichever set of coils is used.

number of types of tubes can be used in the set. If it is not so desired, the audio-frequency end of the circuit need not be of the push-pull type; although the quality of reception will probably be somewhat better if this type of amplifier is used. Another point in favor of this receiver is that, although a complete equipment of coils to cover all the wavebands over which the set is capable of operating would be rather expensive, the constructor may purchase the coil mountings and two coils for the short-wave band at which the receiver is to be operated most frequently, and add the other coils later when finances permit. This feature alone is a good indication of the flexibility of this receiver.

With the panel and sub-panel drilling layouts shown here, it will be a simple matter to place the various parts in their proper positions. It will be noted that, although the front panel measures only 24 inches long, the spacing from center to center of the variable condensers is 8 inches; more than the usual spacing of such instruments. Because of the short wavelengths to which this set can be tuned, this spacing was deemed desirable to prevent interaction between units and eliminate any need for shielding. The coils are placed at right angles to each other and sufficient space is left between them to assure correct operation.

In assembling the set, the sub-panel should be drilled first and the apparatus mounted on it. After this, the front panel should be drilled and the condensers (C1, C2 and C3) volume control (R6) and oscillation control (PH) mounted. Care should be taken in laying out the panel and sub-panel, in order to get the holes at the right points; as otherwise considerable difficulty will be encountered when mounting the apparatus. After all of the parts have been mounted on the panel and sub-panel, the brackets should be screwed into place and the set is ready for wiring. The oscillation control has been mounted on the front panel because of the need of readjusting it with the different coils and tubes that will possibly be used.

It will be noticed that a double-pole, double-throw, jack switch (Sw) has been incorporated in the set between the radio-frequency and detector tubes. This switch is for the purpose of comparing results obtained with the set when the radio-frequency stage is used and when the set is operated as a simple regenerative receiver. It is also helpful in adjusting the receiver when it is first tried out.

necessary to use coils having a large number of turns of wire, in order to get an inductance value high enough to cover the waveband between 200 and 500 meters. While it is true that a tuned circuit having a large inductance and a small capacity will usually give louder signals from any given station than a smaller inductance and large capacity tuned to the same station, it is also true that the *selectivity* of the circuit using the small condenser and large inductance will not be as great as that of the other combination.

FAULTS OF EARLY DESIGN

It seems to have been the idea of the designers, of most short-wave receivers, that these were to be used entirely for reception of short waves; and that a separate receiver would be used for the regular broadcast band. While the use of plug-in coils will enable the operator of a short-wave receiver to cover the different bands, it will result in a receiver that is not very selective above 200 meters. The design of most of these short-wave receivers is rather a step backward, when compared with the usual set used for broadcast reception; since practically all of the sets designed for short-wave work are of the plain regenerative type.

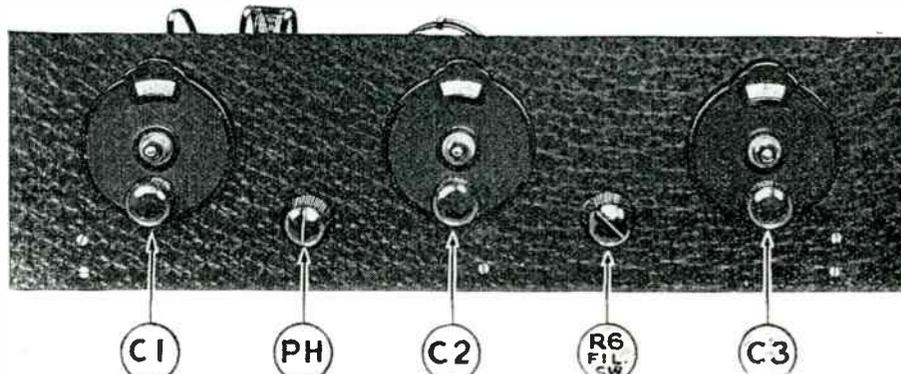
It must be admitted that the use of two receivers has some advantages; but it must also be pointed out that the cost of two receivers is beyond the means of many. Besides this, there is the requirement of additional space, not only for the receivers but for the separate sets of batteries that would probably be used.

The special short-wave receiver described in this article was designed to be a flexible

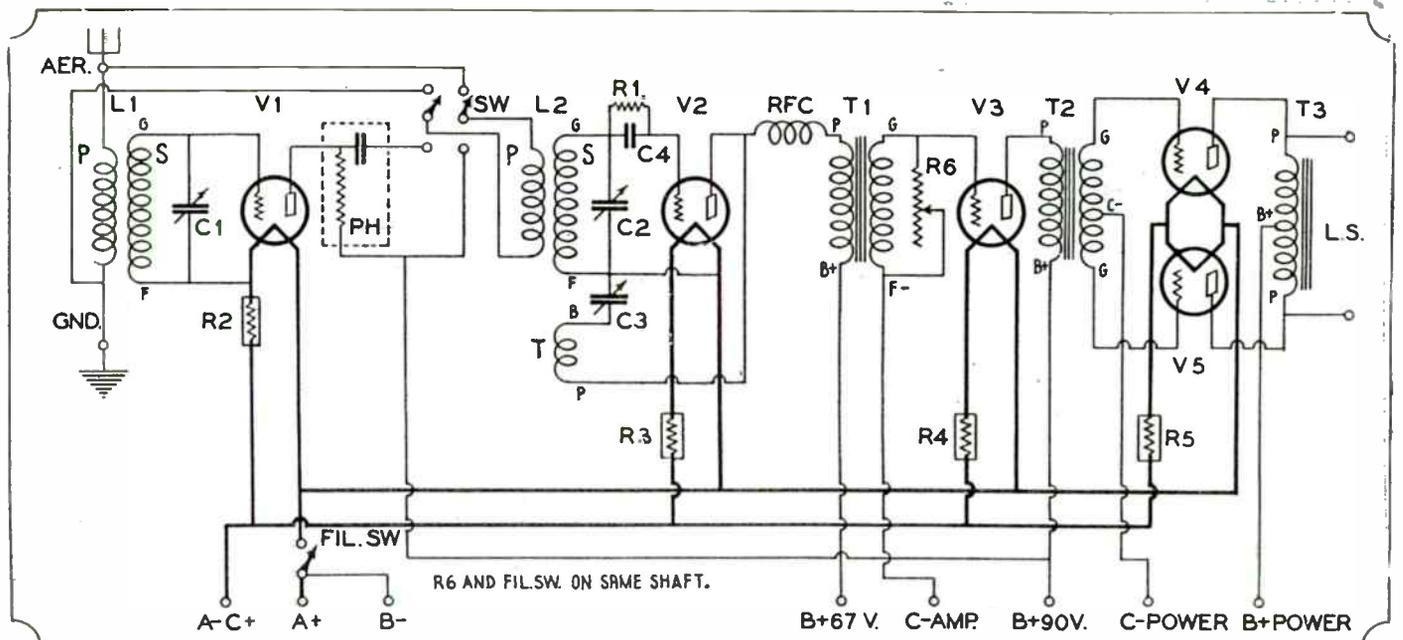
receiver, suitable for use on any wavelength band merely by plugging in the proper coils. By referring to the schematic diagram of this set, you will see that a stage of tuned radio frequency has been placed before the usual regenerative circuit. Because of this additional tuned circuit, the receiver is very selective on wavelengths above 200 meters, even though small tuning condensers are utilized. The audio-frequency amplifier has been designed for quality reception; it includes one stage of straight transformer-coupled and one of push-pull amplification. Thus, it will be seen that this set combines the advantages of both the broadcast and short-wave receivers in one flexible all-wave circuit.

CONSTRUCTION

The set is so designed that the experimenter will find it easy to construct according to his personal desires, since a wide



This shows the arrangement of controls on the front panel of the set. C1 and C2, wavelength tuning dials; C3, regeneration control; PH, oscillation control; R6-Fil. SW, volume control and filament switch. The plug-in coils are partly visible.



This schematic wiring diagram gives complete details of all electrical connections in the receiver; and the symbols which are used to identify them correspond with those in the other illustrations, as well as the text.

Care should be taken in placing the grid leak R1 and grid condenser C4, to keep them away from the plate wires leading to the radio-frequency tube (V1) and also from the radio-frequency choke (RFC) in the detector plate circuit. The sub-panel mounting brackets are placed as indicated; one slightly off center to provide additional support for the weight of the audio-frequency transformers (T1 and T2).

TESTING AND OPERATING

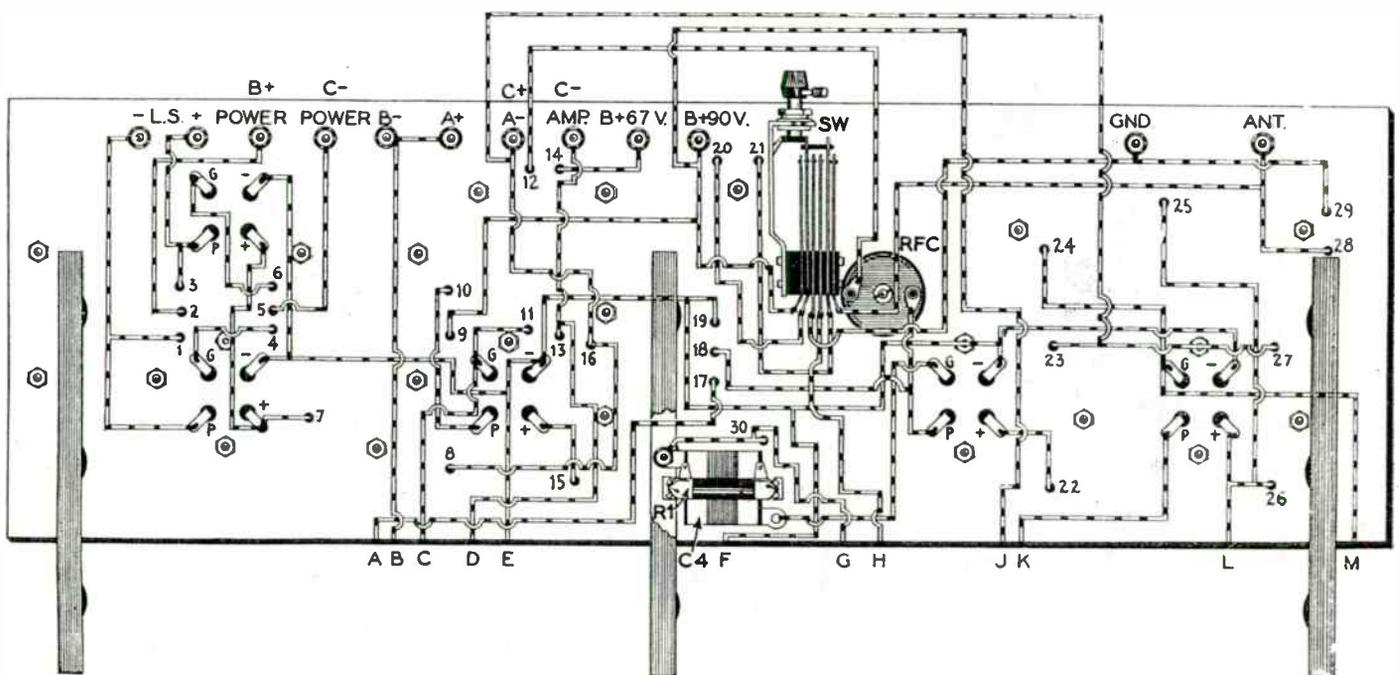
After the wiring is completed the set may be tested. It is best to throw the double-pole switch so that the aerial and ground are connected to the primary of the second tuning unit, in order to get accustomed to tuning the regenerative part of the receiver. It will be noticed that the set is very selective on the short waves;

but, the nearer you come to the band between 200 and 500 meters, the more interference will be experienced. However, when the radio-frequency stage is connected in the circuit, the selectivity is very good, on both broadcast and short waves.

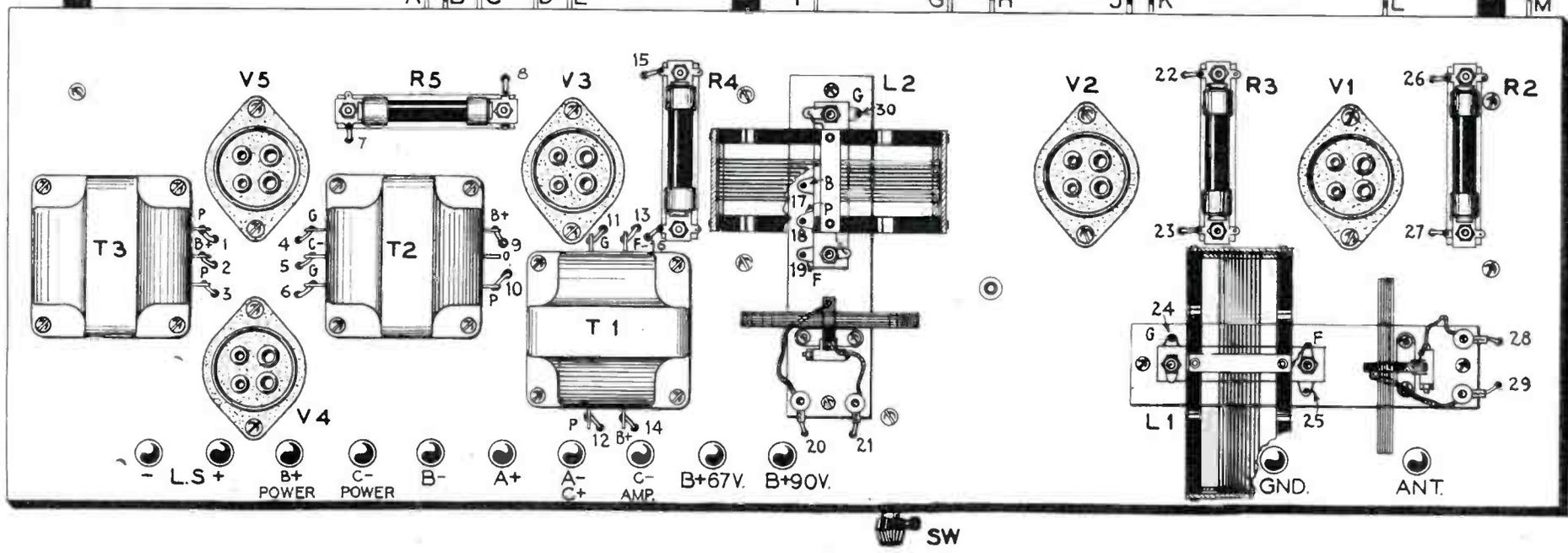
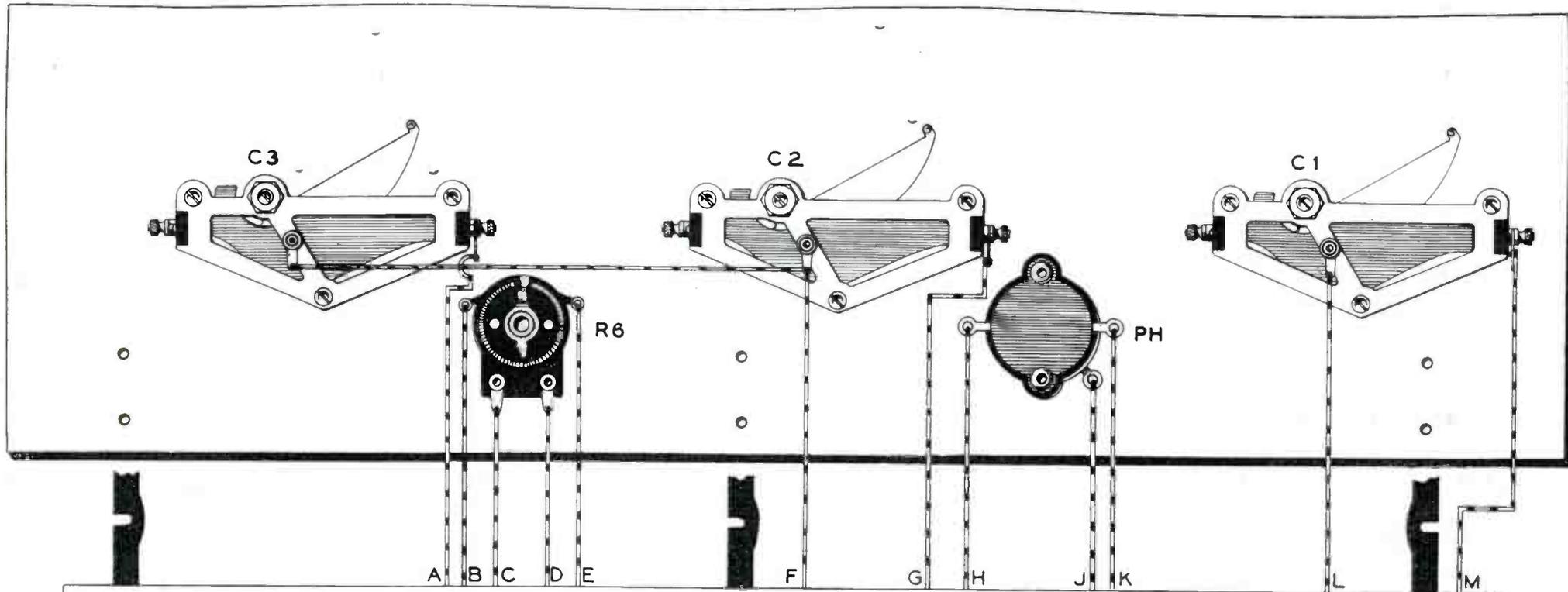
Having spent some time testing the receiver in this manner, the aerial and ground should be connected to the primary of the first tuning unit by throwing the switch (Sw) in the opposite direction. The adjustment of the oscillation control (PH) is not difficult. Tune in a station near the lower end of the condenser scale, turn back the dial of C3 and then slowly turn the dial on the oscillation control (PH) to the left. On returning the dials C1 and C2 no squeals should be heard; if they are heard, turn the oscillation control still farther to the left. If it is found impossible to control the oscillation in this manner, move the primary

of the second tuner further away from the secondary. The relation of the primaries on the tuning coils L1 and L2, to their respective secondaries, governs the selectivity of the set.

It was found in testing the receiver that different adjustments of the oscillation control (PH) were needed for some of the coils, although most of the coils could be operated without the adjustment. When experimenting with the set, a 199 tube was tried in the radio-frequency stage and was found to be easier to control than a 201A but, since it was not difficult to adjust the 201A and since the signals were louder with this tube, it was finally chosen. In changing the tubes, the automatic filament controls (R2, R3, R4 and R5) were found very convenient, since they are easily changed, permitting the use of any type of tube without changing the batteries.



This pictorial wiring diagram indicates the exact arrangement of all wiring under the sub-base panel. Letters and numbers in this drawing refer to corresponding wires and holes, which are similarly marked in the diagram of the wiring above the sub-base panel and the leads to panel apparatus which appears on the opposite page.



operating on wavelengths between 10 and 550 meters. Six different types of coils and two coils of each type (12 coils in all) are needed to cover this wide band. However, all the coils are not required if the builder wishes to limit the wavelength range of the set to a narrower band. The waveband which each of the six coils cover approximately is as follows: coil No. 1, 10 to 25 meters; coil No. 2, 15 to 33.5 meters; coil No. 3, 31.5 to 68 meters; coil No. 4, 57 to 133 meters; coil No. 5, 125 to 250 meters, and coil No. 6, 235 to 550 meters. If it is desired to increase the wavelength range of the set to 725 meters it is possible to do so by connecting a .0001-mf. mica fixed condenser in shunt with each of the tuning condensers (C1 and C2) when coil No. 6 is being used.

In constructing the coils the secondary windings must be spaced. The chart in the drawing gives the number of turns, the size of wire and the length of each secondary winding; and with this data the builder can determine the proper spacing between turns by experiment. The tickler and primary coils are wound with insulated wire and are not spaced. The primary coil consists of form 2½ inches in diameter. The tickler coils are merely glued inside the secondaries, or held in place with a few drops of sealing wax or paraffin from a candle.

However, for those who may find difficulty in constructing these coils, they can be purchased at the local dealer. The coils described here are an exact copy of a well-known product and for that reason should not be difficult to recognize. It should be remembered also that any make of short-wave coil will do.

The following is a complete list of the parts required for the construction of this short-wave receiving set:

LIST OF PARTS

- L1, L2—Two sets of coils (see drawing for details);
- C1, C2—Two S.L.F. variable condensers, .00014-mf.;
- C3—One S.L.F. variable condenser, .00025-mf.;
- C4—One mica fixed condenser, .00025-mf.;
- T1—One A.F. transformer, 3:1 ratio;
- T2—One A.F. transformer, push-pull input type;

| SYMBOL | Quantity | NAME OF PART | REMARKS | MANUFACTURER * |
|------------|----------|---------------------|----------------------------------------------------------------------|-------------------------------|
| L1 | 1 | Coil mounting | Plug-in type (special) | 1 |
| L2 | 1 | Coil mounting | Plug-in type (special) | 1 |
| | | Coils | Plug-in type (special). Various sizes to cover different wave bands. | 1 |
| C1, C2 | 2 | Variable condensers | .00014 mf. straight line frequency | 2 6,8,10,11,12,13,14,15,16,17 |
| C3 | 1 | Variable condenser | .00025 mf. straight line frequency | 2 6,8,10,11,12,13,14,15,16,17 |
| C4 | 1 | Grid condenser | .00025 mf. | 3 4,18,19,20,21,22 |
| R1 | 1 | Grid leak | 5 megohms | 4 3,13,19,21,22,23,24,26 |
| R2, R3, R4 | 3 | Amperites | 1/4-ampere type | 5 |
| R5 | 1 | Amperite | Lampere type | 5 |
| R6 | 1 | Volume control | Equipped with filament switch | 4 |
| RFC | 1 | R. F. choke | 60 millihenries | 1 6 |
| T1 | 1 | A.F. transformer | | 6 2 |
| T2 | 1 | Push-pull trans. | Input type | 6 12,27,28,29 |
| T3 | 1 | Push-pull choke | Output choke coil | 6 12,27,28,29 |
| PH | 1 | Phasetrol | | 4 |
| | 3 | Dials | Vernier type | 6 2,5,7,8,30,31 |
| | 5 | Sockets | UX type | 7 8,13,15,25,27,32 |
| | 1 | Panel | 7 x 24 x 3/16 inches | 38 33,34,35 |
| | 1 | Sub-panel | 7 x 23 x 3/16 inches | 38 33,34,35 |
| | 3 | Brackets | 3 inches high | 8 15,28,36 |
| V1, V2, V3 | 3 | Tubes | 201A type | 9 37,39,40 |
| V4, V5 | 2 | Tubes | 171 type | 9 37,39,40 |
| SW | 1 | Jack switch | Double-pole, double-throw type | 44 8,20,41 |
| | 12 | Binding posts | | 7 8,13,25 |
| | | Connecting wire | Insulated | 42 43,44 |

NUMBERS IN LAST COLUMN REFER TO CODE NUMBERS BELOW.

| | | |
|-------------------------------------|-------------------------------------|------------------------------------|
| 1 Aero Products, Incorporated | 2 Karas Electric Company | 3 Dubilier Condenser Corporation |
| 4 Electrical, Incorporated | 5 Radiall Company | 6 Samson Electric Company |
| 7 H. B. Eby Manufacturing Co. | 8 Pilot Elec. Mfg. Company | 9 C. F. Manufacturing Co. (De'Co) |
| 10 Hammerlund Manufacturing Company | 11 Bremer Tully Manufacturing Co. | 12 Silver-Marshall, Incorporated |
| 13 Ameco Products, Incorporated | 14 General Instrument Company | 15 Benjamin Electric Mfg. Company |
| 16 Gray & Danielson Co. (Remlar) | 17 Camfield Radio Manufacturing Co. | 18 Benjamo Electric Company |
| 19 Toke Deutchmann Company | 20 Carter Radio Company | 21 Polymo Manufacturing Company |
| 22 Leslie F. Water Company | 23 Aerovox Wireless Corporation | 24 Nicomell Radio Corporation |
| 25 Tel. Radio Laboratories, Inc. | 26 Davan Radio Corporation | 27 Thordarson Elec. Mfg. Company |
| 28 Precision Manufacturing Company | 29 All-American Radio Corporation | 30 Martin-Copeland Company |
| 31 Kurtz-Keech Company | 32 Airmap Products Company | 33 Wizard Electric Co., Inc. |
| 34 Formica Insulation Company | 35 American Hard Rubber Company | 36 American Radio Hardware Company |
| 37 Radio Corporation of America | 38 Insulating Company of America | 39 Ken-Rad Corporation |
| 40 E. T. Cunningham, Incorporated | 41 Tuxley Manufacturing Company | 42 Ace Wire Company |
| 43 Cornish Wire Company | 44 Belden Manufacturing Company | 45 |
| 46 | 47 | 48 |

* THE FIGURES IN THE FIRST COLUMN OF MANUFACTURERS INDICATE THE MAKERS OF THE PARTS USED IN THE ORIGINAL EQUIPMENT DESCRIBED HERE.

If you use alternate parts instead of those listed in the first column of manufacturers, be careful to allow for any possible difference in size from those originally used in laying out and drilling the panel and sub-base.

- T3—One A.F. choke coil, push-pull output type;
- R1—One grid leak, 5-megohm;
- R2, R3, R4—Three filament-ballast units, 5-volt, ¼-amp. type;
- R5—One filament-ballast unit, 5-volt, ½-amp. type;
- R6—One 500,000-ohm volume-control rheostat and filament switch;
- RFC—One R.F. choke coil, 60-millihenry;
- PH—One oscillation control, variable resistor-condenser type;

- V1, V2, V3—Three vacuum tubes, 201A-type;
- V4, V5—Two power tubes, 171A-type;
- SW—One jack switch, D.P.D.T. type;
- Three tuning dials, vernier type;
- Five vacuum-tube sockets, UX-type;
- One panel, 7 x 24 x 3/16 inches;
- One sub-panel, 7 x 23 x 3/16 inches;
- Three brackets, 3 inches high;
- Twelve binding posts;
- Two coil mountings (see drawing for details).

Hints on Operation for the Short-Wave Beginner

WHEN the receiver goes in and out of oscillation with a squawk, or a loud cluck, experiment with various grid-leaks until you find the proper value which will allow the receiver to go into oscillation smoothly. Obstinate cases can be cured, generally, by reducing the detector plate voltage.

When wiring the receiver always connect the rotor (movable) plates of the tuning and regeneration condensers to the filament return of the stage.

Power units, of both the "A" and "B" types, are not recommended for use with short-wave receivers. A good "B" power unit is entirely satisfactory when used with a broadcast receiver; for the simple reason that, should a slight A.C. ripple be present in the speaker, it will not be noticed be-

cause of the volume of the reproduced signal. However, listening to a very weak signal with headphones is another matter; in this case A.C. ripples which would be inaudible in a broadcast receiver become literally roars in the phones. It should be remembered, also, that the broadcast receiver is, or should be, operated below the point of oscillation; this is quite a factor in keeping the A.C. ripple down to a minimum. In using a short-wave receiver, as the regeneration control is advanced, the ripple is amplified in direct proportion to the signal.

An efficient vernier dial must be used on the tuning condenser of a short-wave receiver. This refinement is not essential on the regeneration condenser; but tuning on the high frequencies is so critical that often

signals are passed over without the operator being aware of their presence. This statement, also, emphasizes the necessity of slow and deliberate tuning, when a mere slight pressure on the knob of the dial may bring in a station.

It should be remembered that short-wave receivers can be logged—not quite as easily as the stabilized broadcast-wave receiver; but with a fair degree of reliability. After a station has been tuned in to the point where it is loudest, turn the regeneration dial to as low a point as it can be brought without losing the signal; when this has been reached, adjust the tuning condenser until the signal is loudest. At this dial reading the station may be logged; with some assurance of returning to it, when desired, with a minimum of "juggling."

A Screen-Grid Short-Wave Receiver

A Three-Tube Set Employing the 222-Type Tube as an R. F. Amplifier at Ultra-High Frequencies

By Fred H. Canfield

THE screen-grid short-wave receiver described in this article is entirely different from the usual short-wave receiver. Most of the short-wave sets which have been described heretofore have been designed primarily for the experimenter who desires economy and maximum efficiency, rather than ease of control. As a result, the average short-wave set employs only two tubes and is rather complicated in its operation.

In this receiver an attempt has been made to simplify the construction and operation as much as possible, nevertheless retaining a high degree of sensitivity and selectivity. In other words, this set represents an endeavor on the part of the designers to build into a short-wave receiver the desirable characteristics of the usual broadcast receiver.

At this point it should be explained that there is a great difference between the efficiency of a receiver and the sensitivity of a receiver. Every efficient receiver must necessarily be sensitive; but it does not follow that a sensitive set must be efficient. For example, a correctly designed three-tube receiver, employing a regenerative detector and two audio stages, may be both highly efficient and very sensitive; whereas a carefully planned five-tube set, employing two R.F. stages, a non-regenerative detector and two A.F. stages, may be equally as sensitive, but not as efficient—because two extra tubes are required to do the same work.

From the example in the above paragraph it may be seen that high efficiency is not always a necessary, nor even a desirable characteristic; as a five-tube tuned R.F. receiver is much to be preferred over the three-tube regenerative; even though both sets are capable of providing practically the same results. The reason is that by slightly lowering the efficiency of the tuned R.F. receiver, the set possesses all the de-



Fig. A. This picture, taken in RADIO NEWS Laboratories while testing the Screen-Grid Short-Wave Receiver, clearly shows the neat, unencumbered appearance of the front panel. The coils for other wavebands are at the left.

sirable features of the regenerative set and in addition becomes much simpler to operate and the circuits are much more stable.

DESIGN OF THIS SET

The principle of design described above has been applied to this short-wave receiver. In building the set, sensitivity and selectivity were given the first consideration, stability and ease of operation second consideration and then the efficiency was made as high as possible. Of course, it would have been possible to increase the efficiency, but this increase would not have been desirable; as it is not needed, and it would complicate the operation of the set considerably. However, notwithstanding these facts, this receiver is more sensitive and produces greater volume than most short-wave sets of other designs.

The average short-wave set consists of

a regenerative detector followed by a stage of A.F. amplification, making a total of two tubes. It is seldom that a short-wave set using more than two tubes is constructed; as the addition of a tuned R.F. amplifier to a receiver of this type might complicate the set to such an extent that the added sensitivity would be of little value. On the other hand, if an untuned R.F. amplifier using a 201A-type tube were connected ahead of the detector, the gain in amplification would be practically negligible. Therefore, up to the present time, the set employing a regenerative detector with a one-stage A.F. amplifier has been considered the best possible combination for short-wave reception.

The screen-grid short-wave receiver has several advantages over the usual regenerative type. It employs a total of three tubes in a circuit consisting of one stage of R.F., a regenerative detector and one stage of A.F. amplification. The R.F. amplifier is of the untuned type and uses the screen-grid (222-type) tube. Therefore, it does not add a tuning control; but it does provide an appreciable gain in amplification, due to the fact that this tube is used. According to James Millen, the designer of the receiver, the amplification of the R.F. stage is between 3 and 4, depending upon the wavelength.

The addition of the R.F. stage has many other desirable effects upon the operation of the receiver. First, it makes the receiver much more stable in operation. Secondly, it prevents the detector tube from radiating energy into the aerial. Thirdly, it makes possible to calibrate the tuning dial of the set; as the size of the aerial has no effect upon the tuning condenser. Fourthly, the dead spots (points on the tuning dial where the set cannot be made to oscillate because of aerial characteristics) of the set are eliminated, by virtue of the fact that the aerial is not connected to the detector circuit of the set.

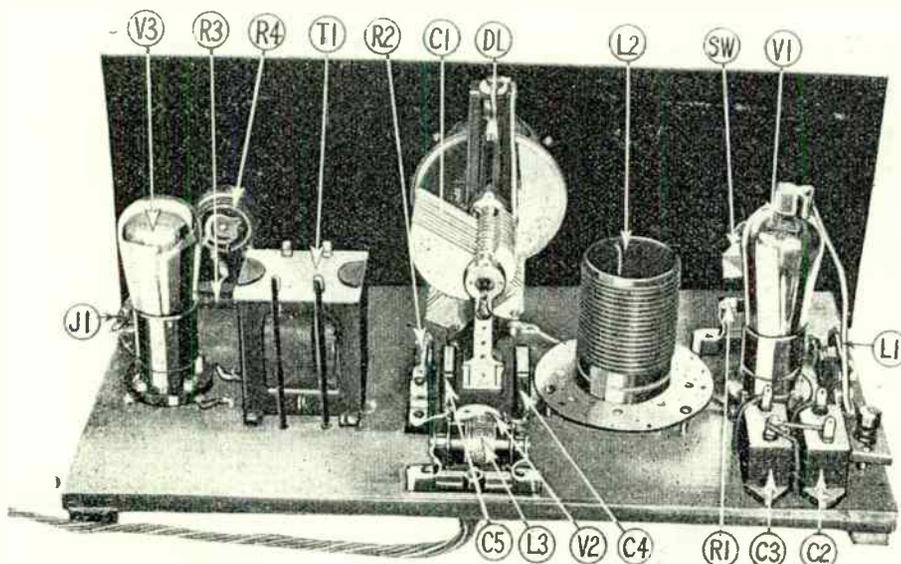


Fig. B. Ample space is available on the baseboard for mounting parts without crowding. This greatly increases the efficiency of the set, especially at the ultra-high frequencies.

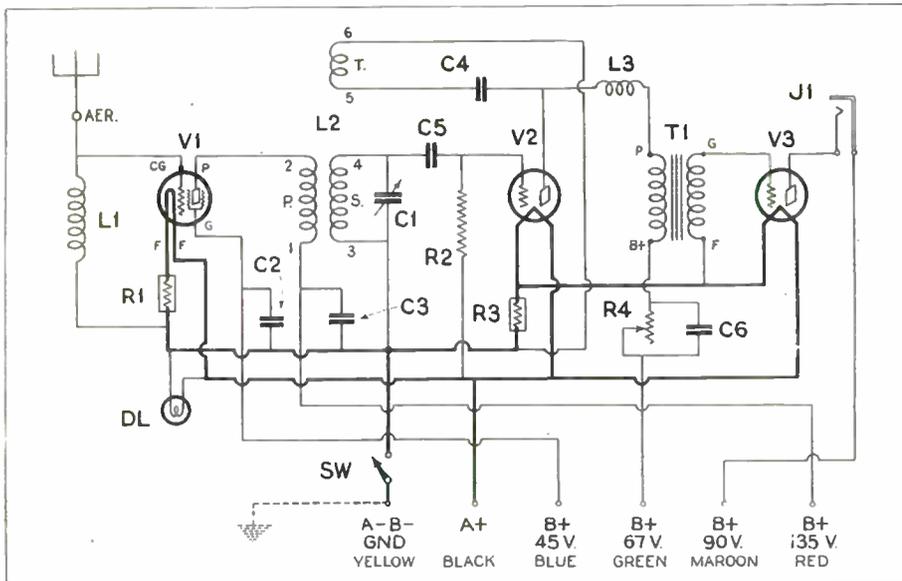


Fig. 1. The symbols used in this complete schematic wiring diagram of the Screen-Grid Short-Wave receiver correspond to those used in the text, list of parts and other illustrations.

The picture shown as Fig. A reveals the simplicity of this receiver as compared with other short-wave sets. In the center of the front panel there is an illuminated vernier dial, and this serves as the only tuning control for the entire receiver. The knob in the lower left corner of the panel controls the battery switch, and that in the lower right corner of the panel the volume-control resistor. These are the only controls; as all rheostats and coupling adjustments were avoided by the designer when building the receiver.

Fig. D. This bottom view of the baseboard shows that the battery-cable leads are attached directly to the parts.

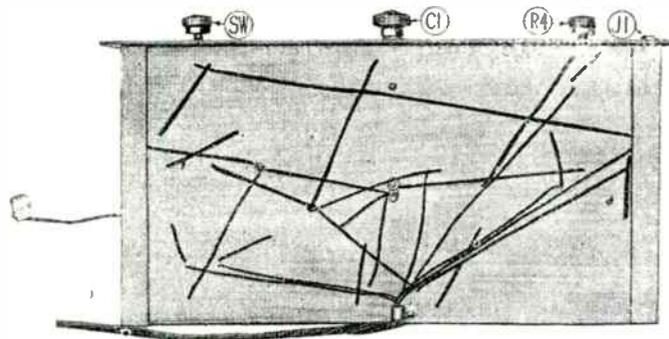
The pictures (Figs. B, C and D) show the simplicity of construction behind the panel and under the baseboard. With the exception of the three instruments mounted on the front panel, all parts of the set are fastened to the wooden baseboard and, in most cases, wood-screws are used for the purpose. Two wooden strips are fastened along the edges of the base on the under side and these make it possible to conceal most of the wiring under the baseboard.

The compactness of the receiver is another important feature. The front panel is 7 x 18 inches and the baseboard measures 9 x 17 inches. The total weight of the set is less than ten pounds.

FEATURES OF THE CIRCUIT

Fig. 1 shows the complete circuit of the receiver. V1 is the screen-grid R.F. amplifier tube, V2 is the detector tube and V3 is the A.F. amplifier tube. It will be noticed that the aerial circuit is untuned, and that an R.F. choke coil (L1), which is connected between the control-grid and the filament of the screen-grid tube V1, serves to couple the aerial circuit to the receiver without the necessity of a tuning control. L2 is a special plug-in R.F. transformer with three windings, which couples the plate

circuit of the screen-grid tube with the grid circuit of the regenerative-detector tube. The coupling between the various windings is fixed; P, the primary winding, is in the plate circuit of the screen-grid tube, S, the secondary winding, is in the grid circuit of the detector tube and T, the tickler winding, is in the plate circuit of the detector tube. The receiver is tuned



by C1, the variable condenser connected in shunt with the secondary winding. The A.F. circuit of the receiver is standard and employs the usual audio transformer (T1).

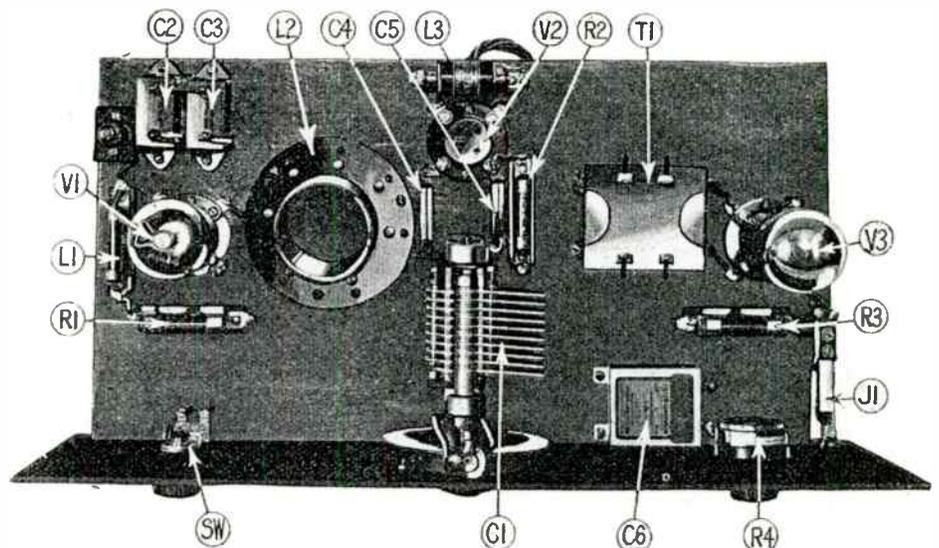


Fig. C. This top view of the receiver shows the exact arrangement of parts; and that on the upper side of the baseboard the wiring brought through the holes seen in Fig. D above is invisible.

A close examination of the circuit will show that it possesses several unusual features and refinements. Automatic filament-ballast resistors (R1 and R2) are used in place of rheostats for controlling the filament current of the tubes. R1 regulates the filament current of the screen-grid tube and R2 controls that of the detector and A.F. tubes. The volume and regeneration of the receiver is regulated by a variable resistor in the plate circuit of the detector. This resistor (R4) varies the voltage applied to the detector tube, and it is shunted by a 1-mf. by-pass condenser (C6). An R.F. choke coil (L3) is connected between the plate terminal of the detector tube and the primary winding of the transformer, and this prevents R.F. current from entering the A.F. amplifier and also improves the control of regeneration.

PARTS REQUIRED

Another feature of the receiver which has not been mentioned previously is that the use of plug-in coils permits a wavelength range of 15 to 115 meters. Also, another coil may be obtained which permits the reception of stations in the broadcast wave band. Four coils are needed to cover the band of short waves mentioned above and these coils are used in the position of L2 in the circuit. They fit into a special six-contact socket and it is a simple matter to change from one coil to another.

A complete list of the apparatus required for the construction of the receiver is as follows:

- One variable condenser, double-spaced .000-125-mf. (C1);
- Two by-pass condensers, 0.5-mf. (C2 and C3);
- One fixed mica condenser, .001-mf. (C4);
- One fixed mica condenser, .00025-mf. (C5);
- One by-pass condenser, 1-mf. (C6);
- One special R.F. choke coil or antenna coupling (L1);
- One set of four plug-in coils, with socket (L2);
- One R.F. choke coil, short-wave type (L3);
- One filament-ballast unit, 222-type (R1);
- One grid leak, 6-megohm (R2);
- One filament-ballast unit, 112 type (R3);
- One volume-control rheostat, 0-500,000-ohm (R4);
- One A.F. transformer (T1);

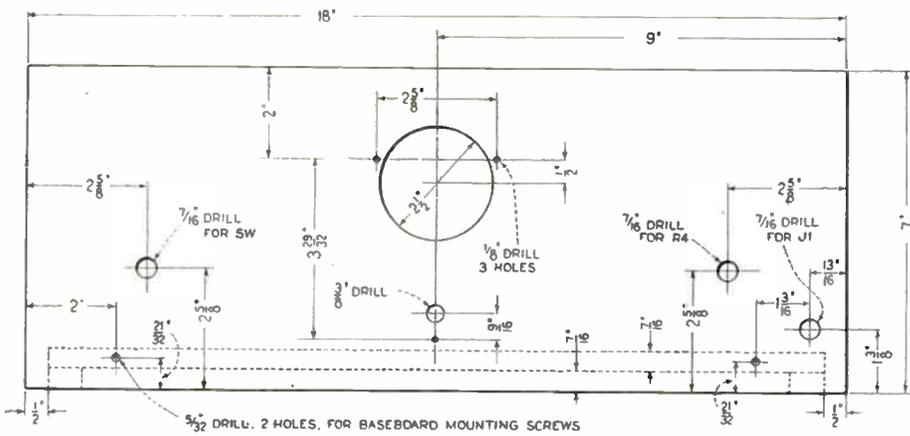


Fig. 5. This drilling layout shows the exact location of all holes required for mounting the various parts on the front panel of this receiver.

design throughout. Therefore, it is ideally suited for short-wave reception, but any efficient condenser of this capacity may be used.

COILS REQUIRED

The four short-wave coils illustrated in this receiver are manufactured units; however, home-made coils may be used, if desired. The following directions tell how to build coils which duplicate electrically the ones shown in the illustrations:

Each of the four coils is wound on a piece of bakelite tubing 2 inches in diameter. The smallest coil requires a form $2\frac{3}{8}$ inches long, and this coil has a wavelength range of 15 to 25 meters. The next largest coil, with a wavelength range of 24 to 40 meters, requires a form $2\frac{3}{4}$ inches in length. The two largest coils, with wavelength ranges of 37.5 to 65 meters and 64 to 115 meters, respectively, are wound on forms $3\frac{5}{8}$ inches in length.

Each of the four coils has three separate windings. S, the secondary, is wound with spaced turns of heavy enameled copper wire. P, the primary, consists of turns of fine enameled wire wound between the turns of the secondary coil. The tickler winding T consists of a few turns of wire wound $\frac{1}{4}$ -inch below the end of the primary winding. This method of construction is clearly illustrated in Fig. 2.

In constructing home-made coils provision may be made for using the same type of socket receptacle if desired. This socket consists of a bakelite disc with a maximum diameter of $4\frac{1}{4}$ inches. A circular hole, $2\frac{1}{16}$ inches in diameter, is cut in the center of this disc, for the coils to fit into. Six contact springs of phosphor bronze or spring brass are mounted at equal distances

- One single-circuit pack (J1);
- One battery switch (SW);
- One vacuum tube, 222-type (V1);
- Two vacuum tubes, 201A-type (V2 and V3);
- Three tube sockets, UX-type;
- Two grid-leak clips for L1 and L3;
- One vernier dial, illuminated type;
- One front panel, 18 x 7 x $\frac{3}{16}$ inches;
- One wooden baseboard, 19 x 9 x $\frac{1}{2}$ inches;
- One battery cable, 7-wire type;
- One binding post;
- Connecting wire, screws, solder, etc.

and has an inductance slightly less than 2 millihenries. It is much easier to buy this piece of apparatus than to attempt its construction; however, the fan who wishes to do so may find it interesting to experiment with coils of various sizes in this position. Also, a resistor might be substituted for the choke coil, but the results would not be quite as satisfactory. In order to determine the size of resistor which will give most satisfactory results, several units of less than 100,000 ohms should be experimented with. The choke coil which is used in the L3 position also fits in a grid-leak mounting, but this is a standard unit, and any short-wave R.F. choke coil may be substituted, if desired.

The tuning condenser specified has a capacity of .000125-mf. and is of the double-spaced type; this condenser is provided with pigtail connections and is of low-loss

Most of the parts mentioned in the above list are standard. However, the two R.F. choke coils require special mention. The R.F. choke coil L1 was especially designed for antenna coupling on short wavelengths, and is the only one of its kind which has ever been brought to the attention of the writer. It fits in a standard grid-leak clip

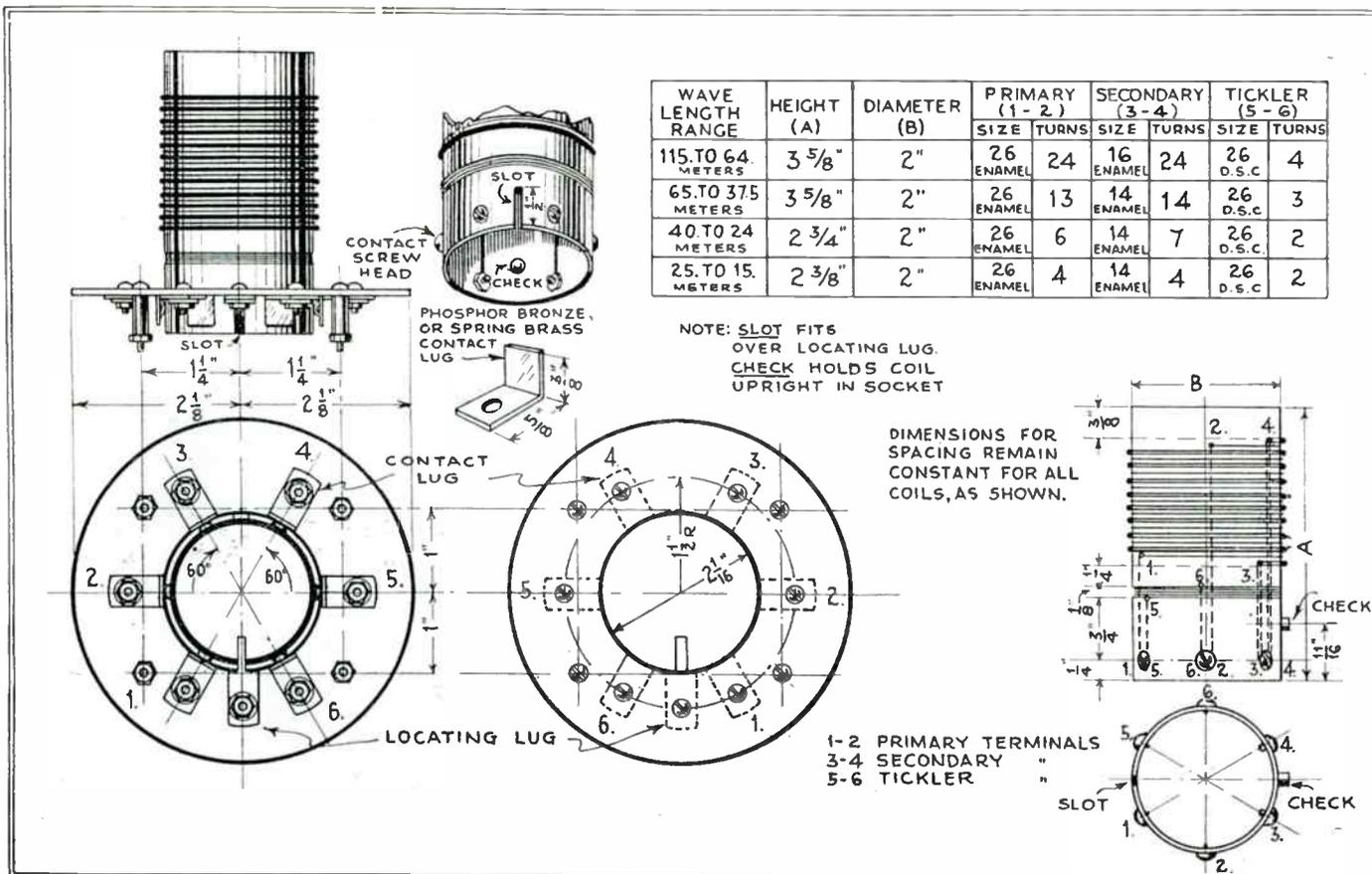


Fig. 2. This diagram gives details for making the four short-wave plug-in coils which are required, in order to cover the waveband of 15 to 115 meters with a 125-mmf. condenser, and also how to make the base receptacle, into which the coils are plugged.

apart around the circumference of the smaller circle, and these springs make contact with the contact screws of the plug-in coils. Also, a locating lug, which fits into a slot of each plug-in coil, is mounted on the base to insure that the coils shall be inserted in the socket in the proper manner. The method of constructing the base is clearly shown in the constructional drawings.

Before winding the coils, it is necessary to drill six holes at one end of each of the coil forms. These holes are for the connecting screws which are the means of providing contacts between the coil and the coil socket. They are spaced equally on the circumference of the coil form, and 1/4-inch from the end of the tube. After the holes have been drilled, machine screws should be fitted into them, with the head of the screw on the outside of the coil form and a nut on the inside to hold the screw in place. Now, place a number alongside each screw, starting with 1 and continuing in a clockwise direction until the last screw is numbered 6. Next, between screw terminals numbers 1 and 6, cut a slot 1/2-inch long and 1/8-inch wide in the tube. This slot fits over the locating lug of the coil socket. Also, as a further precaution, a check may be located between the terminals 3 and 4 to support the tube on the other side. This check may be a short machine screw.

In winding the 15-meter coil, the secondary winding should consist of 4 turns of No. 14 enameled wire spaced the equivalent of one turn apart. The primary coil consists of 4 turns of No. 26 enameled wire, wound between the turns of the secondary winding. The tickler coil is wound 1/4-inch below the secondary winding and consists of 2 turns of No. 26 D.C.C. wire. All coils are wound in the same direction.

The other coils are of similar construction to the 15-meter coil described above. The 40-meter coil has 7 turns of No. 14 enameled wire on the secondary, 6 turns of No. 26 enameled wire on the primary and 2 turns of No. 26 D.S.C. wire on the tickler. The 65-meter coil has 14 turns of No. 14 enameled wire on the secondary, 13 turns of No. 26 enameled wire on the primary and 3 turns of No. 26 enameled wire on the tickler. The 115-meter coil has 24 turns of No. 16 enameled wire on the secondary, 24 turns of No. 26 enameled wire on the secondary and 4 turns of No. 26 D.S.C. wire on the tickler.

After the four coils have been wound, connections should be made between the ends of the coil and the contact screws mounted at the base of the coil form. Terminal No. 1 connects with the beginning of the primary winding, that is, the end of the winding nearest the base of the coil form; terminal 2 connects with the other end of the primary; terminal 3 connects with the beginning of the secondary winding which is adjacent to the beginning of the primary winding, and terminal 4 connects with the end of the secondary winding. Terminals 5 and 6 connect with the tickler winding; terminal 5 with the end of the winding which is nearest the base, and terminal 6 with the end nearest to the primary and secondary windings.

WIRING SIMPLE

The arrangement of parts on the base-board is shown clearly in Fig. 3 and Figs. B and C. This placement of parts is prob-

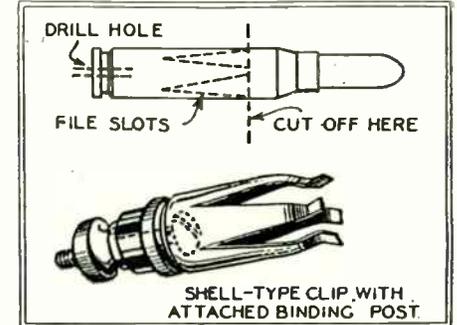
ably the simplest from the wiring viewpoint, but it is not essential that it be followed exactly. Good results may be obtained from any arrangement of parts which does not greatly lengthen the wiring required in the R.F. circuits. All of the parts are held in place with wood-screws, with the exception of the variable condenser (C1) which is secured in place by two machine screws which pass through the base.

Binding posts are not used in the power circuit of the set, but the wires of the battery cable are connected directly to the proper terminals in the set. This method greatly facilitates connecting the set to the batteries. In the pictorial and schematic wiring diagrams, a color code is given for the battery cable; but any other code will be just as satisfactory. Also, if the cable has more than the six required wires, three wires may be soldered together in order to provide separate leads for the "A-," "B-" and "Ground" connections.

Ability to obtain good results from the receiver may be gained only by practice in tuning the set. Until the operator has had a little experience it might be well to practice adjusting the coils for the short-wave program of KDKA, which is broadcast on a wavelength of 62.5 meters. This station will be received when using the 37.5-to-65-meter coil. Probably the simplest way to tune in a telephone station is to make the detector tube oscillate by adjusting the volume-control resistor (R4); and then the carrier wave of the station will be received when the variable condenser (C1) is set at the correct position.

A Good Screen-Grid Clip

The accompanying drawing shows a simple way to make a good clip for screen-grid tubes from an empty cartridge shell. Any shell between 30 and 45 calibre may be used for the purpose; but the cartridge should be fired before any attempt is made to use the



An excellent terminal clip for a 222-type (screen-grid) tube may be made from an empty cartridge shell, with the aid of a file and pliers.

shell. First, saw or file off the shell about three-quarters of an inch from the primer (closed) end or base; and then file four slots at right angles, making four prongs. Next, with a pair of round-nose pliers, bend the tips of the prongs outward a slight distance. Slightly below this bend the prongs should be bent inward sufficiently to fit the terminal snugly.

| A Screen-Grid Short-Wave Receiver | | | | | |
|-----------------------------------|----------|--------------------|------------------------------------------------------|-----------------|----------------|
| SYMBOL | Quantity | NAME OF PART | REMARKS | List Price Each | MANUFACTURER # |
| C1 | 1 | Variable condenser | .000125 mf., double-spaced type | \$ 4.50 | 1 |
| C2, C3 | 2 | By-pass condensers | 0.5 mf., paper type, moulded case | .70 | 2 |
| C4 | 1 | Fixed condenser | .001 mf., mica type | .45 | 2 |
| C5 | 1 | Fixed condenser | .00025 mf., mica type | .35 | 2 |
| C6 | 1 | By-pass condenser | 1 mf., paper type | .90 | 2 |
| L1 | 1 | R.F. choke coil | 2 millihenries | 1.00 | 1 |
| L2 | 1 | Plug-in coil set | 4 Special, plug-in type short-wave coils with socket | 10.00 | 1 |
| L3 | 1 | R.F. choke coil | Short-wave type | 1.25 | 1 |
| R1 | 1 | File-ballast unit | 222 type | 1.10 | 3 |
| R2 | 1 | Grid leak | 6 megohms | .50 | 4 |
| R3 | 1 | File-ballast unit | 0.5 ampere, 5-volt type | 1.10 | 3 |
| R4 | 1 | Variable resistor | 0 - 500,000 ohms | 1.50 | 5 |
| T1 | 1 | A.P. transformer | 3:1 ratio | 6.00 | 6 |
| J1 | 1 | Telephone jack | Single-circuit type | .40 | 7 |
| SW | 1 | Battery switch | Panel-mounting type | .70 | 7 |
| V1 | 1 | Vacuum tube | 222 type (screen grid) | 6.50 | 8 |
| V2, V3 | 2 | Vacuum tubes | 201A type | 1.75 | 8 |
| | 1 | Tuning dial | Illuminated vernier type | 3.25 | 1 |
| | 3 | Grid-leak clips | Standard single mounting | .35 | 4 |
| | 1 | Front panel | 16 x 7 x 3/16 inches | | 9 |
| | 1 | Baseboard | 17 x 9 x 1/2 inches | | |
| | 1 | Battery cable | 7-wire type | .55 | 10 |
| | | Connection wire | Flexible insulation | .40 | 10 |

| NUMBERS IN LAST COLUMN REFER TO CODE NUMBERS BELOW. | | |
|-----------------------------------------------------|-------------------------------------|----|
| 1 National Company | 10 Helden Manufacturing Company | 19 |
| Helden, Mass. | 2300 S. Western Ave., Chicago, Ill. | |
| 2 Aerovox Wireless Corporation | 11 | 20 |
| 70 Wash. St., Brooklyn, N.Y. | | |
| 3 Radiall Company (Amperite) | 12 | 21 |
| 50 Franklin St., New York City | | |
| 4 Arthur H. Lynch, Incorporated | 13 | 22 |
| Flak Bldg., New York City | | |
| 5 Electrad, Inc. (Royalty) | 14 | 23 |
| 175 Varick St., New York City | | |
| 6 Silver Marshall, Inc. (S-M) | 15 | 24 |
| 846 N. Jackson Blvd., Chicago, Ill. | | |
| 7 Yenley Manufacturing Company | 16 | 25 |
| 9 South Clinton St., Chicago, Ill. | | |
| 8 C. F. Manufacturing Company (CoCo) | 17 | 26 |
| 702 Eddy St., Providence, R. I. | | |
| 9 American Hard Rubber Company (Ace) | 18 | 27 |
| 11 Mercer Street, New York City | | |

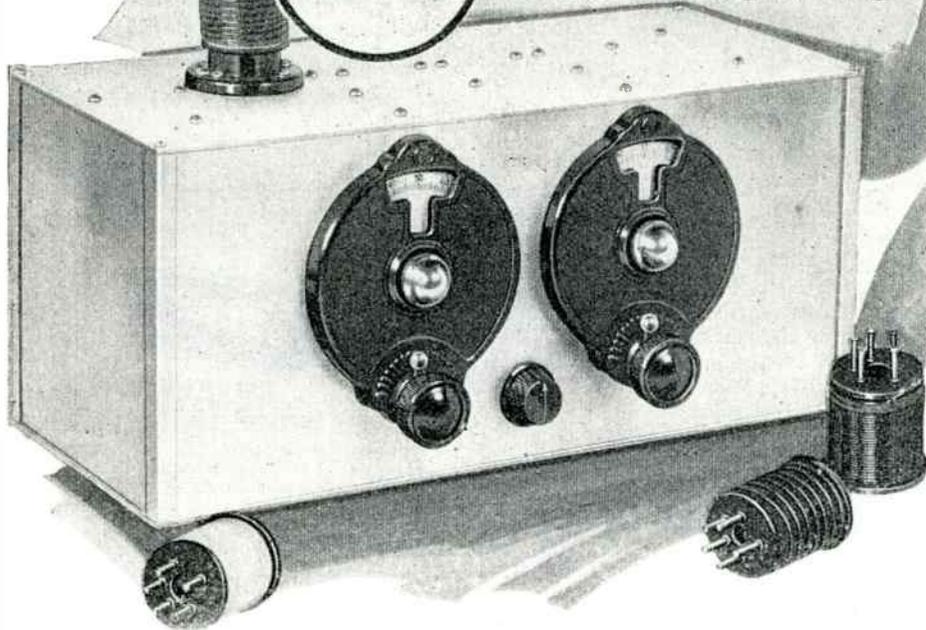
* THE FIGURES IN THE FIRST COLUMN OF MANUFACTURERS INDICATE THE MAKERS OF THE PARTS USED IN THE ORIGINAL EQUIPMENT DESCRIBED HERE.

If you use alternate parts instead of those listed in the first column of manufacturers, be careful to allow for any possible difference in size from those originally used in laying out and drilling the panel and sub-base.

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No. 62

The "SM" Round-the-World-Four



THE unquenchable rumors that television is here in form simple enough for home experimentation have led to increased interest. If that be possible, in short wave reception. Many of the experimental television transmissions take place on short waves, such as that from WRNY, New York and WLEX, Boston, Mass. A short wave receiver was used in these experiments, and it is certain that no matter what the form, television impulses must be tuned in upon receivers of more or less conventional design, but of a higher degree of performance than is necessary simply for short-wave code reception.

The short wave receiver illustrated and described herewith provides this higher degree of performance, plus freedom from radiation, for the oscillating detector is isolated from the antenna by a screen-grid R.F. amplifier tube. While the average three-tube short wave set will have ample sensitivity for code signals when in an oscillating condition, the performance when not oscillating is seldom, if ever, satisfactory for modulated or telephone reception (broadcast programs for instance). This is because of the fact that amateurs, interested primarily in C.W. code signals heterodyned by an oscillating detector, have taken little or no pains to obtain the smooth regeneration control absolutely necessary to satisfactory modulated signal reception. In the development of the four-tube set illustrated, great care was taken to obtain smooth regeneration control; telephone broadcast programs weakly heard, if at all, on ordinary short wave sets are satisfactorily tuned in on this receiver with considerably greater strength due to careful design and layout and to additional amplification provided by the screen-grid R.F. amplifier tube. This R.F. tube does not add a tuning control, its input circuit being untuned, yet it boosts telephone signal volume quite a lot, and entirely

eliminates "dead spots" at which the set will not oscillate, since it effectively isolates the antenna from the sensitive detector circuit.

LIST OF PARTS

- 1 S-M 317 or Amsco .00014 tuning condenser, C1
- 1 S-M 316B or Amsco .00035 tickler condenser, C2
- 1 each S-M 131-T, 131-U, 131-V, and 131-W coils, L2
- 1 S-M 512 5-prong socket
- 2 S-M 277 R.F. chokes, L1, L4
- 1 S-M 275 R.F. choke, L3
- 1 S-M 818 hook-up wire (25 feet)
- 1 S-M 734 aluminum shielding cabinet with terminal strip
- 1 S-M 255 first stage A.F. transformer, T1
- 1 S-M 256 second stage A.F. transformer, T2
- 3 S-M 311 tube sockets
- 1 Yaxley 20-ohm midjet rheostat, R4
- 1 Yaxley 500 switch attachment, SW
- 2 Yaxley insulated tip jacks
- 1 Na-Aid 481XS spring socket for detector
- 1 Polymet .00015 condenser, C5
- 1 Polymet .002 condenser, C6
- 1 Polymet .005 condenser, C4
- 1 Polymet grid leak mount
- 1 Polymet 5 megohm grid leak, R3
- 1 Durham 50,000 ohm resistor, R5
- 1 Sprague ¼ mf. condenser, C3
- 2 Carter H-10, 10-ohm resistors, R1, R2
- 1 Carter H-2, 2-ohm resistor, R6
- 8 binding posts consisting of 8/32 screw, nut, and insulated top
- 2 National type B vernier dials.

An unusual degree of smoothness of regeneration control, freedom from "putting" and "fringe effect" as the set goes into oscillation is effected by careful circuit and coil design, notably by using a small coil, which on the lower waves (particularly around 20 meters and be-

low) provides smoother and sweeter control than the two, three, and even four inch short wave coils generally used. The coils are actually a refinement of the popular "tube base" or "Scottish" idea which has been found to give such excellent and economical results. These forms are slightly larger and longer than the average tube base, by dimensions sufficient to allow more efficient coils than are possible on the ordinary tube base (often not available except at the expense of breaking good tubes). A winding space 1½" long and 1½" in diameter is available, with tickler slot ⅛" deep and 1/16" wide at the filament end. On the bottom of the moulded form are five hollow pins, properly positioned to fit any five-prong A.C. tube socket. These coil forms are so inexpensive that any number of experimental coils for different wave bands can be wound at little cost, to be tuned by any size of condenser that may suit the builders' fancy. In this matter of "builders' fancy," however, it is well to incidentally remark that, while a code receiver can be thrown together almost any old way and still work, physical placement of parts and wiring details must be most rigidly watched in order to get a good modulated signal receiver.

The set illustrated is mounted on the top and front of a satin-finished aluminum cabinet, 14" long, 6" wide, and 6" high, with all parts placed in a simple straight line as in a schematic diagram, instead of being tied up in a knot difficult of assembly and "trouble shooting." Looking at the inside of the receiver with bottom and sides removed, the antenna choke coil is seen at the left; next to it is the screen grid R.F. tube socket, then the screen grid tube by-pass condenser and plate choke. The 5-prong coil socket is mounted on the other side of the top, on 1" studs, directly above the screen grid tube socket and by-pass condenser. Next is the grid leak and detector socket, with the tuning condenser directly in front of them; then the plate choke, regeneration condenser, two audio tube sockets, and two S-M Clough-type audio transformers. A 20-ohm rheostat with switch attachment is placed on the panel to control detector filament voltage. All binding posts and speaker tip jacks are mounted on a small bakelite strip at the rear of the cabinet.

National vernier dials are used. The matter of a good short wave variable condenser is an interesting one, for few good broadcast condensers, even of properly reduced capacity, are good at 20 meters and below, for bearing noises develop to

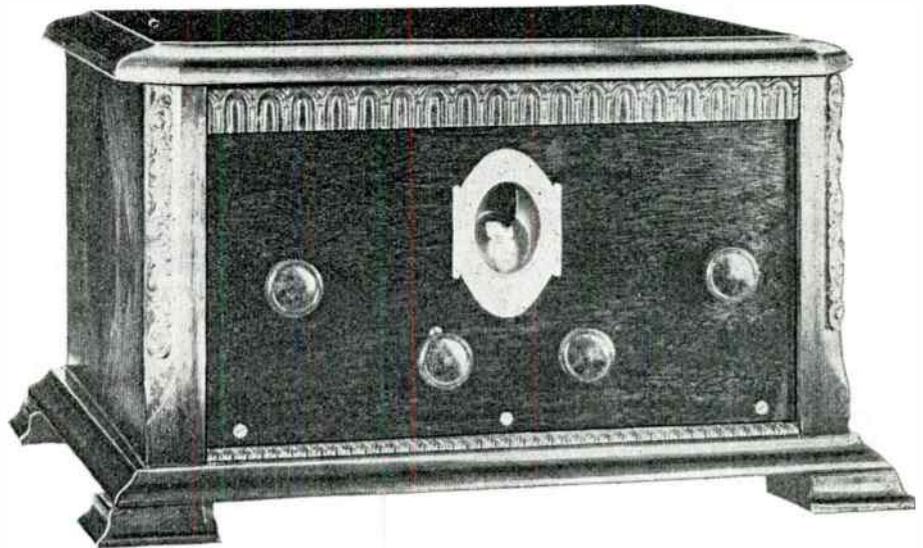
The Hammarlund "Trans-Oceanic Two"

An Ultra-Modern Short-Wave Receiver Embodying the Latest Developments in the Art. It May Be Used as a Converter or as a Straight Receiver. Its Simplicity Makes It Ideal for the Broadcast Fan

CONSISTENT reception of television impulses and European broadcast stations requires a receiver which must possess ultra-sensitivity, extreme selectivity and, along with these last-mentioned essentials, smoothness of operation and ease of control. All the sensitivity and selectivity in radio are worthless unless they can be brought under the finger tips of the operator and controlled at his will.

Short-wave receivers of the past were, for the most part, straight regenerative circuits and, as such, laid claim to all the eccentricities and temperments of this circuit. Those who have dabbled with high-frequency receivers in which the oscillating detector was fed directly into the antenna, can appreciate the trials and tribulations which they had undergone in getting a short-wave station into the phones and what is most important, holding it there. Not only that, but stability of operation certainly was not one of the features it boasted. Along with these aforementioned disadvantages was what probably was the gravest weakness of the straight regenerative short-wave receiver—it, invariably, possessed a tuning peculiarity known as "deadspot" tuning. In other words, wide gaps would be found on the tuning dial in which nothing could be heard; for example, stations would be heard on the dial say, from 10 to 30 when suddenly the receiver would stop oscillating and nothing would be heard until the dial had reached say, 50 when it would start oscillating only again to repeat the performance on another point of the dial.

Furthermore, though the seriousness of any such action of a receiver is perfectly obvious, the circuit also lacked the very necessary element of sensitivity coupled with



The completed receiver in its cabinet. The latter is standard equipment and can be obtained from the manufacturer. Note its similarity to the modern broadcast receiver.

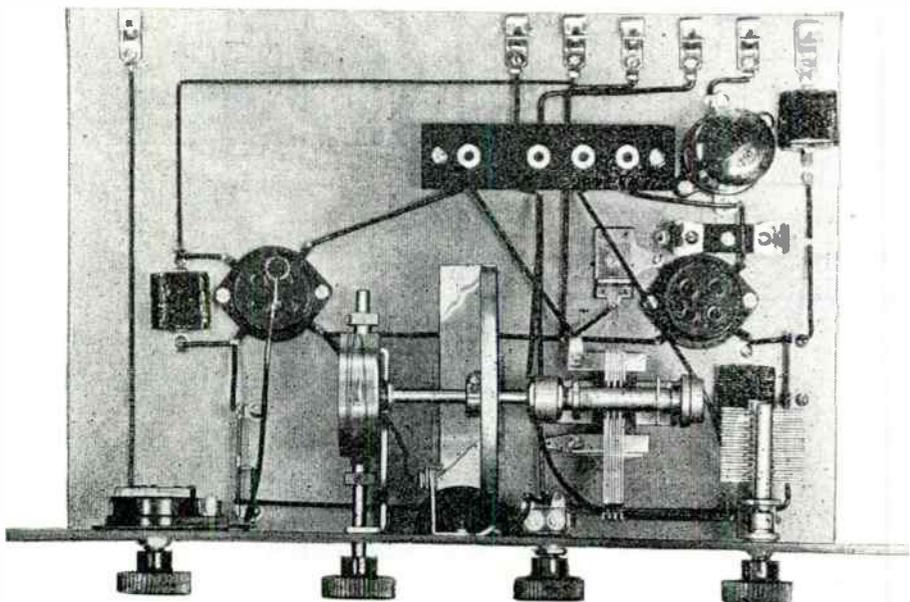
stability. All of us, by now, are accustomed to turning the switch of our broadcast receiver and merely with the twist of a dial bring a station roaring in. Such is far from the same in short-wave reception where we find that "the most sensitive receiver is not sufficiently sensitive." In other words, efficiency factors of a short-wave receiver simply cannot be overated or, to put it in popular fashion, it is one of those things of which we cannot have enough.

Conditions as outlined above were endured by the short-wave fan and transmitting amateur for the simple reason that if

one desired to correct the deficiencies it was necessary to pursue an engineer's course in ferreting out the trouble and then end up in a higher mathematical spree in redesigning the antenna and receiver to match each other and to harmonize, as it were, with the surrounding atmosphere.

This condition existed up to the introduction of the screen-grid tube and its adaptation to short-wave receivers when it was found that with the addition of this tube as a stage of untuned radio-frequency amplification before the detector a marked increase in signal strength was obtained. And, what is far more important, "deadspot" tuning was eliminated with a consequent stability of operation and smoothness of control which took short-wave reception out of the skilled experimenter class to which it had been confined and helped place it in the hands of the average broadcast listener who was assured of maximum results even though he knew little or nothing about radio.

The Hammarlund Short-Wave Receiver herewith described and illustrated combines those technical features employed by the transmitting amateurs in making their phenomenal distance records, and a screen-grid stage of untuned radio-frequency amplification before the detector. In short, it is a receiver designed especially for the broadcast fan with little knowledge of radio who desires consistent, long-distance reception on the short waves. Not only is the circuit the latest development in short-wave reception, but the external design and general appearance of the complete assembly equals that of the finest custom-built broadcast receiver. Where in the past the broadcast listener has been accustomed to the breadboard, haw-wire construction so typical of the transmitting amateur, he now has available a



This baseboard view of the Hammarlund Short-Wave Receiver proves that it is as simple in construction as it is pleasing in appearance. It is possible to construct this model in 2 or 3 hours.

short-wave receiver finished in mahogany, including panel and knobs, and, what is a new note in short-wave design, an illuminated drum-dial such as is found on the most expensive broadcast receivers.

AS A CONVERTER

Furthermore, in designing the receiver, the circuit and the layout of the components were so arranged that the receiver could be operated as a converter. This feature makes the set a highly desirable one from the viewpoint of both the transmitting amateur who requires a thoroughly efficient and reliable receiver for his code communications, and the broadcast fan entering the short wave field who desires to make use of the audio amplification system in his broadcast receiver. For both cases, it is an ideal short wave set.

The following list of parts should be employed in building this receiver:

- 1 Hammarlund ML-7, .0014 mfd. Midline Condenser (C).
- 1 Hammarlund SWC-3, Coil Set (L2, L3).
- 1 Hammarlund SDW, Knob Control Drum Dial (DL is the dial light).
- 3 Hammarlund SDWK, Walnut Knobs.
- 1 Hammarlund EC-70, Equalizer (C-2).
- 1 Hammarlund RFC-250, Radio Frequency Choke (L-4).
- 1 Hammarlund MC-23, Midget Condenser (C-1).
- 1 Hammarlund SWAP, Adapter Plug and Cable.
- 3 Sprague Type F .1 mfd. Condensers (C-3, C-4, C-5).

- 1 Yaxley No. 10 Midget Battery Switch.
- 1 Yaxley No. 820 C, 20 ohm Mid-tapped Resistor (R-1).
- 1 Yaxley No. 804, 4 ohm Resistor (R-2).
- 2 Eby No. 12 Sockets.
- 1 Durham Metallized Resistor, 2.9 meg-ohms (R-3).
- 1 Electrad Type P Tonatrol (R).
- 1 Westinghouse Micarta, 7 in. x 14 in. panel.
- 1 Baseboard 9 in. x 13 in. x 3/4 in.
- 7 Spring Clip Binding-posts.

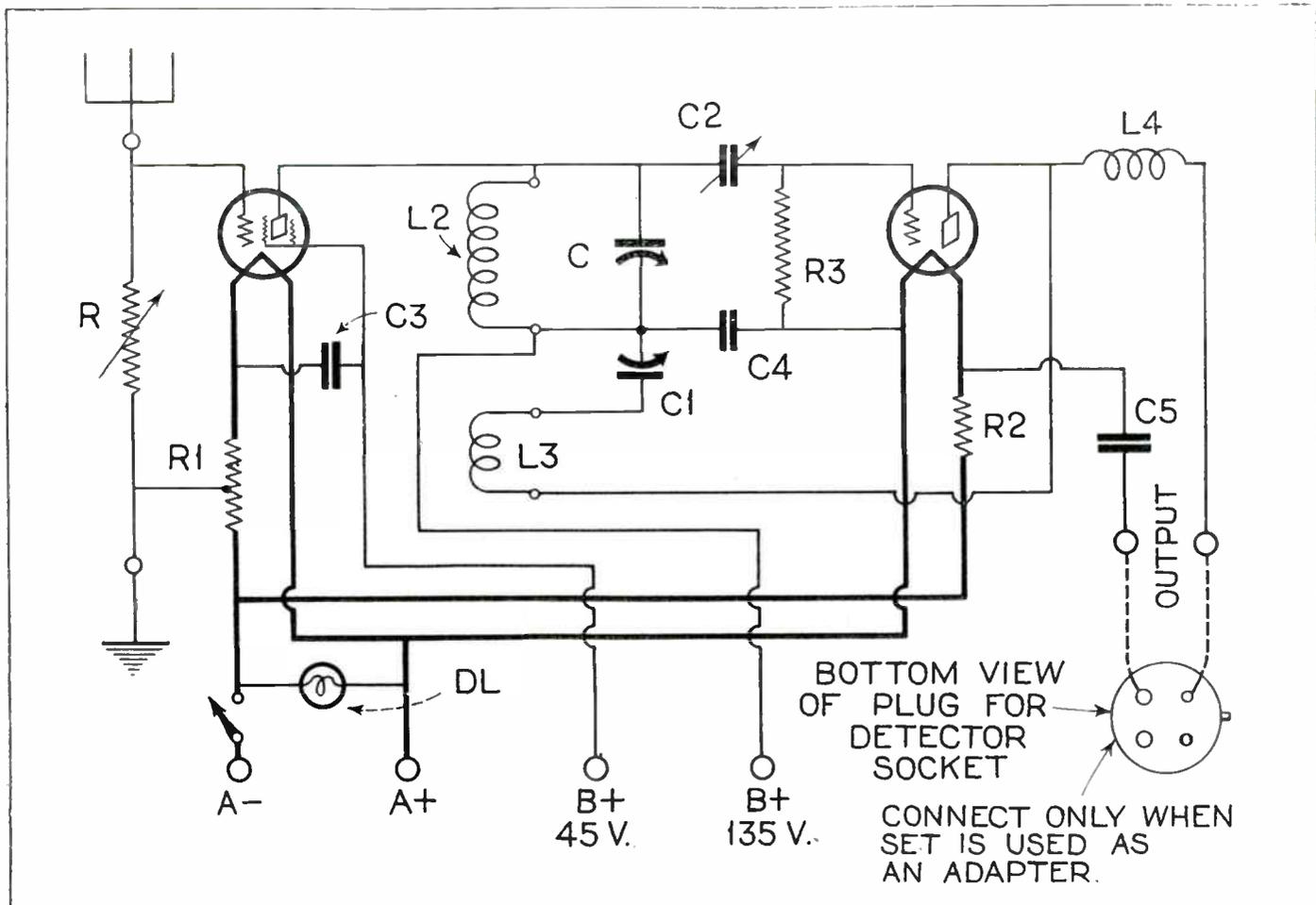
The various components which go to make up the set, including the front panel, are being marketed in kit form so that the assembly can be completed and wired by the average beginner in two or three hours. The front panel supplied with the kit is already drilled, and so, what is probably the greatest time consumer of the job, is eliminated.

The screen-grid short-wave receiver has several advantages over the usual regenerative type described in the opening of this story. The receiver described herewith employs two tubes in a circuit consisting of one stage of untuned radio-frequency-amplification and a regenerative-detector. The R.F. stage being of the untuned type (it employs the 222-type tube) does not add a tuning control; but it does provide for a very noticeable gain in amplification due to the fact that this sensitive tube is used. There is no doubt that the amplification obtained by the use of this tube averages between 3 and 4, depending upon the wavelength. To the beginner this may not sound as though it would make any difference in reception,

but amazing distances have been covered merely because of the additional amplification obtained by the use of the 222-type tube before the detector.

The addition of this tube has many other desirable effects on the operation of the receiver. First and most important, it makes the receiver much more stable in operation. It prevents the detector tube from radiating energy into the aerial, and, what is convenient, though not essential, it makes it possible to calibrate the tuning dial of the set; as the size of the aerial has no effect upon the tuning condenser. And, as was mentioned before, the "deadspots" of the receiver are eliminated due to the fact that the aerial is not connected directly to the detector circuit. The photograph shown in Fig. B reveals the simplicity of this receiver and the apparent ease with which it can be built.

The knob to the extreme left serves as the antenna resistance for volume control. This knob, if desired, may remain fixed, once it has been adjusted to the best point of operation. The next knob is the tuning control, and controls the drum dial. A filament switch and a regeneration control condenser complete the assembly for the front panel. There are but two controls in actual operation; practically one, because the regeneration condenser requires adjusting every twenty or thirty degrees of the dial. Thus, single dial tuning can be accomplished over quite a band of frequencies before the other hand is required for regeneration readjustment.

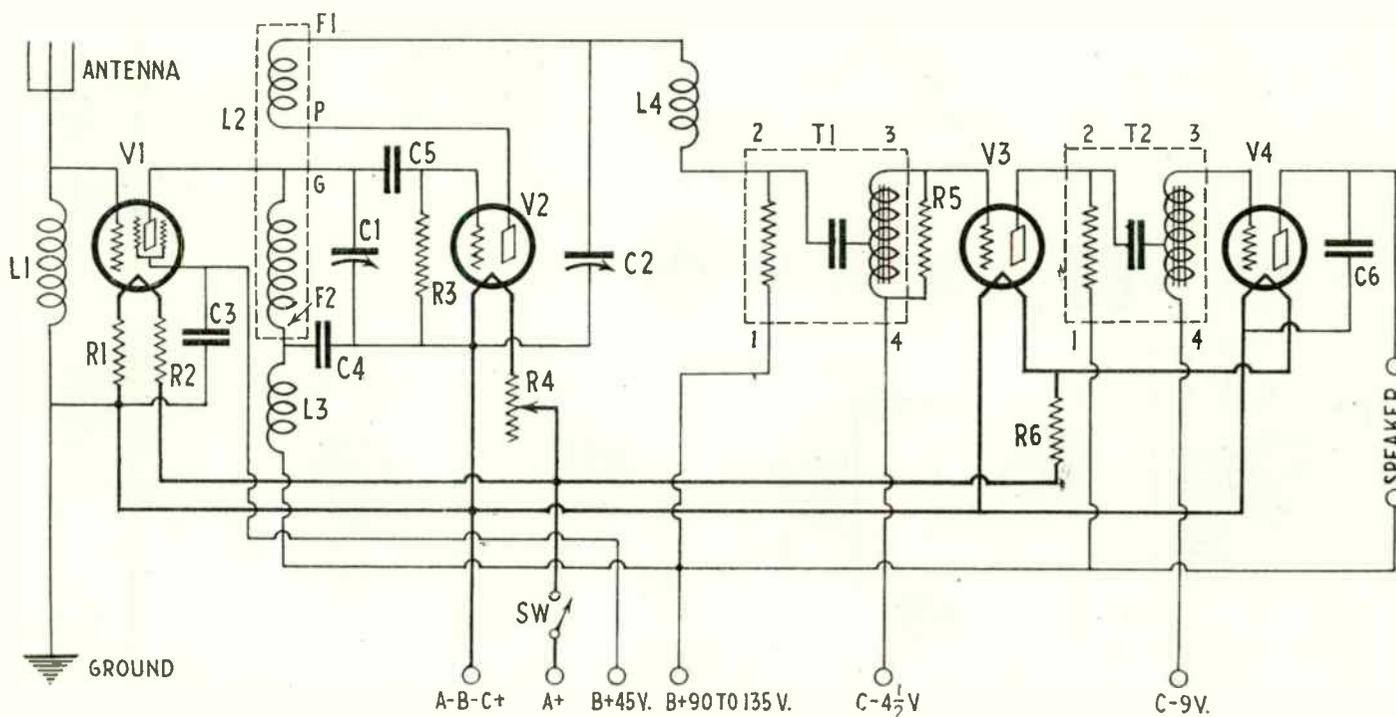


The circuit diagram of the "Trans-Oceanic Two." The dotted lines between the output terminals and the adapter-plug indicate that this method of use is optional. No audio-frequency amplification is included because of this, and, also, because of the preference of many constructors who desire to keep their audio systems away from the detector.

an annoying degree. A noisy broadcast type of condenser can often be quieted for short-wave use by insulating its bearings, at increased cost and labor. However, the type of compression bearing found in the Amsco and Silver-Marshall

ground can be obtained by connecting direct to any mounting screw fastening of the aluminum cabinet. All wiring should be short, direct, and well soldered, and care taken to avoid the possibility of "closed loops" of wiring which would

The parts used in the model are listed above, and are all standard parts selected for their high quality. The circuit was carefully designed around them to make sure that all builders will obtain the same results in spite of minor variations bound



Schematic wiring diagram of the S-M "Round-the-World Four." A 222 type tube is used in socket V1; two 201-A's in V2 and V3 and a 112-A in V4.

condensers is quite quiet at 20 meters, and offers all the advantages of a good mechanical bearing of brass and steel, yet perfectly quiet in operation. This feature of quiet bearings may be possessed by other types on the market as well.

In building this set, the parts should be placed as shown. A short direct

pick up energy and possibly cause irregular regeneration control. The apparently unnecessary by-pass condenser, shown connected from the second audio tube plate to ground, should be used; its purpose is to cut out the stray radio frequency currents in the audio amplifier, all in the interest of a good smooth set.

to occur in home assembly; therefore substitution should be made only when absolutely necessary. (Do not substitute for R.F. chokes, coil form size and variable condensers unless willing to "smooth up" your own particular set's operation by the "cut and try" scheme of adding by-pass condensers, R.F. chokes and resis-

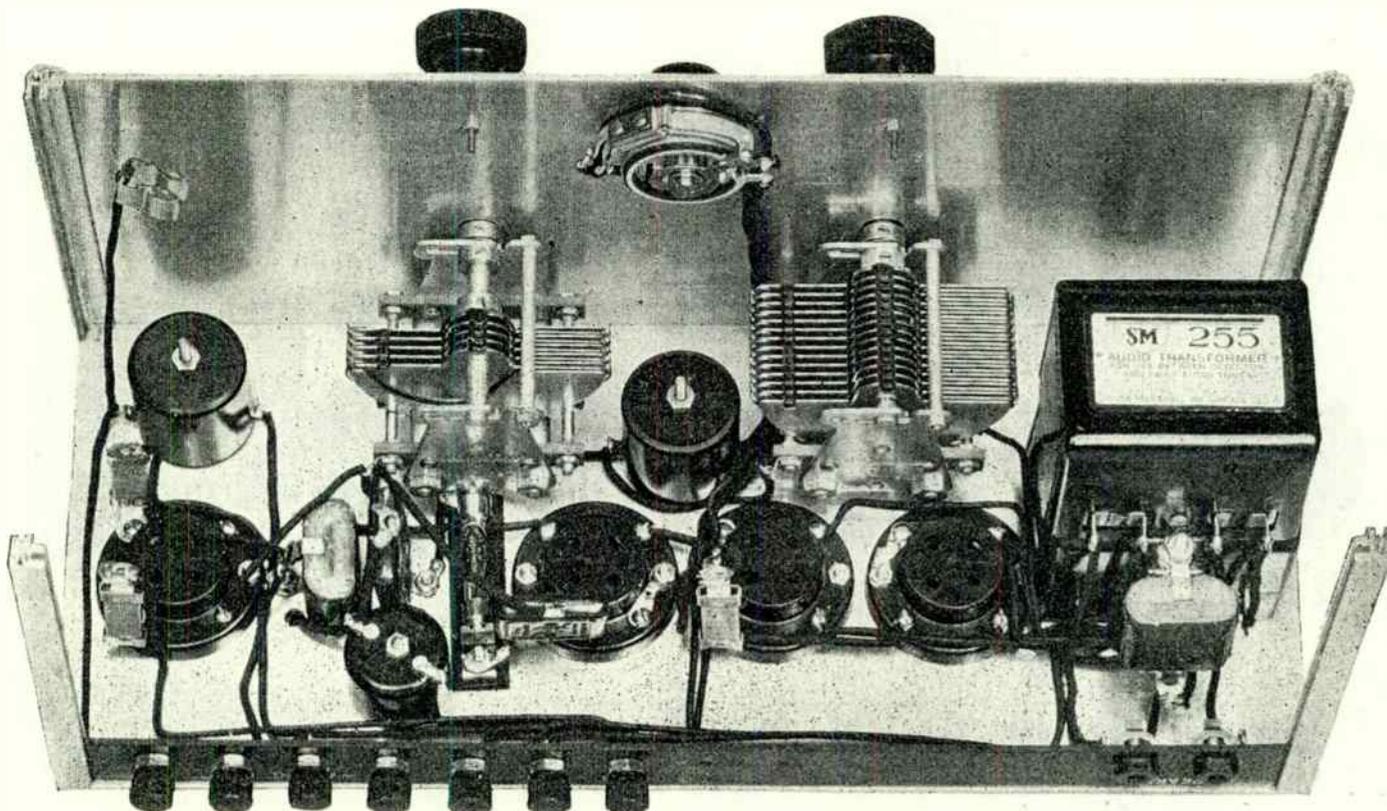
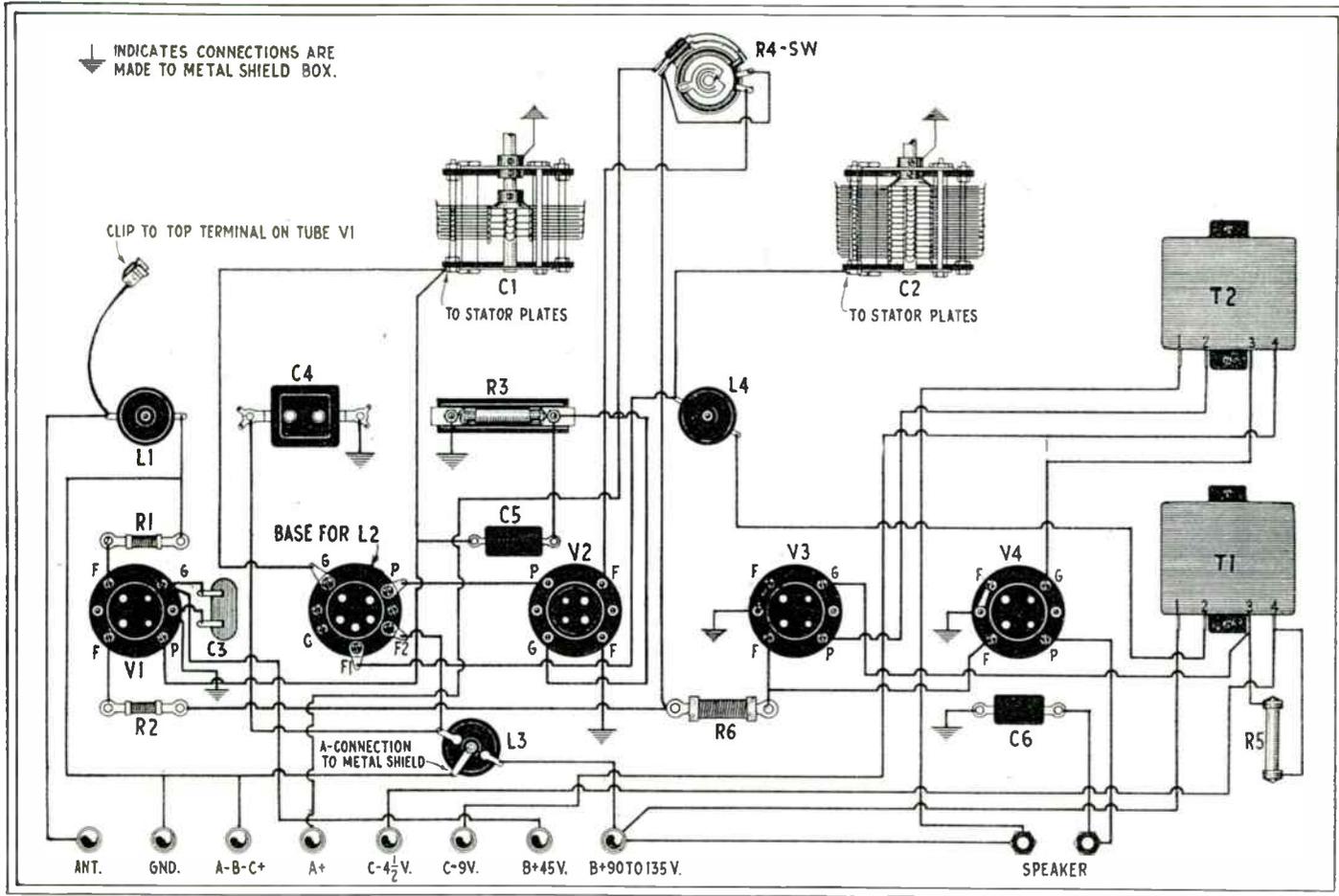


Photo of the set with the back and sides of the shield casing removed to show all the parts as they appear when wired.



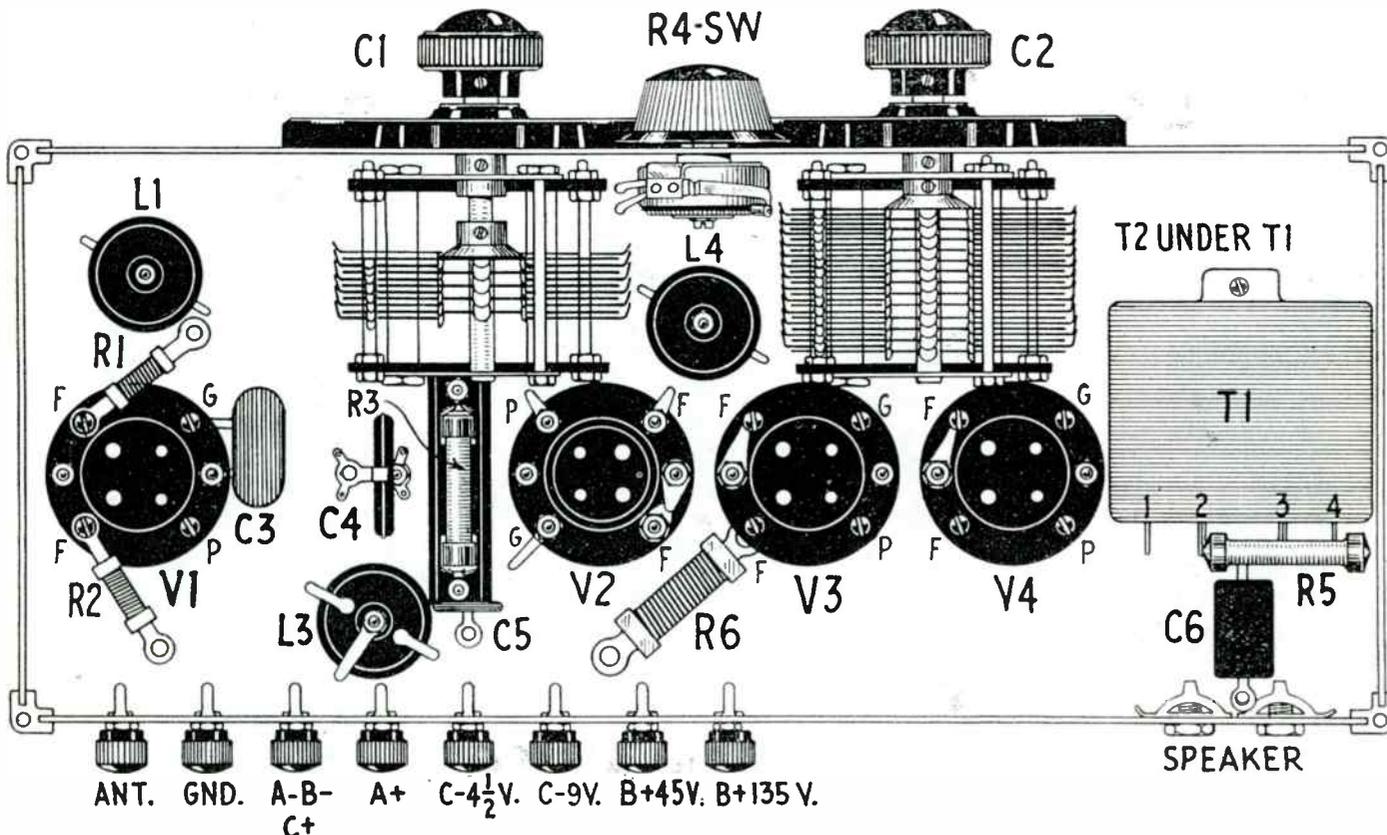
A picture wiring diagram of the set. All parts are indicated to correspond with the list of parts, schematic diagram and layout.

tors at needed points and trimming coils—or unless you are only interested in code reception.)

The coils are all wound on the same type of Silver-Marshall forms, with No. 34 D.C.C. wire for ticklers, and No.

22 P.E. wire for the secondaries (except the large coil which used No. 24 D.C.C.). All secondaries have turns so spaced that the windings cover the full 1½" of form space. The windings are so connected that the top or start of the secondary termi-

nates in the "G" post of a standard 5-point tube socket, and the bottom or end in the right-hand "F" post (the "F" post nearest the "P" or plate post). The slotted tickler, wound in the same direction. (Continued on page 31)



This is the layout of parts showing the location of each component. Note the neat compactness of the entire arrangement.

The picture Fig. B shows the complete picture diagram of both the front panel which is 7 x 14 inches, and the baseboard. On the front panel are mounted the volume control R, drum dial control, the filament switch and the regeneration condenser C1. On the baseboard are mounted the spring clip binding posts along the rear of the baseboard, and the other components which make up the receiver. C3 is a by-pass condenser in the R.F. circuit. A feature of this receiver is the adjustable grid condenser, C2, which is seen along side the detector tube socket. R3 is the grid leak, which, unlike the customary procedure, is wired across the grid and filament return of the detector tube. The radio-frequency choke coil is of a type specially designed for short-wave work and functions equally efficient on all frequencies; this is quite essential in short-wave reception.

EFFICIENT COILS

The coils supplied with this receiver are of an excellent low-loss type, using for the coil form a highly efficient insulating compound which holds the coil windings in an

"iron" grip. With this type of construction the constructor has the assurance that the inductive value of the coils will not be changed each time they are inserted or withdrawn from the coil receptacle. A set of these coils in this laboratory has been in use quite some time during which period they were subjected to rather rough treatment; and it must be said, they are still as good as new with their electrical characteristics unchanged. They cover the wavelength range from 15 to 107 meters with a .00014-mf. condenser. There is ample overlap making the tuning very smooth over the entire wavelength range. Hammarlund coils are available which will extend the range down to 8 meters and up to 215 meters.

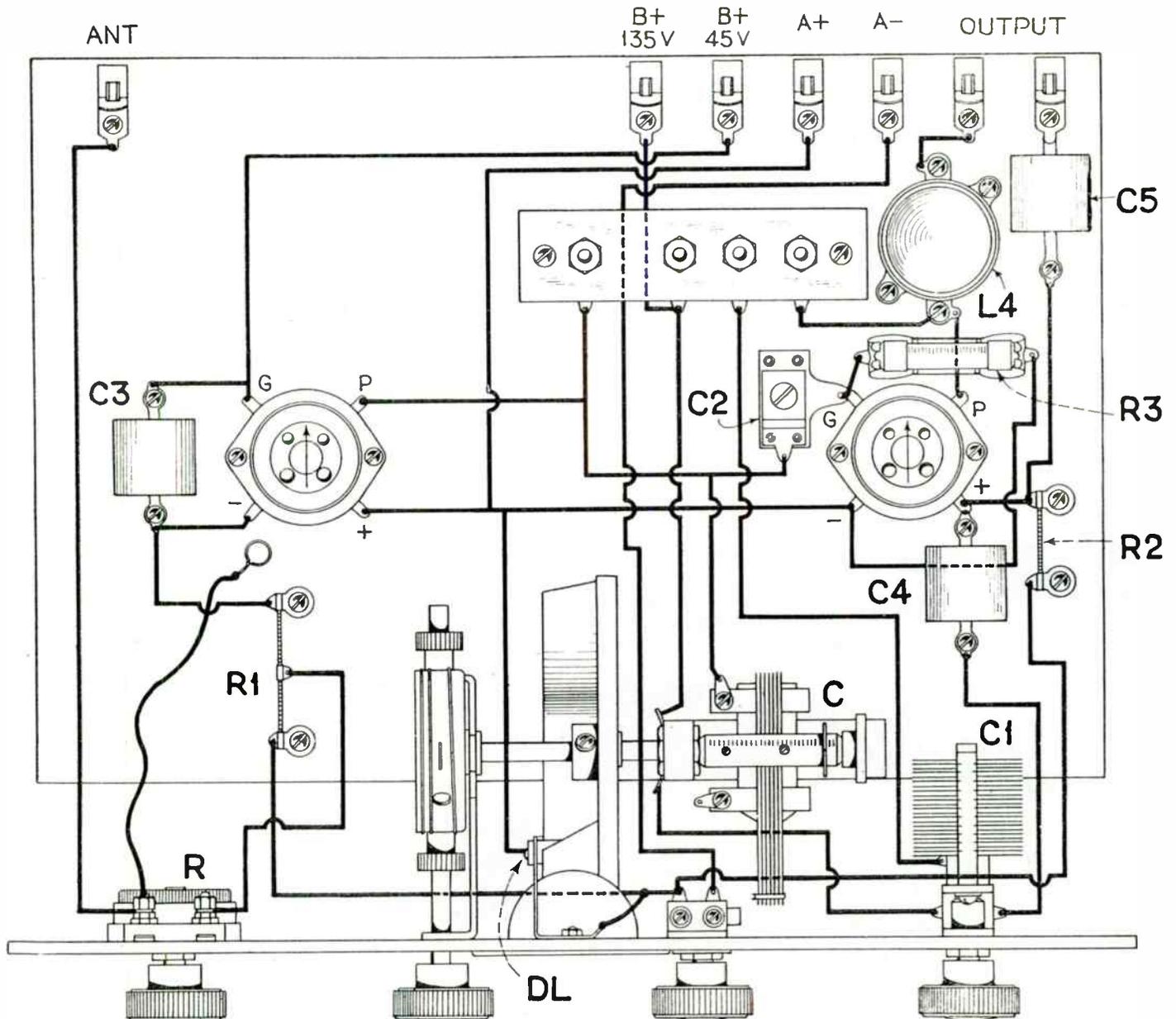
The operation of this receiver presents no difficulties to the man who has operated at any other time a regenerative receiver in any form. Those who have had no experience with any receiver of this type can readily grasp the principles of tuning. Distant stations may be found by increasing the regeneration condenser capacitance until a hissing noise is heard and the detector just begins to oscillate. This is the point of maximum

sensitivity. The control should be kept as near as possible to the "just oscillating point" throughout the tuning range. When properly adjusted there will be a slight hiss and the carrier waves or whistles of the stations will come in with maximum intensity. A phone station may be identified by the fact that there are no breaks in the signal, that there are no dots and dashes and by the fact that there is a sort of mushy sound to the noise, due to the modulation of the carrier by speech.

Whenever it is desired to determine whether or not the receiver is oscillating, touch the stator plates of the detector condenser. There should be a sharp click in the headphones or loud speaker. If there is no click, increase the capacitance of the regeneration condenser.

When a station is located, the regeneration should be decreased slightly, and the tuning condenser readjusted until the whistle is very low in pitch. Both adjustments should be made simultaneously so that the pitch is very low at the point the receiver starts oscillating.

(Continued on page 30)



The above is a picture diagram representing the various components which go to make up this highly efficient receiver. Spring-clip binding posts are used because of the simplicity of mounting them. A feature of this receiver is the Electrad Tomatrol which is employed as a volume control.

An 18- to 1500-Meter Receiver

Description of an Easily-Constructed Set with Plug-In Coils

By L. W. Hatry

THE amateur set constructor who can read radio code will find this receiver a most delightful one to operate. If he is listening to broadcast music and suddenly feels the urge to hear amateur or ship stations, he can satisfy the feeling instantly by merely lifting out one coil and replacing it by another. He can cover the whole sweep of wavelengths from 18 to 1,500 meters in this manner and is certain of finding something interesting to listen to. The receiver is extremely sensitive on the broadcast band, and will bring in many distant stations without trouble. It is just the thing for the man who wants one set and no more.—EDITOR.

THE plug-in coil idea, which assumed importance with the birth several years ago of the "honey-comb" type of coil-winding, has proved the most satisfactory solution of the problem of constructing a general-purpose radio receiver covering a great frequency range. For such a set, in which the several circuits—antenna, grid and plate,—require individual windings, it is desirable, if convenience is to be considered, that these three be on a single plug-in form.

In the set constructed by the writer and illustrated here, the coil forms have six contacts and are designed to fit a keyed circular socket with six spring contacts. The keying makes certain that the coil-form will fit the socket in only one way. With these six contacts and a little ingenuity it is possible to devise upwards of twenty-five dif-

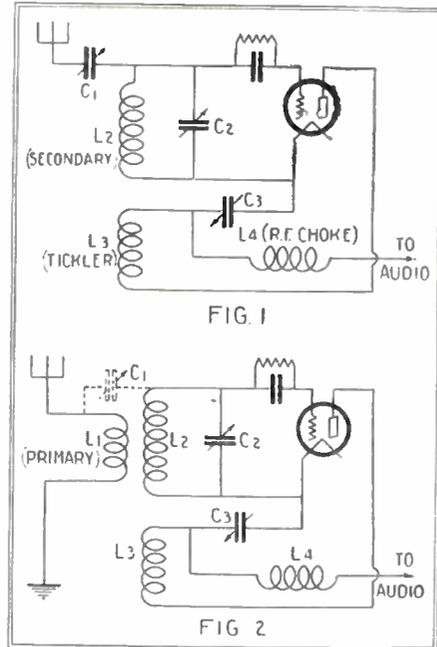
ferent coil arrangements for different purposes.

The circuit used is conventional. For the shorter wavelengths, below 200 meters, it is the well-known one of Fig. 1; and, for those which are longer, it is the equally well-known one of Fig. 2. A very slight difference exists due to the presence of the condenser C1, which is not used with the primary coil (L1). The primary is on, or rather in, the coil-form for the higher waves and plugs into the circuit automatically when the proper coil is used. The short-wave forms carry only two windings; secondary and tickler (L2 and L3).

The complete circuit, including the audio amplifier, is shown schematically in Fig. 3.

CHOICE OF CONDENSERS

To avoid multiplicity of coils and to provide overlap of the tuning ranges, the author has chosen for these standard coil units a tuning condenser of .00014-microfarad maximum, with a minimum in the order of .000015 microfarad. This value of the minimum is due partly to the tuning condenser itself and partly to the tube and its associated wiring. This condenser value is suitable for the higher frequencies, represented by waves of 200 meters and less. A higher maximum capacity and greater capacity range is needed to tune to the lower frequencies (higher wavelengths). For the wavelengths above 200 meters the coils are designed for use with .00035-mf. as the maximum capacity, with practically the same minimum as before. To get these the two capacity ranges, necessary to cover the waves from 18 to 1,500 meters, a simple switch and a series-condenser arrangement



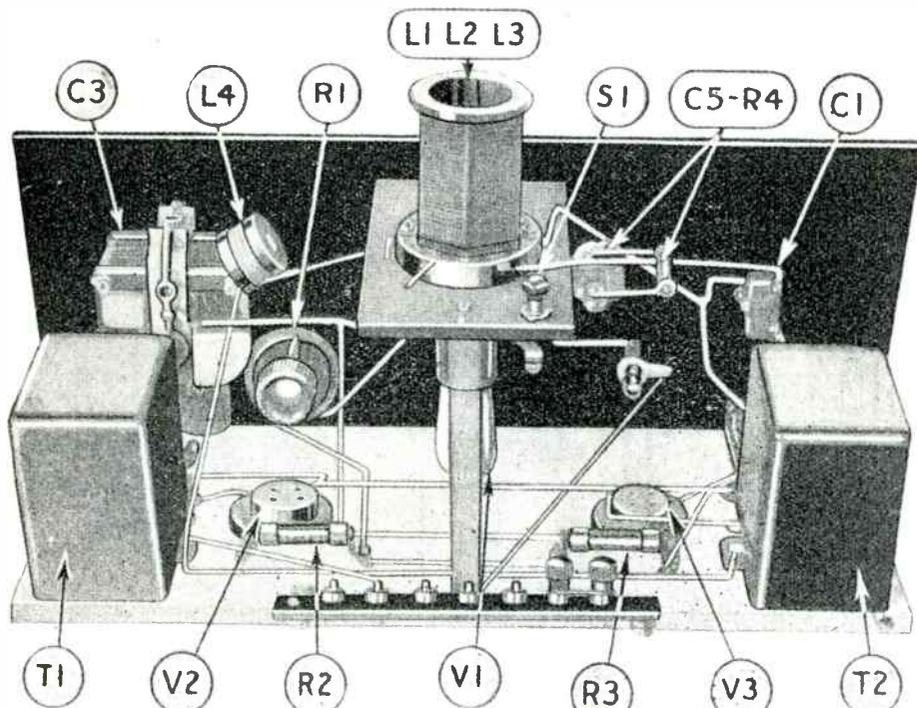
In Fig. 1 is shown the receiving circuit used for short waves, and in Fig. 2 that for wavelengths up to 1,500 meters.

is used in conjunction with a standard .00035-mf. (maximum) variable condenser.

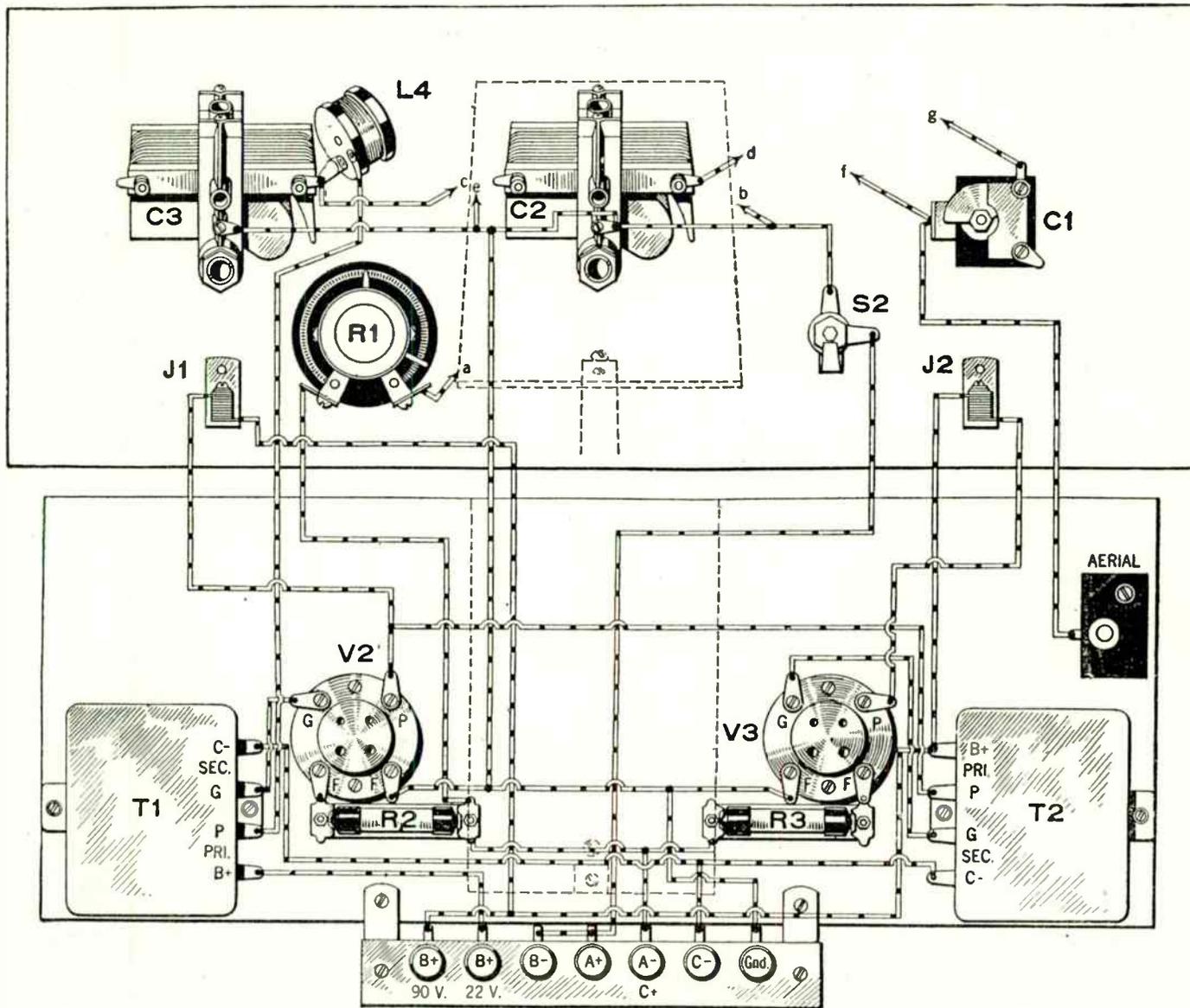
A straight-line-frequency variable condenser is desirable for two reasons; it makes tuning easy and accurate; and it conforms with logic. One is necessary in an arrangement such as that used in this set, since a series capacity enters into the design considerations. In Fig. 4 are shown several curves, all plotted against frequency and dial-settings; the usual arbitrary 100-division, half-circle range being considered as standard. Curve "C" is that of a variable condenser with semi-circular plates, whose curve of capacity-increase against dial settings is a straight line. The curve "C" shows how badly the frequencies at the lower dial settings are crowded and how they are spread out at the higher.

If it is desirable to make the tuning curve plotted in Fig. 4 straight, both "C" and "B" would be unsatisfactory. Curve "B" indicates the need for a condenser whose plate design will give nearer a straight-frequency line. Curve "A" is a straight-frequency line such as would result from the use of the proper variable condenser, and "D" shows the alteration in the same curve resulting from the use of a series capacity. For tuning convenience it is decidedly inadvisable that the tuning condenser (C2) used in Fig. 3 be other than one whose plate-design is intended to give a straight-frequency-line. Of course, if the "curve" is not straight, the electrical efficiency of the set will not be altered, but the tuning convenience will.

The detector-tube socket is on the underside of the coil-socket shelf, to assure short leads and the consequent wiring simplicity that results. The coil-socket shelf is of decided utility; the coil socket is thus located



L1, L2 and L3, plug-in inductor; C1, midget condenser; C3, variable condenser; C5, grid condenser; R1, 60-ohm rheostat; R2 and R3, ballast resistors; L4, R.F. choke; R4, grid-leak; S1, wave-changing switch.



Wiring diagram of the 18-1500 meter receiver. There is a shelf indicated over the condenser, C2. The wiring of the apparatus on this shelf is shown in detail on page 24.

where one can put in the coil without hunting behind the panel and without rising, if one is sitting before the set. The detector tube hangs nose down.

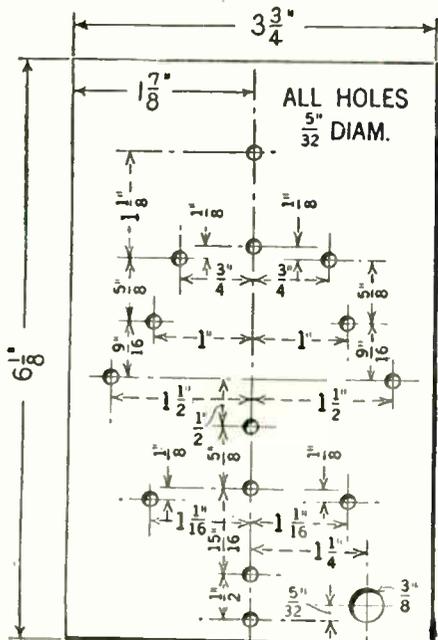
The back edge of the coil-socket shelf, as shown, is supported by a plain stick of wood, which may be a length of half-inch dowel stick.

SMALL-CAPACITY GRID CONDENSER

After several comparative tests the writer has for a long time used a .00005-mf. grid condenser in his broadcast receiver; it does

not, apparently, reduce volume sufficiently to bother the ear, and the improvement in quality is evident.

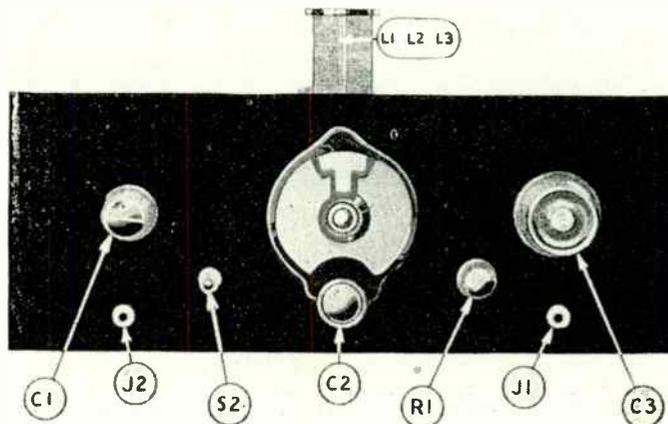
This set, tuning down to 18 meters, could afford a smaller grid condenser at the shorter waves, but then the 200- to 1500-meter signals would suffer; so an average is struck which preserves the quality for broadcasting, as much as possible, in the detector, and at the same time saves the D. C. notes that some C. W. stations have in full volume at the higher tones.



Drilling details for the shelf on which is placed the socket for the inductors.



Right: Front panel view of the set, showing how the plug-in coil L1-L2-L3 protrudes above the top. If a cabinet is used, a hole must be cut in its top to pass this coil.



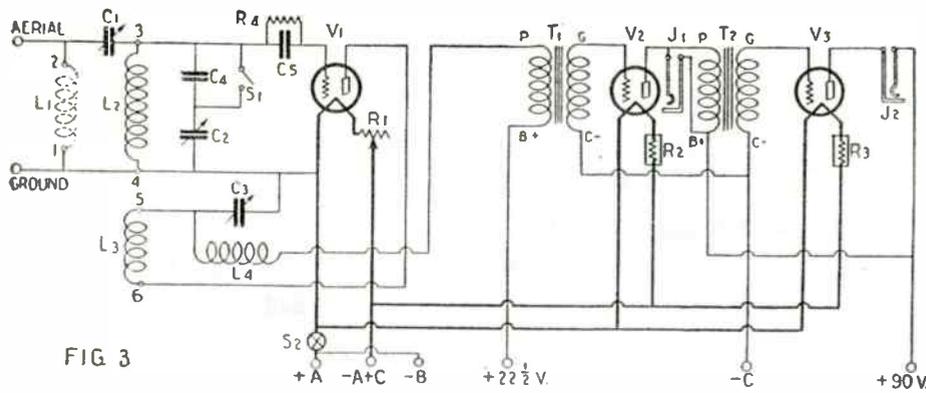


FIG 3

The schematic diagram of the 18-1500 meter receiver. The switch, S1 is used for shorting the condenser, C4. It is left open on the short waves, and closed for the high.

RANGE OF COILS

The various wavelength ranges with the standard plug-in coils specified, the first with the .00014-mf. maximum and then with .00035-mf. maximum are given below.

| Coils (in order of size) | Range (meters) with .00014-mf. | Range (meters) with .00035-mf. |
|--------------------------|--------------------------------|--------------------------------|
| No. 1 | 18-32 | 19-51 |
| No. 2 | 30-53 | 33-85 |
| No. 3 | 51-90 | 57-144 |
| No. 4 | 85-150 | 95-240 |
| No. 5 | 150-350 | 190-550 |
| No. 6 | 450-900 | 500-1500 |

These figures are not exact and cannot be. The series-feed condenser, C1, upsets everything, if set at full capacity all the time, so the figures are more or less of an average.

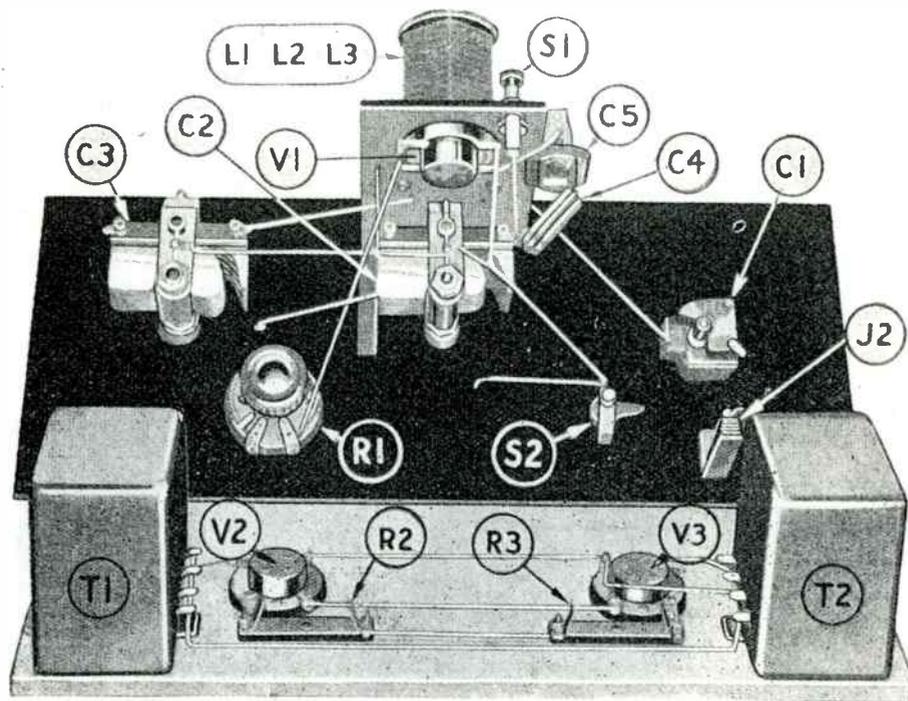
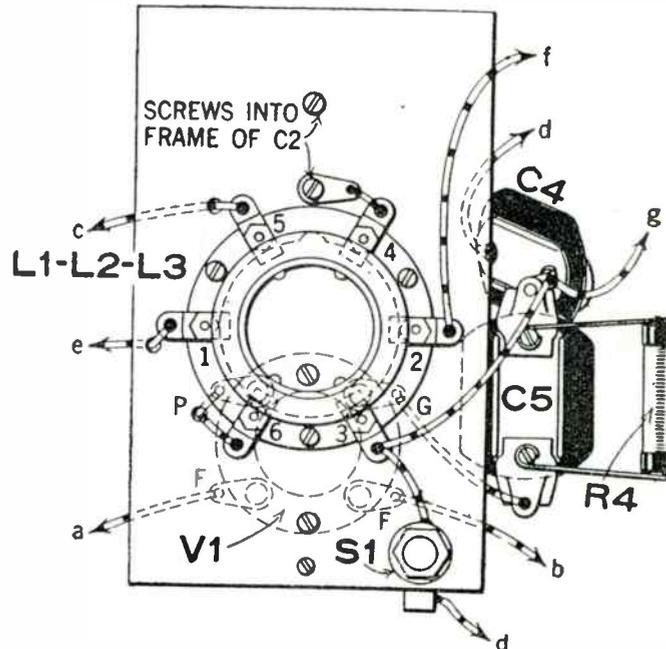
For instance, the 18-meter minimum is a trifle high, although not much lower may be obtained.

The utility of the double capacity range is obvious. With the switch, S1 (Fig. 3) open, the tuning capacity maximum (C2 and C4 in series) is .00014-mf.; any wavelength range in the .00014-mf. column (table) with the correct coil, can be obtained. With the same coil, and the switch closed, the wave-length range is extended to that ob-

tained from the .00035-mf. maximum. When using the 18-meter coil, in other words, it is possible to chase up to 40 meters quickly to see if anything is going on, by merely



The small letters at the ends of the wires coincide with those shown at the ends of the loose wires on the picture diagram found on page 23. The tube socket V1 is screwed bottom up to the under side of the sub-panel. Its four posts are lettered F, F, G, P.



C2, variable condenser; S2, battery switch; T1 and T2, A.F. transformers; J2, jack. The rest of the apparatus is numbered as in the other illustrations. The set is shown here half assembled.

closing the switch and without changing coils. Tuning will be easier and signal strength slightly better when the proper coil and capacity for the proper wavelength ranges are used, however.

A feature to interest the 600-meter, commercial man, it seems to me, is the largest coil and its 490-900-meter wavelength range, with .00014-mf.; because with this coil and capacity values, he can cover the entire useful 600-traffic zone with nicely spread-out tuning. I have enjoyed tuning up there on that account.

The R.F. choke coil is not a small choke; it is one-millihenry and the style specified for wavelengths on the order of 2000 meters. With capacity regeneration control such a choke is necessary generally to insure good results. Otherwise the tube oscillates continuously on wavelengths from 200 to 1,500 meters when the ticklers are of the right size to cover the range. This seems to me,

after check-up with small and large audio transformers, to be due to the distributed capacity of the A.F.T. primary, which takes effect and nullifies the use of the variable condenser which is the controller of regeneration. When the choke is put in oscillation stops immediately (if the control condenser is set to minimum) and starts up under control of this condenser, C3. No R.F. choke is needed between 200 and 18 meters; the primary of the A.F.T. seems to offer enough opposition.

OBTAINING BEST RESULTS

After having carefully picked a fairly respectable, non-distorting size of grid condenser and its shunt resistance, it would be silly for the constructor to put poor audio transformers in this little set. For broadcast reception high-grade transformers are necessary. For telegraph reception it is equally important; for many of the amateur C.W. tones are A.C. at frequencies between 32 and 240 cycles, all of which are out of the reach of poor audio transformers whose amplifying effectiveness is gone at 250 cycles or whose optimum range is limited definitely between 400 to 1000 cycles. Both the short-wave fan and the broadcast

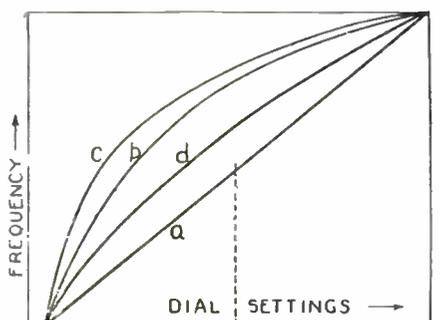


FIG. 4

A family of curves: (a) S.L.F. condenser. Half the frequency range is confined to half the scale, causing even frequency tuning. (b) S.L.W. condenser. Two-thirds of the frequency range is confined below 50 on the dial, and only one-third shows in the upper half of the scale. (c) S.L.C. condenser (old-style semi-circular plates). Four-fifths of tuning range is confined to lower half of dial. (d) S.L.F. with series condenser, showing how curve (a) is altered to crowd a somewhat higher percentage of the tuning range below 50 on the dial. This effect would be worse if the alteration occurred in the (b) or (c) curve.

fan want a transformer whose amplifying ability is good all the way down to 60 cycles. The only person who could be served by a transformer amplifying best between 400 and 1000 cycles is the commercial operator on shipboard who uses 500-cycle tones most often. The utility of a selective audio amplifier on 600 meters is high. But on a set covering such a very broad band of wavelengths, and intended for so many purposes as this 18- to 1,500-meter outfit, good audio transformers are desirable.

The tuning of the set is not difficult. The midget condenser, C1, is set over to the left, or minimum, before starting up with the short-wave coils. Then the filament rheostat and the regeneration control tell one how the detector is operating for regeneration. After that an adjustment of the midget to permit fair regeneration control and good signal strength leaves the rest of the adjustments up to the tuning dial and the

regeneration control. When the two coils having primary windings are plugged in, the midget is left at minimum setting and the angle of the primary winding is adjusted to give fair volume and selectivity, and left there. The set is regenerative and tunes like others of the class.

At wavelengths below the broadcast band, reception of amateurs all over the world is its regular performance, for the writer, liv-

ing in Hartford, Conn. He has heard South Africa, England, France, Germany, Italy, Australia and New Zealand, and thus it goes. In the broadcast band the set is a three-tuber, and no imagination can make it otherwise. For ship traffic it is especially good, and the writer enjoys listening to the crisp cross-talk a great deal. Ships are heard on both coasts and far into the Gulf of Mexico.

| SYMBOL | Quantity | NAME OF PART | REMARKS | MANUFACTURER * |
|------------|----------|---------------------|------------------------------------------|----------------------------------------------|
| L1, L2, L3 | 4 | Plug-in coils | Wavelength range 18-150 meters | with 1 |
| L1, L2, L3 | 1 | Plug-in coil | Wavelength range 150-350 meters (,00016) | 1 |
| L1, L2, L3 | 1 | Plug-in coil | Wavelength range 450-900 meters | mf. 1 |
| C2, C3 | 2 | Variable condensers | 0.00035 mf. | 1 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 43 |
| T1, T2 | 2 | A. F. transformers | | 1 4, 17, 21, 22, 23, 24, 25, 26, 54 |
| S1, S2 | 2 | Battery switches | | 2 13, 23, 27, 28, 29, 30, 31, 34, 54 |
| | 3 | Tube sockets | UX 199 type | 1 4, 13, 16, 17, 21, 28, 29, 32, 33, 34 |
| C1 | 1 | Variable condenser | Midget .00025 mf. or smaller | 1 11, 19, 57 |
| L4 | 1 | R. F. choke coil | 1 millihenry | 1 7, 14, 16, 17, 24, 35, 36, 37, 38, 39 |
| R1 | 1 | Rheostat | 60 ohms | 2 4, 19, 23, 31, 33, 41, 42, 43, 56 |
| C5 | 1 | Grid Condenser | .00005 mf. or .0001 mf. | 3 2, 23, 26, 39, 40, 44, 45, 46 |
| C4 | 1 | Fixed condenser | .00025 mf. | 3 2, 23, 26, 39, 40, 44, 45, 46 |
| R4 | 1 | Grid leak | 2 megohms | 2 10, 23, 43, 44, 46, 47, 48, 49, 56, 58 |
| J1, J2 | 2 | Jacks | open circuit | 4 2, 13, 19, 23, 26, 29, 30, 31, 47 |
| R2, R3 | 2 | Bellat Resistors | for 199 tubes | 5 55, 56 |
| | 1 | Vernier Dial | | 6 7, 8, 17, 21, 22, 24, 32, 34, 47 |
| | 1 | Binding Post Strip | 1" X 7" X 1/8" | 7 34, 48, 50, 53 |
| | 8 | Binding Posts | | 8 7, 34, 43, 53, 54 |
| | 1 | Panel | 7" X 18" X 3/16" | 7 34, 48, 50 |
| | 1 | Baseboard | wood 6 1/2" X 17" X 1/2" | 7 34, 48, 50 |
| | 1 | Coil Shelf | 6" X 3 1/2" X 3/16" | 7 34, 48, 50 |
| V1, V2, V3 | 3 | Vacuum Tubes | 199 type | 9 51, 52 |

NUMBERS IN LAST COLUMN REFER TO CODE NUMBERS BELOW.

| | | |
|------------------------------------------|--------------------------------------|-----------------------------------|
| 1 Silver-Marshall, Inc. | 2 Electrad, Inc. | 3 Sangano Electric Co. |
| 4 Pacent Electric Co. | 5 Radiall Company (Amperite) | 6 National Company |
| 7 Micarta Fabricators, Inc. | 8 H. R. Eby Mfg. Co. | 9 C. F. Mfg. Co. |
| 10 Deven Radio Corp. | 11 Hammarlund Mfg. Co. | 12 Hartzen Mfg. Co. |
| 13 Allen Mfg. Co. (No-Aid) | 14 Ambassador Sales Co., Inc. | 15 Walbert Mfg. Co. |
| 16 Gray & Donelson Mfg. Co. (Reiner) | 17 All-American Radio Co. | 18 Wirt Co. |
| 19 Chelton Elec. Co. | 20 Radio Condenser Co. | 21 Brainer-Tully Mfg. Co. |
| 22 Bruno Radio Corp. | 23 Federal Radio Corp. | 24 Samson Elec. Co. |
| 25 High Frequency Labs. | 26 Stromberg-Carlson Tel. Mfg. Co. | 27 Bryant Fil. Co. |
| 28 Cutler-Hammer Mfg. Co. | 29 Setaun Mfg. & Sales Co., Inc. | 30 Millimeter Machine Works, Inc. |
| 31 H. H. Frost, Inc. | 32 General Industries Co. | 33 Klesner Radio Corp. |
| 34 F. W. Morse Co. | 35 F. W. Sickles Co. | 36 Ma-Rad Radio Corp. |
| 37 General Winding Co. | 38 Globe Radio Equipment Co. | 39 Radio Receptor Co. |
| 40 Pellego Switchboard & Supply Co. | 41 Central Radio Labs. | 42 General Instrument Corp. |
| 43 Amco Products, Inc. | 44 Wisconsin Radio Corp. | 45 John-Deutchman Co. |
| 46 Dubilier Condenser Corp. | 47 Martin-Copeland Co. (Mar-Co) | 48 Scientific Laboratories |
| 49 International Res. Co., Inc. (Durham) | 50 American Hard Rubber Co. (Radion) | 51 Northern Mfg. Co. |
| 52 Schickelring Products Corp. | 53 L. L. Radio Labs. | 54 Conn. Tel. & Elec. Co. |
| 55 Langbein-Krausnig Mfg. Co. | 56 L. S. Brech Mfg. Co. | 57 General Radio Co. |
| 58 Allen Bradley Co. | | |

* THE FIGURES IN THE FIRST COLUMN OF MANUFACTURERS INDICATE THE MAKERS OF THE PARTS USED IN THE ORIGINAL EQUIPMENT DESCRIBED HERE.

If you use alternate parts instead of those listed in the first column of manufacturers, be careful to allow for any possible difference in size from those originally used in laying out and drilling the panel and sub-base.

LIST OF SHORT-WAVE STATIONS OF THE WORLD

Stations will prefix their calls with their allotted national letters on or before January 1, 1929.

| Radio Call Letters | BROADCAST STA. Location | Wave (Meters) | Power (Watts) | Radio Call Letters | BROADCAST STA. Location | Wave (Meters) | Power (Watts) | Radio Call Letters | BROADCAST STA. Location | Wave (Meters) | Power (Watts) |
|----------------------|--------------------------------------------|---------------|---------------|----------------------------------------------------------------------------------------------------------------|-----------------------------------|-----------------|---------------|--------------------|-------------------------|---------------|---------------|
| UNITED STATES | | | | | | | | | | | |
| WKA (WXX) | East Pittsburgh, Pa. (W8XS, W8XP-portable) | 62.50 | 40,000 | WJW (W5AF) | Cleveland, Ohio | 66.04 | 500 | | | | |
| KEJK (W6XAN) | Los Angeles, Calif. | 27.00 | 250 | WJR-WCX (W5AO) | Pontiac, Michigan | 32.00 | | | | | |
| KEWE | Bollinas, Calif. | 105.90 | | WJZ | New Brunswick, N. J. | 59.96 | 30,000 | | | | |
| KFPY (W7XAB) | Spokane, Washington | 105.90 | 100 | WLW (W8XAL) | Cincinnati, Ohio | 52.02 | 250 | | | | |
| KFQU (W6XBH) | Holy City, Calif. | 31.00 | 50 | WNAL (W9XAB) | Omaha, Neb. | 49.96 | 250 | | | | |
| | | 53.00 | | WNST | Elgin, Ill. (Time Signals) | 35.50 | 500 | | | | |
| | | 63.00 | | WND | Ocean Township, N. J. | 46.48 | | | | | |
| KFQZ (W6XAL) | Hollywood, Calif. | 108.20 | 50 | WOR (W2XAQ) | Kearny, N. J. | 65.40 | 50 | | | | |
| KFVO (W6XB) | Culver City, Calif. | 105.50 | 50 | WOWO | Fort Wayne, Ind. | 22.80 | 1,000 | | | | |
| KFWB (W6XBR) | Los Angeles, Calif. | 105.00 | 50 | WRNY (W2XAL) | New York, N. Y. | 30.91 | 500 | | | | |
| | | 40.00 | | WTFF | Mt. Vernon, Va. | 56.00 | | | | | |
| KFWO (W6XAD) | Avalon, Calif. | 53.07 | 100 | WZXC | Rocky Point (transatlantic phone) | 16.02 | | | | | |
| KGER (W6XBV) | Long Beach, Calif. | 48.86 | | <i>(Several short waves are used for transatlantic telephony. This is private business, not broadcasting.)</i> | | | | | | | |
| KGB | San Diego, Calif. | 65.18 | | SWEDEN | | | | | | | |
| KGDE | Barrett, Minn. | 40.00 | 50 | SAS | Karlsborg | 52.50 | | | | | |
| KGO (W6XAX, W6XN) | San Francisco, Calif. | 10 to 40 | 10,000 | SAA | Karlskrona | 44.40 | | | | | |
| KHJ (W6XAU) | Los Angeles, Calif. | 104.10 | 50 | SAJ | Karlsborg | 47.00 | | | | | |
| KJBS (W6XAR) | San Francisco, Calif. | 61.60 | 50 | SMHA | Stockholm | 41.00 | | | | | |
| KJR (W7XC, W7XO) | Seattle, Washington | 105.20 | 250 | SWITZERLAND | | | | | | | |
| KMOX | St. Louis, Mo. | 49.00 | 15 | H9OC | Berne | 32.00 | | | | | |
| KMTR | Los Angeles, Calif. | 108.20 | 250 | H9XD | Zurich | 85.00 and 32.00 | | | | | |
| KNRC (W6XAF) | Santa Monica, Calif. | 108.20 | 100 | AFRICA | | | | | | | |
| KNX (W6XA) | Los Angeles, Calif. | 107.10 | 100 | AIN | Casablanca, Morocco | 51.00 | | | | | |
| KOIL (W9XU) | Council Bluffs, Iowa | 61.86 | 500 | IBR | Constantine, Tunis | 42.80 | | | | | |
| KWE-KEWE | Bollinas, Calif. | 14.10 | | JB | Johannesburg, U. S. Africa | 32.60 | | | | | |
| KWJJ (W7XAO) | Portland, Oregon | 53.54 | 100 | JLO | Nairobi, Kenya | 90.00 | 4,000 | | | | |
| WAAM (W2XBA) | Newark, N. J. | 65.18 | 50 | AUSTRALIA | | | | | | | |
| WABC (W2XE) | Richmond Hill, N. Y. | 58.50 | 500 | ZBL | Sydney | 32.50 | | | | | |
| WAJ | Rocky Point, N. Y. | 22.48 | | ZFC | Sydney | 28.50 | | | | | |
| WBRL (W1XY) | Tilton, N. H. | 109.00 | 250 | ZME | Sydney | 28.50 | | | | | |
| WCGU (W2XBH) | Brooklyn, N. Y. | 54.90 | 150 | ZAR | Melbourne | 55.00 | | | | | |
| WC5H (W1XAB) | Portland, Maine | 63.79 | 250 | ZLO | Melbourne | 32.00 | | | | | |
| WCX | Pontiac, Michigan | 32.00 | 75 | ZAG | Perth, West Australia | 32.90 | | | | | |
| WEAJ | Rocky Point, N. Y. | 22.48 | | | | | | | | | |
| WEAO (W8XJ) | Columbus, Ohio | 54.02 | 25 | | | | | | | | |
| WGY (W2XAF) | Schenectady, N. Y. | 31.40 | | | | | | | | | |
| | (W2XAD) Schenectady, N. Y. | 21.96 | | | | | | | | | |
| AUSTRIA | | | | | | | | | | | |
| | | | | OHK2 | Vienna | 70.00 | | | | | |
| | | | | EATH | Vienna | 37.00 | | | | | |
| | | | | | Vienna | 22.20 | | | | | |
| BELGIUM | | | | | | | | | | | |
| | | | | EB4A2 | Brussels | 42.00 | 300 | | | | |
| CANADA | | | | | | | | | | | |
| | | | | CF | Drummondville, Quebec | 32.00 | | | | | |
| | | | | CJRX | Winnipeg, Man. | 25.60 | 2,000 | | | | |
| DANTZIG | | | | | | | | | | | |
| | | | | EK4ZZZ | Dantzig | 40.00 | | | | | |
| DENMARK | | | | | | | | | | | |
| | | | | O7MK | Copenhagen | 32.05 | 500 | | | | |
| | | | | D7RL | Copenhagen | 42.12 and 84.24 | 250 | | | | |
| ENGLAND | | | | | | | | | | | |
| | | | | 55W | Chelmsford | 24.30 | 15,000 | | | | |
| | | | | 2NM | Caterham | 32.50 | | | | | |
| | | | | GBS | Rugby | 24.40 | | | | | |
| FINLAND | | | | | | | | | | | |
| | | | | | Helstingfors (Helsinki) | 31.50 | | | | | |
| FRANCE | | | | | | | | | | | |
| | | | | F8GC | Paris ("Radio LL") | 61.00 | 500 | | | | |
| | | | | F8AV | Nogent | 80.00 | 500 | | | | |
| | | | | Radio Vitus | Paris | 37.00 | 1,500 | | | | |
| | | | | Eiffel Tower | Paris (time signals) | 32.00 | | | | | |
| | | | | YR | Lyons ("Radio Lyon") | 40.20 | 250 | | | | |
| | | | | YN | Agon | 30.75 | | | | | |
| | | | | YV | Lyons | 58.00 | 3,000 | | | | |
| | | | | FW4 | Nancy | 15.50 | 500 | | | | |
| | | | | | Ste. Asaise | 24.50 | | | | | |

(Continued on page 29)

A "Junk Box" Short-Wave Receiver

For the Experimenter Who Wishes to Try His Luck Below a Hundred Meters

By Robert Hertzberg



BECAUSE of the extraordinary DX work that is being accomplished by amateurs and broadcasters on the short waves (i.e., below 100 meters), many radio fans have become possessed of the idea that the apparatus used for such reception must necessarily be complicated, expensive, and difficult to construct and operate. These fans read of the success of listeners in South America, Africa, Australia and New Zealand in picking up programs transmitted on short wavelengths from Schenectady and Pittsburgh in the United States, and from London, in England; and of the similar success of American listeners in hearing broadcasts from England, Holland, Germany, Russia, Siberia, and Australia. As a result, they are apt to conclude that the receivers must contain at least eleven tubes and be two yards long.

The truth of the matter is that the receivers employed by the majority of these listeners are of the simplest possible design, rarely containing more than three tubes and usually only two. They are of the "straight regenerative" type, and can be made in an hour or so of spare parts, such as are found in every experimenter's junk box. They enable their owners to pick up the programs of numerous short-wave broadcast stations, conversations between amateurs using voice transmission, and code signals from thousands of amateur and commercial transmitting stations in every part of the world. The "thousands" is no exaggeration; for there are more than 16,000 licensed amateur transmitting stations in the United States alone, and large numbers in other countries. International communication between these stations, over distances as great as there can be between two points on this earth, is a nightly affair.

OUT OF THE JUNK BOX

For the purpose of illustrating how simple an efficient short-wave receiver can be, a member of the staff of RADIO NEWS selected a handful of idle parts from his own private junk box and assembled a complete two-tube set in less than two hours' time. He worked a second evening "juggling" the various coils, to make them cover the short-wave bands from 20 to 100 meters, but the reader of this article will be spared this work; all the data are ready for him. The little outfit produced such gratifying re-

FEATURES OF THIS SET

THE little short-wave receiver described in the accompanying article possesses the following features, which will appeal to everyone:

(1) *It will pick up short-wave broadcast, amateur and commercial stations operating between 20 and 100 meters.*

(2) *It may be assembled in two hours.*

(3) *Its cost is practically nothing; as the necessary parts may be found in almost every experimenter's junk box.*

(4) *It is easily operated, as it uses only two controls and two tubes in a simple circuit.*

sults that we have decided to publish the following description of it. The designer of the set guarantees that any reader who duplicates it exactly will be rewarded with more thrills than he has experienced from any other radio receiver in several years.

The first thing to do, of course, is to gather together the necessary parts. You will need the following:

One wooden baseboard, not smaller than 10 $\frac{1}{4}$ by 7 inches and at least $\frac{3}{8}$ -inch thick.
 Three UX-type tube sockets.
 Two 32-mmf. "midget" variable condensers (so-called "verniers" usually used in broadcast receivers for neutralizing or compensating purposes), C1 and C2.
 One .0001-mf. grid condenser and a 3-megohm leak, (a regular .00025-mf. size will work, but the smaller condenser is better on the short waves); C4, R1.
 One battery switch SW.
 One R.F. choke coil. (This is important; if you haven't a good one on hand, buy one that will work from 20 meters up); L2.
 One A.F. amplifying transformer (anything available); T1.
 Two $\frac{1}{4}$ -ampere filament ballast resistors, with mountings; R2, R3.
 Nine spring binding posts.
 Five burnt-out tubes with UX-type bases.
 Enough scrap brass to make L-shaped mountings for the two midget condensers and the battery switch and for the aerial coupling condenser, C3.

CONSTRUCTION SIMPLE

The first thing to do is to make the L-shaped brackets to hold the midget condensers and the battery switch upright. Select any odd strips of stiff brass, about $\frac{3}{8}$ -inch wide, and bend three pieces to form L's about two inches high, with legs half an inch long. Drill the legs to pass small wood screws, and the upper ends to pass the switch. Screw them down along the front edge of the baseboard, as shown clearly in the accompanying illustration, and mount the instruments afterward.

Now nail or screw down seven of the spring binding posts along the back edge of the board, and the remaining two on the right edge, near the back. Continue by screwing down the R.F. choke L2, the transformer T1, the filament ballasts R2 and R3, the three tube sockets. Separate the two sockets on the left enough to leave room for the grid condenser.

The two sockets at the right are for tubes, but the one at the left acts as a receptacle for the plug-in coils used with the receiver. Before making up these coils, construct the aerial coupling condenser C3, as shown in an accompanying illustration. This condenser has a very small capacity, and its adjustment is not at all critical. Any arrangement for separating two pieces of brass or copper each one-half inch square is satisfactory.

Break the glass bulbs off the five burnt-out tubes, and clean the insides of the bases, removing the connecting wires, bulb stems and cement. If the cement defies removal by ordinary scraping, heat the bases gently over a gas flame and scrape it out as it softens. Apply a soldering iron to the prongs in the bases and melt out all the solder so that new connecting wires may be pulled through later. If the solder refuses to flow out, push a toothpick through each pin while the metal is still soft, and ream the opening clean. Also file off the little bayonet-lock pins on the sides of the bases.

MAKING THE PLUG-IN COILS

In order to provide the receiver with a wavelength range of 20 to 110 meters, five plug-in coils, each containing a grid and a tickler winding, are necessary. The tube bases are long enough to accommodate the required number of turns of wire for the first four coils; but the fifth base must be fitted with an extension that will make it about three inches long. Simply glue a piece of cardboard around the base and tie it up with cord until it dries. When the wire is wound on it later it will remain tightly in place.

Following are the specifications of the five coils:

- No. 1: Grid and tickler windings, each 7 turns; wavelength range approximately 19 to 25 meters.
- No. 2: Grid and tickler windings, each 10 turns; range, 25 to 35 meters.
- No. 3: Grid and tickler windings, each 15 turns range, 35 to 45 meters.
- No. 4: Grid and tickler windings, each 22 turns; range 45 to 64 meters. Tickler wound as double layer to save space.
- No. 5: Grid and tickler windings each 40 turns; range, 62 to 110 meters. Tickler also double-layer.

The grid coils are all wound with No. 24 D.C.C. wire, and the ticklers with No. 28 D.C.C.

Before starting to wind the coils, drill through each of the bases four small holes to pass the ends of the windings. The proper places for these holes can be determined from a careful study of the illustration, which shows how the various ends connect to the four prongs in each base.

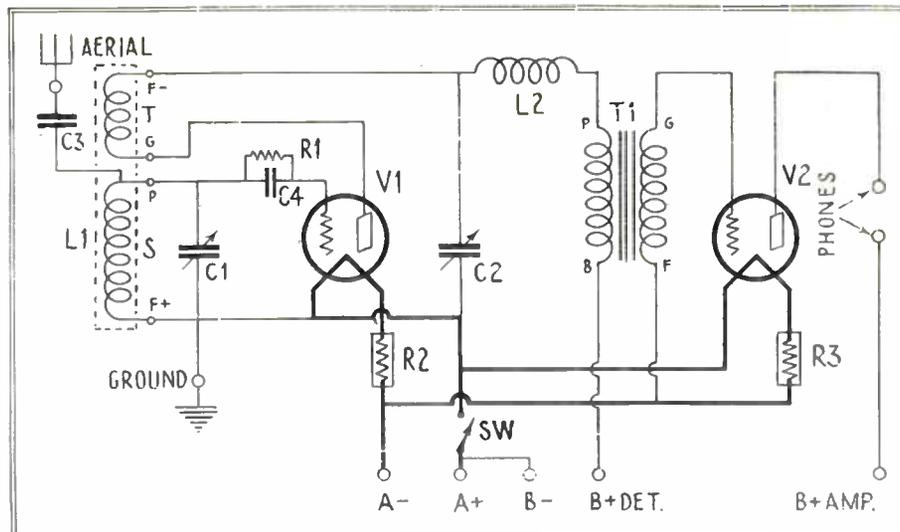
To start coil No. 1, push the end of the spool or roll of No. 24 wire through the hole nearest the open end of one of the bases, leaving a free piece about five inches long. Wind on the required seven turns, cut an extra five inches, and pull the end through the second hole. Start the tickler winding about a quarter of an inch away, and wind in the same direction. Leave generous ends on the wires.

It is extremely important that the four loose ends you now have be connected properly to the four prongs. The loose end of the top of the grid winding is pulled through the pin that makes contact with the plate or "P" terminal of the tube socket. The bottom of this same winding is pulled through the pin that makes contact with the "F+" socket terminal (which should be the one under the "P" terminal and diametrically opposite the "G" post). The beginning of the tickler (the end nearest the grid coil) goes through the other filament pin, while the other end goes to the grid pin. Study the arrangement of the pins in the base, not how they fit into the socket, and you will have no trouble. After pulling through the wires, solder them at the tips of the prongs and cut them flush.

The other coils are wound in exactly the same fashion, except that for Nos. 4 and 5 the ticklers are wound double layer. The wire in all cases may be secured with collodion or other prepared coil binders. This treatment is not absolutely necessary, but it will keep the coils in good condition.

CONNECTIONS

The wiring of the set is so simple, and is made so plain in the diagram and the large illustration, that little comment need be made on it. The letters, "F," "G," "P" and "F,"



The simplicity of the construction of this receiver is apparent from a glance at the circuit diagram above as well as the pictorial layout on the preceding page. The interchangeable inductance, L1, is wound on an old tube-base, and plugs into the tube socket seen in the picture below.

alongside the coil L1 in the schematic diagram, represent the terminal markings on the socket which acts as the coil receptacle. The connections are short and direct, the grid leads being especially so. The grid condenser need not be screwed down, as the short lengths of wire connected to it will hold it in place.

The rotor connections of the midget condensers are wired together. A short lead extends from C1 to the "F+" post on the coil receptacle, and thence to the ground binding post; while another lead, from C2, runs two inches to the nearest filament post on the detector-tube socket, V1.

The circuit is of the simplest imaginable regenerative type, with the aerial coupled directly to the grid tuning coil by means of the tiny condenser C3. This wavelength range of the set depends on the size of this grid coil and the capacity of the tuning condenser, C1. Regeneration is made possible by the tickler winding, connected in series with

the plate-circuit elements, and is controlled by the other variable condenser C2.

Circuits of this type, when used on the regular broadcast band (200 to 550 meters), radiate and cause terrible interference in neighboring receivers; but they are not at all obnoxious on the short waves because the average-size receiving aerial cannot readily be shocked into oscillation at wavelengths as low as 20 to 100 meters.

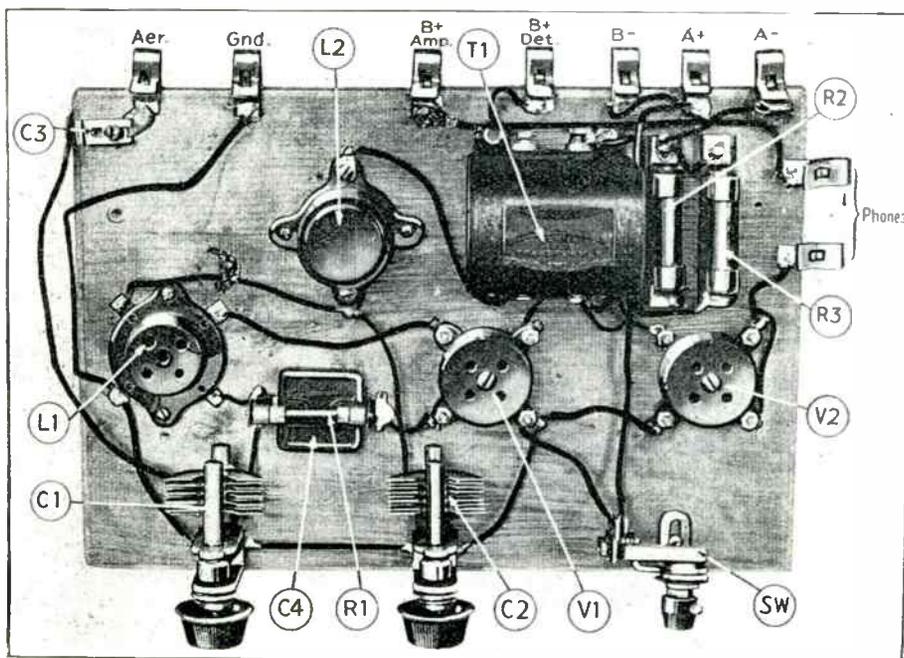
OPERATION AND TUNING

To place the set in operation, connect your regular aerial and ground to the posts provided for them and hook-up the usual six-volt "A" battery and one or two 45-volt blocks of "B" battery. Run a wire from the 22½-volt post on the first block for the detector tube, and use the full 45 or 90 volts on the amplifier. (Note: A "B" socket-power unit cannot be employed with a short-wave receiver.) Push the tip connections of a pair of headphones through the two clips on the right hand edge of the baseboard, insert 201A-type tubes in the two tube sockets, plug in coil No. 4 as a starter, and snap on the battery switch.

The set should regenerate without trouble when the condenser C2 is turned in slowly. With the tuning condenser practically all in (near maximum capacity) you should be able to pick up KDKA, Pittsburgh, on its 62.25-meter wave. (This station has what is probably the most consistent short-wave broadcast transmitter in the world. You should hear it also on coil No. 5 with the condenser all out (minimum capacity). With coil No. 4 you should also pick up, without delay, the signals of WLW, on 52 meters. With coil No. 2 and most of the condenser in, WGY, on 32.77 meters, should roll in nicely. Once you hear these stations you will have some definite condenser adjustments to rely on in "fishing" for stations on other waves.

To obtain smooth control of the regeneration is a simple matter. Each coil, when the tuning condenser C1 is set at maximum, should start oscillating just as the other condenser, C2, is turned to maximum. If the set oscillates before maximum position is reached, remove one turn at a time from the tickler winding until this operating condition is attained.

(Continued on page 30)



All the connections employed in this set are made on top of the wooden baseboard, as may be seen in the illustration. The capacity, C3, consists of two separately-movable metal plates.

Short-Wave Stations of the World

(Continued from page 25)

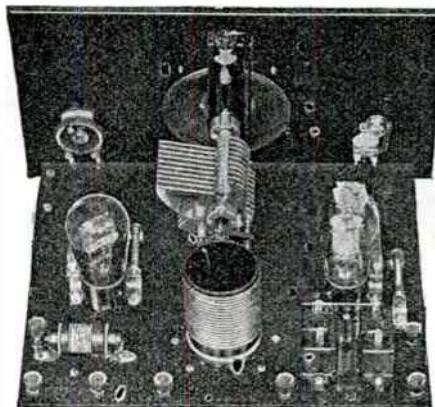
| GERMANY | |
|---------|-------------------------|
| AFL | Königsusterhausen 14.00 |
| AFL | Hamburg 70.00 and 52.00 |
| AFT | Königsusterhausen 14.00 |
| AFU | Königsusterhausen 14.00 |
| AFK | Berlin 67.65 |
| HEA | Nauen 11.00 |
| | Nauen 13.55 |
| AGC | Berlin 17.20 |
| AGJ | Nauen 56.70 |
| AGK | Nauen 11.00 |
| LA | Langenberg 43.90 |
| POF | Nauen 11.00 |
| | Nauen 14.90 |
| POZ | Nauen 18.10 |
| | Königsusterhausen 52.00 |
| | Stuttgart 41.00 |
| HOLLAND | |
| PCJJ | Eindhoven 31.4 30.00 |
| PCKK | Kootwijk 16.00 |
| PCLL | Kootwijk 18.10 32.00 |
| PCMM | The Hague 46.50 |
| PCPP | Kootwijk 16.50 |
| PCRR | Kootwijk 37.00 |
| PCTT | Kootwijk 21.00 |
| PCUU | The Hague 37.00 |
| ITALY | |
| HAAX | Rome 45.00 |
| IAY | Rome 45.00 |
| IMI | Milan 45.00 |

THIS list of the short-wave broadcast stations throughout the world is not complete, although we have endeavored to list every station of whom we have heard reports; since in many cases reliable information about the programs, wavelength and power of the stations cannot even be obtained from the stations themselves.

| JAPAN | |
|----------------------|----------------------------------|
| JFAB | Talpeh Formosa 39.50 |
| JHBB | Ibarakiken (Hiraso) 37.50 2.00 |
| JIPP | Tokyo 20.00 |
| JKZB | Tokyo 20.00 |
| JOAK | Tokyo 30.00, 60.00, 35.00 50 |
| IAA | Iwatsuki 40.00 |
| JAVA | |
| ANE | Malabar 33.00 |
| ANF | Bandoeng 31.80 and 33.00 |
| ANHJ | Malabar 56.00 |
| | Malabar 17.00 |
| | Batavia 46.50 |
| MEXICO | |
| XC51 | Mexico City 44.00 |
| MOROCCO | |
| AJN | Casablanca 51.00 |
| NORWAY | |
| LCHO | Oslo 33.00 |
| LGN | Bergen 31.25, 30.00 |
| U. S. S. R. (RUSSIA) | |
| RDRL | Leningrad 28.50 |
| ROW | Moscow 83.00 |
| RFM | Knabarovak (Siberia) 70.20 12.00 |
| RFN | Moscow 50.00 |
| RA19 | Tomsk (Siberia) 37.00 |
| SPAIN | |
| EAM | Madrid 30.70 |
| EAR55 | Barcelona |

Although the above list is presented to the reader with the hope that the information given therein be exact, there is no method whereby we were able to confirm any of this information. Short wave stations themselves were lax in offering information to the various periodicals interested in compiling a list of this nature, and up to the present writing continue to assume this attitude.

IT'S EASY TO BUILD AND EASY TO TUNE



NATIONAL SHORT-WAVE SHIELD-GRID TUNER

Covers all waves from 15 to 115 meters with four plug-in transformers.

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Heterodyning the Short-Wave Signal

After the tuning condenser has been varied to generate a "local" frequency, very near to that of the transmitted impulses picked up by the antenna, both "local" and "signal" oscillations are impressed upon the grid of the detector tube. The result of the blending of these two frequencies is known as the "beat frequency." This is nothing more than an audible note of a few hundred cycles; dropped off, as it were, in the blending of the incoming and local frequencies, each of which may run into the millions of cycles. Its frequency equals the difference between the two radio frequencies; one of which cancels the other except for the

"beat-frequency" effect, sometimes called "heterodyne."

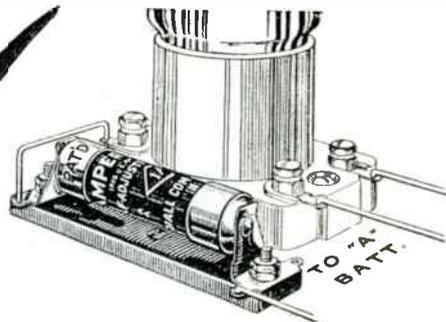
As transmitting stations use different sending frequencies, it is merely a matter of turning the tuning dial in order to vary the frequency of the local oscillation to coincide with that of the incoming wave. It is by this method that a different station is received at each variation of the secondary condenser.

A practical demonstration of the variation in beat frequency can be noted in the change of the received note as the tuning condenser is turned. This is merely a matter of changing the local frequency, somewhat similar

to the action of "damping" or fingering a violin string at various lengths in order to obtain different musical tones.

After a signal has been received, the tickler is retarded to a point known as the "peak" (the position just before the break-over) where the signal will be heard at its maximum strength. This is "reducing the amplitude" or strength of the local oscillation to a point as near to the amplitude of the incoming oscillation as we can bring it. After reducing the amplitude of the local frequency, it may be found necessary to retune, slightly, the secondary circuit.

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AMPERITE
REG. PAT. OFF.

The "SELF-ADJUSTING" Rheostat

The Hammarlund "Trans-Oceanic Two"

(Continued from page 21)

A slight readjustment of the tuning condenser is necessary, because the regeneration control effects the tuning or secondary adjustment slightly.

The value of the grid condenser and leak resistor are interdependent, but in general about a 2 to 5 megohm leak, and nearly maximum capacitance of the adjustable grid condenser will be found best. The setting of the variable grid condenser the resistance of the leak, its return connection (A plus or A minus) and the detector plate voltage will determine the suddenness with which the receiver goes into oscillation. The set should not go into oscillation abruptly or with a "blop", as this makes it difficult to operate the receiver at a point of maximum sensitivity. A little experimentation will indicate the best setting for the grid condenser and the best plate voltage on both tubes.

WIRING THE SET

The wiring of short wave receivers deserves much more attention than is accorded in broadcast receivers. All leads should be as short and direct as possible that is, "bee line" wiring should be used. In the receiver illustrated herewith, rigid bus bar wiring has been used for photographic purposes. Wires carrying radio-frequency currents should cross each other as nearly at right

angles as possible, and should clear each other as much as possible. A slight increase in lead length may be permitted to make these possible.

Soldering the connections in a short wave receiver is a matter which should demand the constructor's greatest care. Use as little flux as possible. Avoid "cold" connections—that is where the iron is withdrawn from the soldered joint before the solder has had a chance to run freely, and thus make a perfect joint. After all connections have been soldered, go over each joint and wipe each cone free of any paste or flux which may have remained after the connections have cooled.

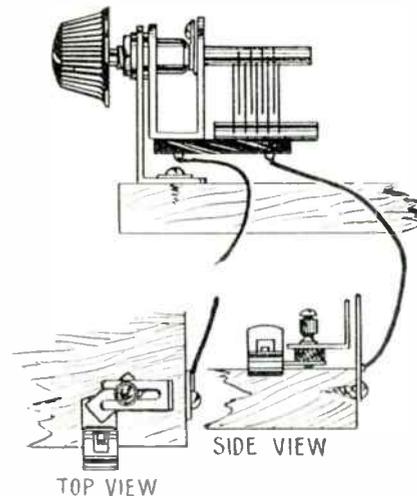
A.C. operation of short wave receivers and converters has not been found altogether satisfactory, due to the fact that the "B" power unit introduces many more extraneous noises on short waves; also, a hum which may be present in a "B" power unit will not be noticed when used with a broadcast receiver. But in short wave operation where the receiver is being operated at its point of maximum sensitivity, and where earphones are invariably used at all times, any trace of hum emanating from a power unit will interfere seriously with reception.

For this reason, it is always recommended that batteries be used throughout in a short wave receiver.

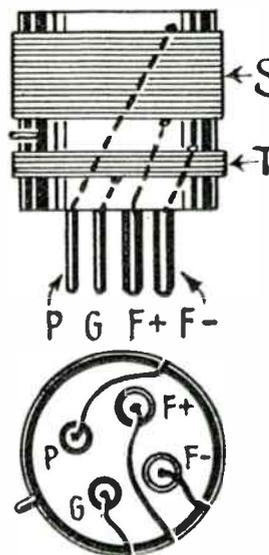
A Junk-Box Short-Wave Receiver

(Continued from page 28)

The best adjustment for the aerial condenser C3 must be found by trial; it will depend on the dimensions of the individual aerial. Likewise, different values of the grid leak should be tried.



Above, a side view of the midget tuning condenser, C1. One lead runs to the top of the grid winding S and to the aerial condenser, C3, formed by the small adjustable plates shown in the top and side views. Its adjustment for the aerial used must be determined by experiment. The two opposed surfaces are about one-half inch square.



The details of one of the plug-in coils used in the "junk-box" short-wave receiver, which is built up on the base of a burnt-out UX-type tube. This is large enough to give room for the tickler winding T and the aerial-secondary S, of suitable size to be tuned by a 32-mmf. condenser (C1) up to 64 meters. Above this it is necessary to add a cardboard extension to the base to increase its height. Details for the five sizes of coils will be found on the first page of this article. The connections shown in plan at the bottom, are as follows; top of grid winding to "P" prong; bottom of grid winding to "F+"; top of tickler (T) to "F-"; bottom of tickler to "G."

The normal ground should be made in all cases, to the most convenient water or steam pipe. If such a pipe is removed several rooms from the location of the short-wave set, fasten the ground wire around the nearest electric-light fixture. This makes a rather good ground and contrary to expectations, does not introduce hum in the receiver.

The S-M "Round-the-World-Four"

(Continued from page 18)

starts at the "F" post nearest the "C" or cathode post and ends at the "P" post.

The number of turns necessary to cover the four bands from 17 to 240 meters is given below, using an S-M 317 tuning condenser of .00014 capacity and a .00035 tickler condenser.

SHORT WAVE COIL WINDINGS

| SECONDARY | | | TICKLER | |
|-------------|---------------|--------------|----------------------|--------------|
| Coil Number | Wire Size | No. of Turns | Wire Size | No. of Turns |
| 131-T | No. 22 Plain | 67½ | No. 34 double cotton | 5½ |
| 131-U | Enamel | 13½ | | 5½ |
| 131-V | No. 24 double | 25½ | | 9½ |
| 131-W | | 49½ | | 15½ |

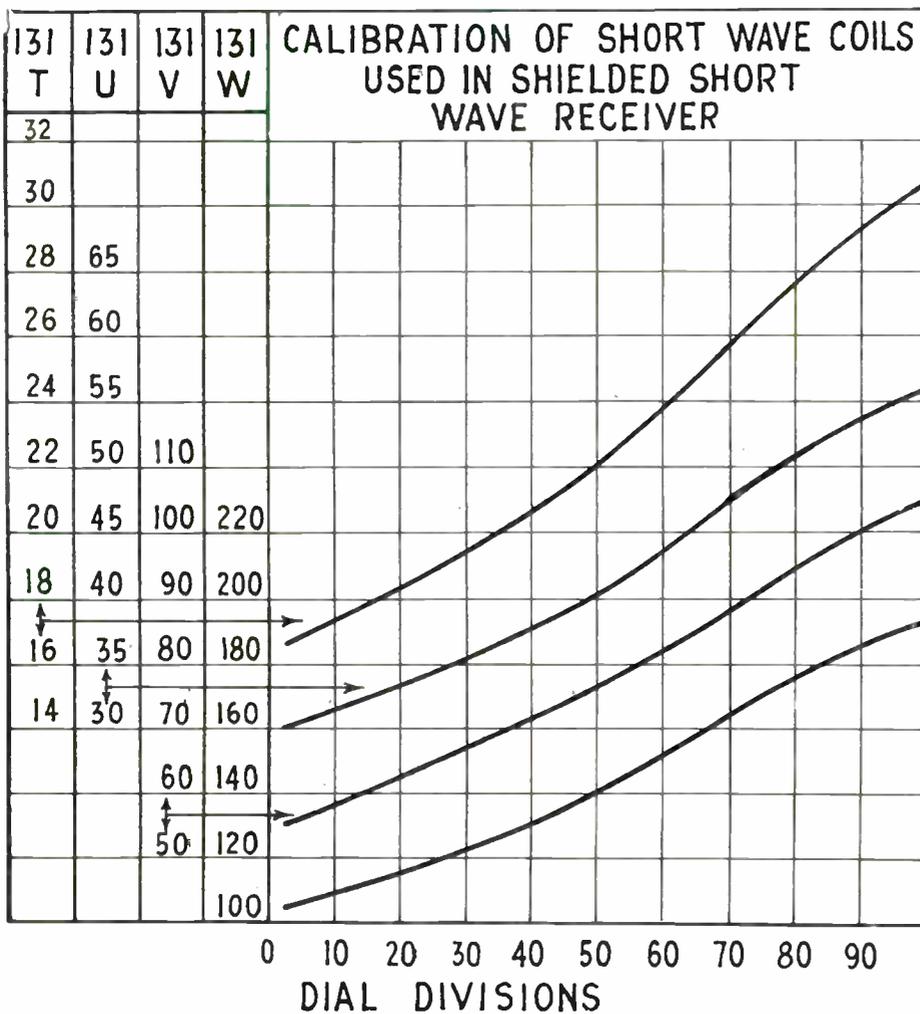
The tuning curves for a particular set of four coils are given as an aid in finding stations when the set is first operated, and it will be seen that the amateur wave bands fall well away from the ends of the condenser scale, so that with good vernier

wound, but this is easily done, or coils simply rewound on the small bakelite forms. Coils of fewer or greater numbers of turns for other wave bands, can be quickly wound for the "Round-the-World-Four."

The operation of the set is simple, almost any antenna from fifteen to fifty feet giving quite good results; even a long broadcast antenna does not seem to destroy the sweet control of the set. Any good storage battery, 9 volts of "C" battery, and 135 to 180 volts of "B" battery (or as low as 90 will do) are all that is necessary for operating power.

Eliminators are generally noisy on short waves and are not to be recommended, for the detector tube at least. Two 112-A audio tubes, a 201-A or better yet, a 112-A detector, a 222 screen-grid R.F. tube, and phones or loud speaker make up all the equipment needed to listen in on almost all of the world from England to Australia, Africa to Alaska, and back again (if reports of short waves circling the world are true). One may be certain though, of the thrill of 5,000 or 10,000 mile reception as a fairly regular thing, and will have the tried and proven performance of a good short-wave receiver as a known factor to start with in the experimental reception of television.

The thrill of short wave reception cannot be appreciated until one has actually experi-



Calibration chart of short-wave coils used in the S-M "Round-the-World-Four."

dials no difficulty is had in tuning amateur code signals.

To duplicate the curves given, it may be necessary to trim coils a bit once they are

enced the reception of signals emanating from a station located at the other end of the world. Short waves—the greatest annihilator of space.

Bringing in Short Waves

Amateur experimenting with short waves is fascinating, but it demands sensitive handling and equipment of more than ordinary precision and dependability, if quality of reception and freedom from distortion are to be secured. Short-wave fans are getting their best results when using laboratory tested Electrad resistances and volume controls.

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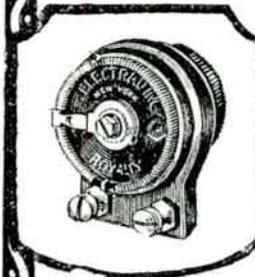
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