Antenna

SHORT WAVE RADIO

September
1934

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Edited by
Robert Hertzberg and Louis Martin

IN THIS ISSUE:

A 4-Tube T.R.F. Set With Double Regeneration

A Band-Spread Portable Receiver

The Tuned Antenna for Short-Wave Receivers
By Robert S. Kruse

High Power From Type 45 Tubes

Foreign Station Data
By J. B. L Hinds

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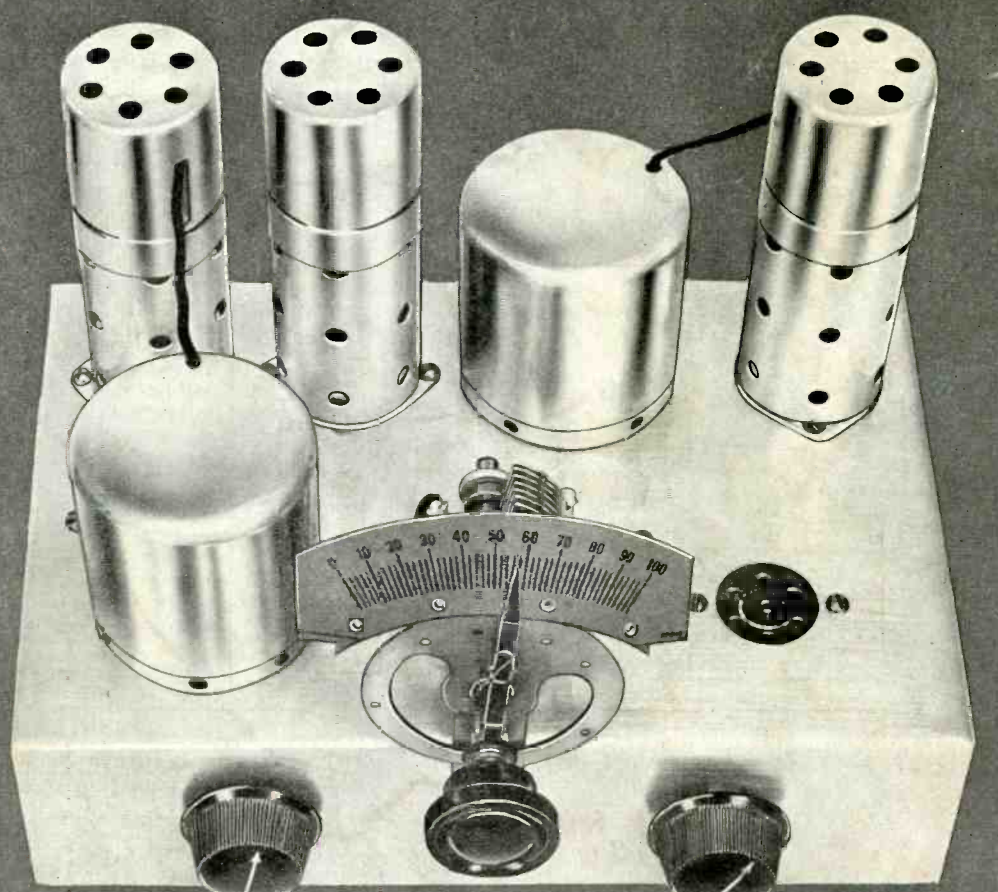

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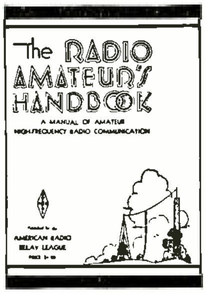
BOOKS FOR THE RADIO MAN

Many of the questions asked daily by radio experimenters, constructors and listeners all over the country are answered completely and clearly in various books. To assist radio men in buying books best suited for their own particular needs, we have made a selection of representative works that we can recommend very highly. These books are all up-to-date and will prove very valuable.

"The Radio Amateur's Handbook"

238 Pages of Data



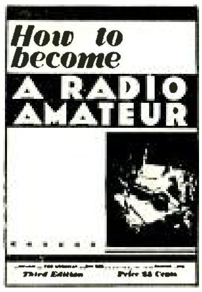
Price $1.00 postpaid

The RADIO AMATEUR'S HANDBOOK was first published in the fall of 1926. It was in response to a growing demand upon the American Radio Relay League for some sort of a manual of operation for short-wave experimental radio work. The first edition met with great favor and two reprintings were necessary to supply the demand. Since that time ten subsequent editions have been published and more than 215,000 copies have been sold.

The latest edition (11th edition, published January, 1934) is approximately 15% larger than the first edition, and represents probably the most comprehensive revision yet attempted. New receiver circuits and designs are presented, together with a thorough treatment of the recently-developed "single-signal" sets. A completely re-written 36-page chapter is devoted to all that is new in the world of transmitters. New circuits and layouts are given, all problems which face the transmitting amateur being discussed in a lucid and comprehensive manner. The radio telephony chapter represents all new material. New designs for Class B modulators and speech amplifiers are featured. Still another new chapter is that on antennas.

"How to Become a Radio Amateur"

Completely done over in 1934 style, telling all about amateur radio and describing the latest equipment—*push-pull transmitter—bandspread pentode receiver—simplest of monitors.*



The third edition of "How to Become a Radio Amateur" marks another milestone in amateur development. Still the standard elementary guide for the would-be amateur, the simple, inexpensive station described incorporates features which in the past have been confined to the more advanced layouts. The designs have been made flexible, so that parts out of the junk box can be readily substituted. The performance of the completed station is such that any amateur can own and operate it with satisfaction and pleasure. It's a real amateur station, with construction and operation described in clear, understandable language.

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Before you can operate an amateur transmitter, you must have a government license and an officially assigned call. These cost nothing—but you must be able to pass the examination. The License Manual tells how to do that—tells what you must do and how to do it. It makes a simple and comparatively easy task of what otherwise might seem difficult. In addition to a large amount of general information, it contains 198 typical questions and answers such as are asked in the government examinations. If you know the answers to the questions in this book, you can pass the examination without trouble.

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Standard Publications, Inc., 1123 Broadway, New York, N. Y.

September, 1934 Vol. 1, No. 1

SHORT WAVE RADIO

devoted to short-wave transmission and reception in all their phases

Robert Hertzberg, *Editor*
Louis Martin, B. S., *Technical Director*

IN THIS ISSUE:

IN FUTURE ISSUES:

CONVERTERS ARE WITH US AGAIN. Now we have converters with tuned outputs and tuned inputs, but even this is not sufficient. One constructor put regeneration in the r.f. stage and the result is extremely promising. You will hear more about this device in a near-future issue.

WE HAVE ANOTHER EXPEDITION ON OUR HANDS. This time a very famous explorer is on his way to the Frozen North. Like Byrd, he has a radio telephone transmitter which has been heard in this part of the country with perfect ease. We will have the low-down on this expedition in an early issue. Here is a chance for you real DX'ers to grease up your aerial and see what can be done about logging this fellow.

YOU HAVE NOT HEARD THE LAST of the superheterodyne by a long shot. Our technical director has started some preliminary investigations of 5 meter supers. If the results are promising, we will let you in on it; and if not, we won't clutter up our pages with a lot of useless data. However, we feel sure that the results of this work will be well worth while.

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would have a separate powerpack
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It would be easy to make but—
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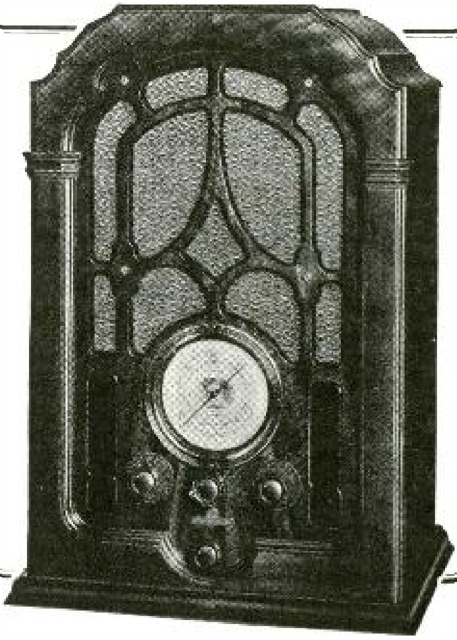
would be helpless against image interference.



THE GENERAL ELECTRIC K-80 ALL-PURPOSE RECEIVER IS NOT SO SIMPLE

IT HAS 2 *integral* stages of *inductively* coupled pre-selecting amplification to erase noises and images. YOU HEAR STATIONS UNOBSCURED BY THE USUAL IMAGES. Admittedly, this requires a 4-section tuning condenser.

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It has a noiseless 1-stage i. f. system and every other modern provision for noise-suppression, such as doublet-antenna facilities and complete shielding.

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The Ultra Short Waves and Television

ABOUT a year and a half ago, the popular press was filled with predictions as to the great benefit the radio industry would enjoy from the development of ultra short-wave broadcasting. A lot of enthusiastic sales executives, who knew little of the technical side of radio, stated that transmission in the neighborhood of five meters would solve the problems of local broadcasting and of television.

Looking over the situation as it stands during the summer of 1934, we are forced to the regretful conclusion that these predictions were a little too optimistic. There has been practically no work at all on ultra short-wave broadcasting as such, a lone station in Buffalo being the only one to put on regular programs of any sort. (See page 7, August issue.)

The necessity of providing separate and special receivers for ultra short-wave broadcasting is probably what has discouraged development along this line. Some people had the idea at first that simple little converters, attached to existing broadcast receivers, would do the trick, but this has not proved to be the case. As a matter of fact, there have been practically no significant developments in ultra short-wave receiver design during the past couple of years. Amateurs who are operating experimental radiophone stations in the 56 megacycle band are, for the most part, using highly elementary super-regenerative receivers. There have been a few five-meter superheterodynes, but admittedly they have been complicated and expensive, and for average use, hardly better than two-tube super-regenerators.

It seems that the best application that has been made so far in the ultra short waves is in the law enforcement field. Two-way communication systems between police headquarters and roving automobiles have been sensationally successful. Certain military applications of the ultra short waves also have been very effective.

* * *

As for television—well, it is still the elusive orphan of the radio industry, as we have previously remarked in these columns.

"Television is perfected," say the big moguls. "We are simply waiting for better economic conditions before we put it over."

"Bunk!" says we.

It is quite certain that if television is to be put over at all, it must be put over on the short waves, for the very simple reason that all the other available channels are jammed full and cannot possibly accommodate any new services. For this reason amateurs and experimenters probably will start the ball rolling, just as they started broadcasting and just as they developed the short waves altogether.

The short waves are adaptable to television for still another reason: the relatively wide channel demanded by a half-way decent television picture is such that it would be a physical impossibility to get more than a few stations on the air at the same time. Up above 1500 kc., of course, there is plenty of room for everybody. See our March issue for more information.

There seems to be a behind-the-scenes fight on the part of the large radio companies as to how television should be handled. Obviously, they don't want television to repeat the frenzied history of broadcasting. (See page 4, March, 1934, issue.) They want to promote television receivers as just another household appliance, like broadcast receivers, refrigerators and washing machines. However, no less a person than Dr. E. F. W. Alexanderson, renowned chief consulting engineer of the General Electric Company, has publicly voiced the opinion that television should be placed in the hands of the experimenters. With 100,000 or more interested enthusiasts working in cellar and attic dens all over the country, probably more will be accomplished in the way of tangible results than from all the feverish research in closely guarded laboratories.

It is our frank and personal opinion that the real reason for the delayed appearance of television is that the actual results are not so good. We have had an opportunity to see practically all open television demonstrations held in the United States during the past eight years and we believe that a lot of improvement will be necessary before Mr. John Public hands out $50 or $75 for a television receiver. Perfect motion pictures, even in the 8 and 16 millimeter fields, are setting television a terrific handicap as far as the general public is concerned. Short-wave amateurs and experimenters are not concerned so much about immediate results as they are about methods and technique. If they are only given a chance to work on the methods, the quality of the results will take care of itself.

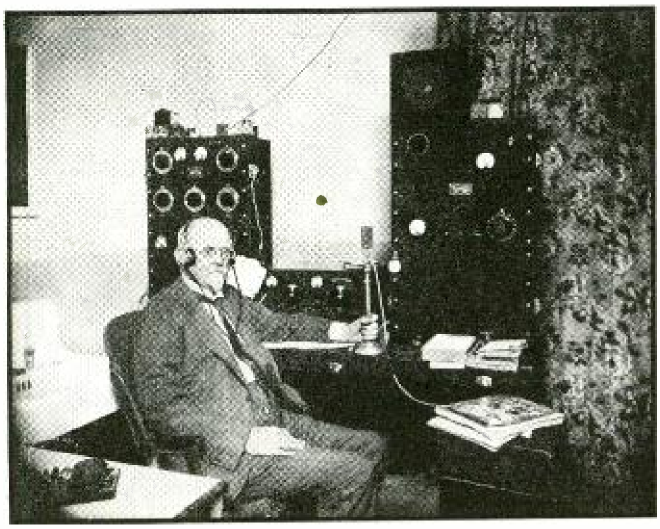
X1G Portable

Dr. James M. B. Hard, operator of station X1G, one of the most comprehensive amateur radio stations in the world, has supplemented his stationary equipment with a beautiful new portable outfit whose call letters are X1G-Portable. The station is located in the town of Cuatla, State of Morelos, 4,190 feet above sea level, in what is known as the *tierra caliente* or "hot country."

The accompanying photograph shows the Doctor at the controls. The equipment consists of a type 30 DXB transmitter manufactured by the Collins Radio Co., and a specially built single signal receiver. Everything is built into trunks in order to facilitate transfer from place to place.

A single wire matched-impedance antenna, 123 feet long is used with a lead-in from the center, 16 feet 8 inches to the transmitter. This aerial runs in a N. N. W. S. S. E. direction. For the receiver, a separate aerial 33 feet long is used which runs at right angles to the transmitting antenna.

In its present location the station is handicapped by poor regulation in the power supplied by the local electric plant. In order to compensate for variations in the supply voltage which are sometimes as great as 50 volts, the Doctor uses a special variable ratio transformer which acts as a voltage regulator and maintains the line voltage fairly constant.



Dr. Hard is probably the best known phone amateur on the air. His main station, X1G, in Mexico City, has been heard all over the world. When away from home, he maintains contact with his radio friends with this "portable" outfit, which many a "ham" wouldn't mind having as his permanent installation.

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Custom-built by McMURDO SILVER

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"I am very glad to state that your new receiver is a 'honey.' Mr. Martin and I played with it for several nights and we were highly pleased with its performance. We would like to have had the thing a little longer, but Mr. Kamps seemed to be very anxious to lay his hands on it. What particularly impressed us was the low noise level. I could not believe the set was on until we ran into a signal."—Robert Hertzberg, Editor, Short Wave Radio Magazine. From letter dated June 28, 1934.

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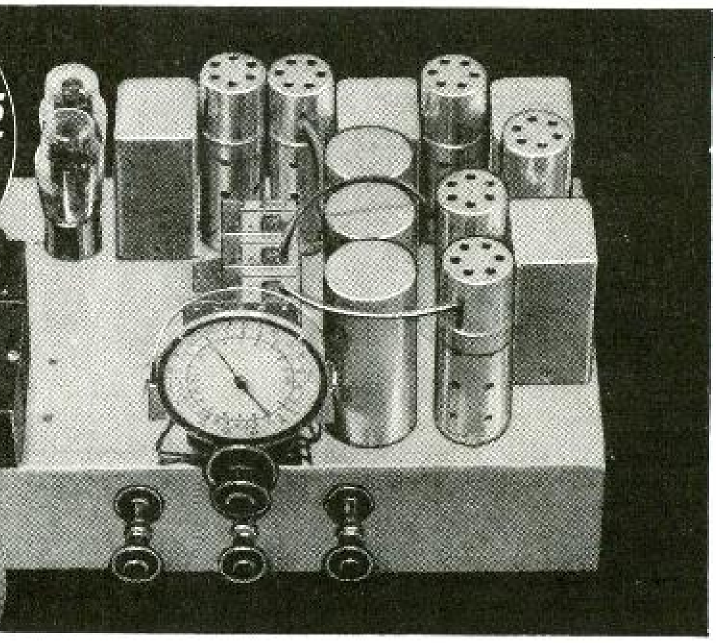

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- Range 13 to 560 meters (23,000 to 540 kc.) in four bands with no gaps. GETS EVERYTHING ON SHORT WAVES.
- NINE LATEST TYPE TUBES: '58 tuned r.f. stage on all four bands, 2A7 electron coupled oscillator-first detector, two '58 air tuned i.f. stages, '55 second diode detector, diode A.V.C.—first audio, '58 electron coupled audio beat oscillator, two 2A5 triodes push-pull Class A Prime and 5Z3 rectifier.
- Sensitivity better than ⅖ microvolt per meter.
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- Audio beat oscillator for quick finding of SW stations and code reception.
- Positive long life six-section coil switch selecting twelve different low loss coils and sixteen capacities at the turn of a knob.
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- Diode second detector for minimum distortion.
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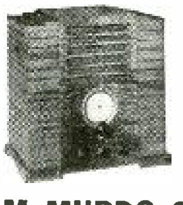

10 DAY TRIAL

Try the World Wide Nine in your own home under your own reception conditions. If after 10 days you think it possible for some other receiver to beat its performance, you can have every cent of your money back instantly without argument or question. Simply send the World Wide Nine back to me, and I'll send your check immediately. Please use the coupon order form from this page.

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Enclosed find $15.00 deposit ☐ check ☐ money order (or full remittance to save C. O. D. collection charges). Ship balance C.O.D. express.

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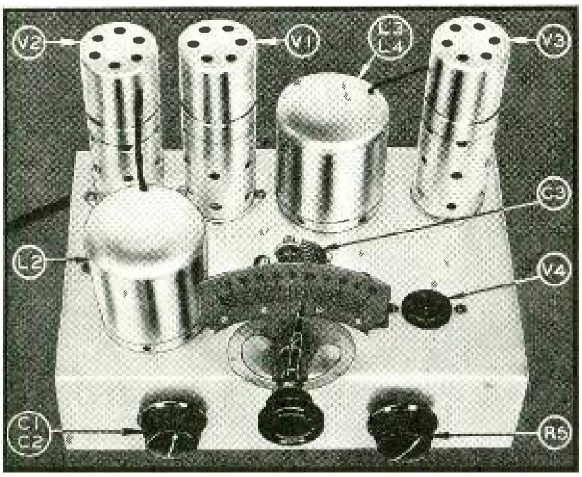


Deck view of the set with all parts labeled.

15-2000 Meters With A Single Coil

The experimental receiver described by the author is the first of its type to be presented to our readers. It tunes from 15 to 2000 meters with but one set of coils —no plug-in coils or switches. You just tune from one end to the other.

Editors' Note

THE receiver presented here is intended only to illustrate the theory involved. It represents a radical departure from the conventional practice of tuning the input circuit—this idea leaves the input circuit open to any and all signals. With but one set of coils—and with absolutely no switches—the entire frequency spectrum commonly used throughout the world is covered.

Again we wish to emphasize the fact that the set here is but the practical application of the idea—further receivers will follow in the future.

We strongly recommend that constructors build this model to acquaint themselves with its mode of operation.

By J. A. Worcester, Jr.

IT is universally agreed that present systems of short-wave and all-wave coverage leave much to be desired. As is well known, present systems of tuning require some sort of a coil-changing operation, which results not only in non-continuous tuning, but introduces serious station congestion on the higher frequencies. This latter difficulty is particularly pronounced when an attempt is made to decrease the total number of switching operations by employing a large tuning capacity of the order of 350 mmf. This station congestion can be alleviated to a certain extent by employing some method of band spreading.

However, the addition of this feature necessitates a total of three tuning controls, including the wave changing device, which makes the tuning procedure too complicated for general acceptance, although this feature has been advantageously incorporated in receivers especially designed for amateur and professional use, where a certain amount of operating skill is assumed. Even if band spreading is employed, unless some provision is made for maintaining the frequency coverage of the band-spreading control substantially constant with different coil ranges and settings of the main tuning condenser, the advantages to be derived from this feature will be greatly lessened, due to tuning, which is too slow at some frequencies and too fast at others.

Ideal Kept in Mind

When attempting to discover a solution to any particular problem, it is often very helpful to visualize the ideal solution, and, with this in mind, attempt to evolve something which approaches this ideal as closely as possible. Needless to say, the complete realization of the ideal solution is not often obtained.

If we were to speculate for a moment on the above problem, we would probably agree that the ideal solution, from the standpoint of simplicity, would consist of a single dial, covering, with a single rotation, the entire frequency range available. However, if the wavelength range of the receiver extends from, say, 15 to 600 meters, it is evident that the congestion would be far too severe to permit satisfactory tuning. Accordingly, we must modify somewhat the above ideal and incorporate an additional tuning control that will cover a substantially smaller frequency range. Inasmuch as the public is accustomed to the station separation provided in the usual broadcast receiver, this control should substantially provide a 1000 kc. frequency coverage.

Summarizing, the ideal all-wave receiver should have a band-setting dial numbered from 1 to 20, indicating the average frequency in megacycles of the band covered by the tuning dial. In order to cover the broadcast band, the band-setting dial is set at 1, and the tuning dial then covers a frequency band extending 500 kc. on either side of this value, or from 500 kc. to 1500 kc. If it is desired to receive one of the 49-meter broadcast stations, the band-setting dial is set at 6; the tuning dial then covers from 5500 to 6500 kc., the average being 6000 kc. (6 megacycles).

In the all-wave tuning system developed by the writer, the above ideal is substantially realized. It is possible to cover the wavelength range of 15 to 2000 meters with a 180-degree rotation of the band-setting dial. The tuning dial provides an approximate 1000 kc. spread at all settings of the band-setting control. This system is applicable to all existing types of circuits, but, for purposes of demonstration, a simple regenerative circuit is employed in the receiver described.

Theory Involved

The theory involved in this system of all-wave coverage is quite simple. As far as circuit connections are concerned, it is quite similar to the mixer portion, or frequency conversion unit, of a superheterodyne. The principle difference is in the frequency range of the local oscillator, which, in our case, varies from about 23 megacycles to 46 megacycles. It will be noted that the above represents the two-to-one frequency coverage possible with a 140 mmf. tuning condenser. From an inspection of the above frequency range, it will be noted that a total coverage of more than 20 megacycles is obtained. This represents the total frequency range existing above 15 meters. It becomes quite obvious, then, that if the tuned transformer in the output of the mixer were resonated at say, 23 megacycles, it would be possible to cover the entire frequency range above 15 meters. For instance, if the oscillator were tuned to 23.5 megacycles, a 500 kc. (.5 megacycles) signal would be amplified by the 23 megacycle output circuit. If it is desired to receive a frequency of say 3.5 megacycles, the oscillator would have to be tuned 26.5 megacycles, and so forth.

It will be noted that the above action requires that the input circuit respond to *all* frequencies in the range to be received, which, in this instance, is from .15 to 20 megacycles (15 to 2000 meters). In this receiver, a choke input, consisting of an 8 mh. winding in four sections is employed, and seems to work very satisfactorily. However, there is undoubtedly some room for improvement in this particular piece of apparatus, and in some future designs a special choke containing a number of different sized sections may be incorporated.

As will be noted from the wiring diagram, the 23 megacycle output circuit forms the input circuit of a regenerative detector; following which is a conventional stage of resistance coupled audio amplification.

Details of Circuit

Before considering the actual constructional details of the receiver, it might be advisable to review briefly the details of the circuit. The mixer tube is a type 58 pentode and is employed in preference to a 57 because of its greater freedom from cross-modulation effects. The grid is properly biased for this particular use by the 2500-ohm resistor, R1. The oscillator also employs a type 58 tube. An electron-coupled type of oscillator is used because of its greater stability, and is particularly required when the frequency coverage is as great as that provided in this circuit. The proper operating grid bias for the oscillator is obtained by the 500-ohm resistor, R2, rather than from the more conventional grid leak and condenser combination. The reason for this selection is that the leak-condenser has a pronounced tendency to produce irregular oscillations at the high frequencies generated when the tuning condenser is near its minimum.

Condenser C1 is employed as the band-setting control, and is ganged to condenser C2. The purpose of condenser C2 is to maintain the frequency coverage of the tuning condenser C3 substantially constant as the band-setting control is rotated. It will be noted that the tuning condenser C3 is connected across only a portion of the oscillator inductance in order to provide a frequency range of 1000 kc. The oscillator is connected to the mixer by the small capacity C5. This capacity is merely that existing between three or four inches of push-back hook-up wire twisted together.

The regenerative detector is also electron-coupled. The padding condenser C7 is adjusted so that the maximum wavelength to be received is obtained when the condenser C1 is all-in. Once this initial adjustment is made, it, of course, requires no further attention. Regeneration is controlled in the usual manner by varying the screen grid voltage. The potentiometer R5 is employed for this purpose, and it is essential that the slider be bypassed with a .1 mf. or larger condenser. It will be noted that the common plate and screen leads are bypassed by two of the condenser sections of C9 and decoupled by the r.f. chokes L6 and L7. In many instances, it may be found possible to dispense with one or more of the above components, but they are included in this design and specified as a precautionary measure. The 2A5 audio pentode is biased by the 500-ohm resistor R9. The 25 mf. dry electrolytic condenser is employed to prevent degenerative feedback at low audio frequencies.

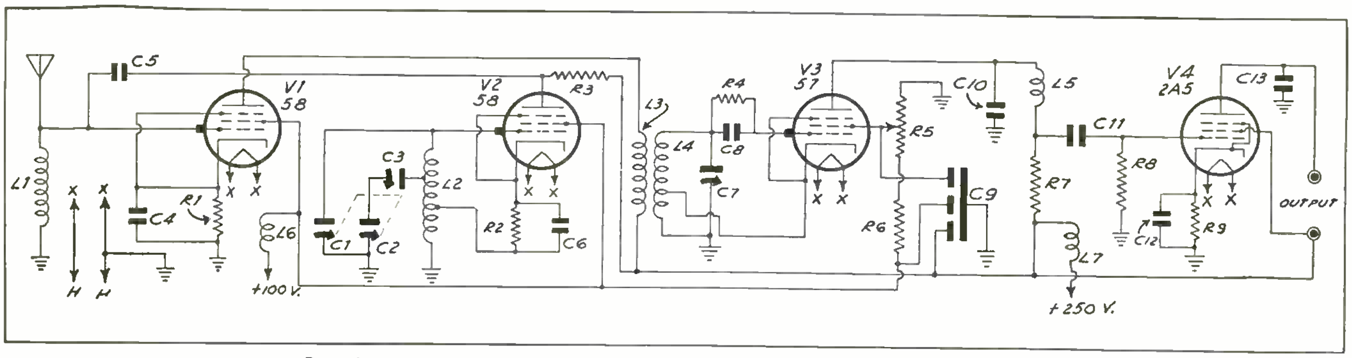
The receiver is constructed on an aluminum chassis 10″ by 6½″ by 2½″. The location of the various components can be noted from an inspection of the photographs, while the proper wiring procedure is evident from the schematic diagram. The receiver is designed for use with an external power supply, which should be well filtered to avoid excessive hum. It is also advisable in the interests of low hum level to employ a power supply equipped with a rectifier tube of the high vacuum type. Mercury type rectifiers almost invariably introduce shock excitation noise which is readily picked up by the high-frequency circuits employed.

Any conventional type of antenna may be employed, while the use of an external ground connection is optional. It will generally be found that a ground connection is advisable for broadcast-band reception; while, for short-wave work, the improvement in results effected by employing a ground connection is not generally noticeable. The receiver is designed mainly for headphone reception, although it will be found possible to obtain satisfactory room reception when employing a small magnetic speaker.

Mounting the Parts

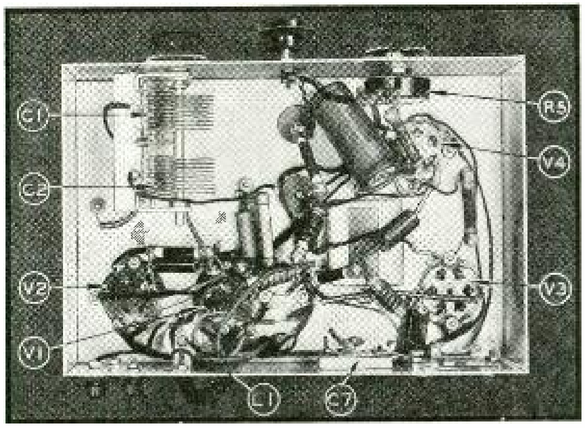
As will be noted from an inspection of the photographs, the dual condenser C1-C2, as well as the regeneration control and the tuning unit, are mounted on the front of the chassis; on top are mounted the tuning condenser C3, the three tube shields, and the two shielded inductances. At the rear of the chassis are mounted the twin speaker jack and binding post assemblies, as well as the padding condenser C7. The remaining apparatus, comprising the various fixed resistors, condensers, and r.f. chokes are mounted underneath the chassis as indicated.

When mounting the various components, there are certain precautions to be taken. The tuning



Complete schematic circuit and list of parts for the new all-wave receiver.

L1—Hammarlund 8 mh. r.f. choke.
L2—See text for winding details. Wound on 2" length of 1" dia. bakelite tubing.
L3, L4—See text for winding details. Wound on 2" length of 1" dia. bakelite tubing.
L5, L6, L7—Hammarlund midget r.f. choke.
C1, C2—Hammarlund 140 mmf. dual variable condenser.
C3—Hammarlund 140 mmf. variable air condenser.
C6—Cornell-Dubilier .001 mf. mica condenser, pigtail leads.
C5—See text for details.
C4, C11—Cornell-Dubilier .01 mf. tubular bypass condenser.
C7—Hammarlund 10-70 mmf. isolantite mica padding condenser.
C8—Cornell-Dubilier .0001 mf. mica condenser, pigtail leads.
C9—Cornell-Dubilier .1-.1-.1 mf. paper bypass condenser.
C10, C13, Cornell-Dubilier .0005 mf. mica condensers, pigtail leads.
C12—Cornell-Dubilier 25 mf. 25-volt dry electrolytic condenser.
R1, R3—I.C.A. 2500-ohm carbon resistor.
R2, R9—500-ohm carbon resistor.
R4—I.C.A. 3 meg. grid leak, ½ watt.
R5—Centralab 50,000-ohm ELF potentiometer.
R6—I.C.A. 100,000-ohm carbon resistor.
R7, R8—I.C.A. 250,000-ohm carbon resistors.
4—I.C.A. 6-prong wafer sockets.
One Crowe tuning unit, three-eighths inch hub.
Three Hammarlund tube shields.
One chassis 6½" x 10" x 2½", Blan.
Two shield cans, 2½" x 2½".
One Eby twin speaker jack.
One Eby twin binding post assembly.
Three feet of 5-conductor battery cable.
Two 2" lengths of 1" dia. bakelite tubing.
One type 57 tube.
Two type 58 tubes.
One type 2A5 tube.
Note: Other, equivalent parts may be used.



Under-view of the receiver. Note the two-gang tuning condenser and the regeneration control. Condenser C3 is insulated from the chassis by means of insulating washers.

condenser C3 must be completely insulated from the chassis. This requires the use of thick fiber or bakelite washers on either side of the mounting screws, as well as large enough holes to accommodate the screws with plenty of clearance on all sides. It is also necessary to employ an insulating bushing to connect the shaft to the dial. For this purpose, a small length of three-eighths inch bakelite tubing, slitted lengthwise to enable the set screw to secure the shaft, is employed. Obviously, the dial should have a hub capable of taking a three-eighth inch shaft.

In order to avoid excessive hum, it was found necessary to shield the grid leak and condenser combination of the 57 detector. The most satisfactory method of doing this is to employ a postage-stamp-size condenser and a half-watt grid leak and mount the combination directly on top of the screen-grid clip. In order to prevent unintentional grounds from this procedure, it is advisable to line the sides and top of the upper portion of the tube shield with light cardboard. If any other method of shielding the grid leak and condenser combination is employed, it will be necessary to also shield the grid lead. It is emphatically recommended that the method described be employed.

It is also recommended that the potentiometer be of the composition variety for smooth control of regeneration. If the slider is not insulated from the shaft, it will, of course, be necessary to insulate the bushing from the chassis. When wiring the dry electrolytic condenser C12, it is necessary to observe the polarity. The proper procedure is to connect the positive terminal to the cathode.

The oscillator coil L2 is wound on a two-inch length of one-inch-diameter bakelite tubing. The winding consists of four turns No. 22 enameled wire spaced to occupy a length of one inch. This winding is tapped one-half turn from the ground end for the cathode tap and also tapped one and one-half turns from the same end to provide the tuning condenser connection. The finished coil is mounted in a 2½" x 2½" round aluminum can by means of a ¾" double angle.

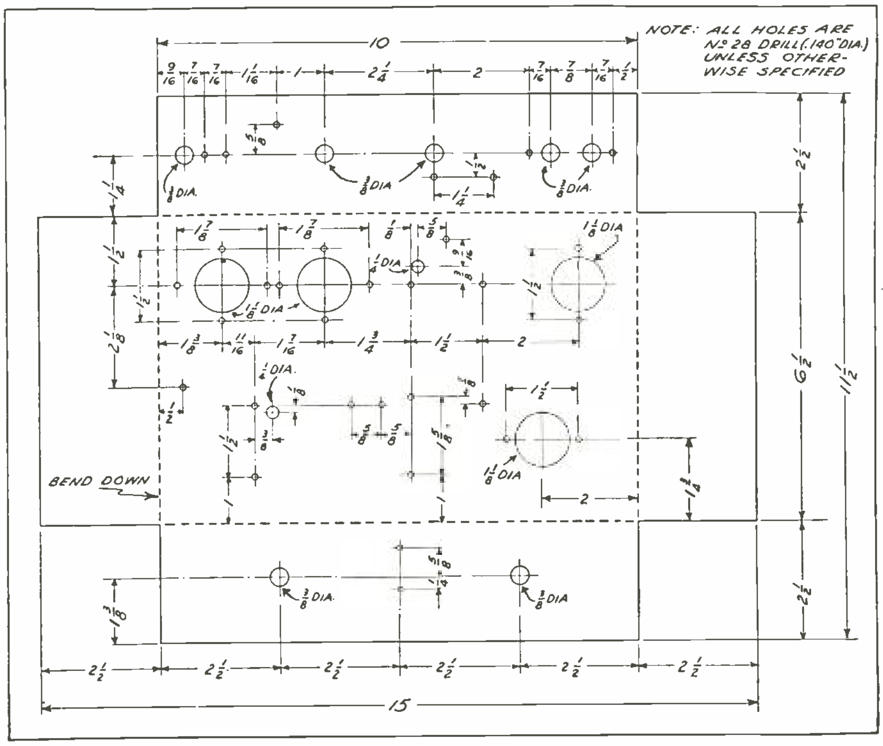
The tuned output transformer, L3-L4, consists of two interwound windings. L4 consists of 6 turns No. 22 enameled wire, spaced to occupy a length of one inch. This winding is tapped two turns from the ground end to provide the cathode tap. The winding L3 is interwound with L4, starting from the ground end, and contains 4 turns No. 30 d.s.c. wire. This coil is mounted in a shield can in the same manner as L2.

To put the receiver in operation, the first thing to do, of course, is to make the various external connections. After waiting a minute or so for the tubes to heat up, the regeneration control is advanced until a pronounced increase in the background hiss is obtained. By rotating the band setting very slowly, it should be possible to locate a pronounced point where the receiver goes out of oscillation. This indicates the point where the oscillator is in tune with the output circuit. The adjusting screw on the padding condenser, C7, should now be tightened until this point is moved so that it is just reached when the plates of the band-setting condenser are all-in. By decreasing the setting of the band-setting dial slightly below this point, it should be possible to tune in carrier squeals of broadcast stations with the tuning dial which can be cleared up by decreasing the regeneration control in the usual manner.

It will be found that the setting of the band setting and tuning controls effect to a certain extent the correct setting of the regeneration control for oscillation production. This is due to the fact that some of the oscillator signal gets on the detector tube grid because of the capacity existing between the windings L3 and L4. To eliminate this effect entirely, it would probably be necessary to employ two loosely coupled tuned circuits in this location, such as is done in the usual commercial design of intermediate-frequency transformer.

The calibration of the band setting dial can be done in any manner suitable to the operator. It can be calibrated from 1 to 20, as suggested above, or in terms of the most commonly used bands such as the 20, 40, 80 and 160-meter amateur bands, the 19, 25, 31, 49-meter broadcast bands, police and standard broadcast, etc.

It might be pointed out in closing this article that this system of all-wave coverage has particular application to the superheterodyne type of circuit, in which the only additional equipment required is a fixed-tuned oscillator to beat the 23 megacycle signal to the intermediate frequency. It will be noted that only one variable circuit is required, hence dispensing with the necessity of ganging and padding two circuits. A superheterodyne receiver along the above lines will appear in a future issue.



Mechanical layout of the chassis of the special all-wave receiver.

A Beat Oscillator for the Super

By Sol Perlman *

THE latest trend in short wave and all wave receivers points to the general use of the superheterodyne circuit. Two disadvantages of the super are the inability to locate stations by the "whistle" and to receive unmodulated c.w. signals. These disadvantages may be appreciated when the fact is known that this whistle is a sensitive indication of a station carrier. When tuning a receiver as selective as a superheterodyne, making known the presence of a station by a whistle when hunting for an elusive carrier is a real time saver. If you can't get a whistle, there is no station. These advantages are included in the superheterodyne by the addition of a beat-note oscillator.

The Theory

The principle upon which the beat-note oscillator operates is simple and reliable. When two radio-frequency signals beat, and the beat is within the audible range of hearing, its presence is made known on a radio receiver by a whistle, whose pitch depends on the difference in frequency of two carriers. In the series of events that take place in tuning in a signal on a superheterodyne, all radio signals are changed in frequency to that of the i.f.

The intermediate frequency amplifier is essentially a narrow band-pass filter and high-gain amplifier. The ideal intermediate-frequency amplifier is one that is designed to pass a signal ten kilocycles wide at a selected fixed frequency. The beat-note oscillator is designed to operate at or near this frequency. When a signal is tuned in on the receiver and passes through the intermediate-frequency amplifier and, in turn, is mixed with a signal fed from the beat-note oscillator, a whistle is heard in the loudspeaker. This whistle tells you that a station is on the air. There may or may not be a program at the time, but the whistle tells you that a *station* is there.

Upon inspection, it will be found that many superheterodyne receivers do not include a beat-note oscillator as part of the original equipment of the receiver. The beat-note oscillator to be described by the writer can be readily attached to any superheterodyne to give it the advantages outlined. It is small, compact, and may be installed in any small space available in the cabinet. It draws the power necessary for its operation from the receiver by means of an adapter placed under the output tube's socket.

As may be seen from the picture, the tube-shield is mounted on one side of the base and the tuning unit on the other. The base has a hole 1 3/16" in diameter for the 5-prong wafer socket. The tuning unit and the grid leak and grid condenser are housed in the shield can. The oscillator coil is mounted on a small brass bracket which is fastened to the midget variable condenser. The grid leak, R1, and the grid condenser C2, are also made part of this assembly, to which are attached the wires that go to the grid, the cathode, and the ground. A hole in the top of the shield can, 7/16" in diameter is for mounting the tuning condenser. A 1/8" hole in the side and near the top of the shield can facing the tube is for the grid wire to pass through. The grid cap is then fastened to this wire.

The cathode and ground wires pass through holes made in the base. In the side of the base are two holes 1/2" in diameter, one in each end of one side. The hole under the tube shield is for the grommet and the other hole is for the toggle switch. Inside the base, and on the machine screw holding the socket, a two-terminal insulating lug is mounted to fasten the resistors R2 and R3 and the condenser C3. The four-wire color-coded cable is pulled through the grommet and wired in.

All the wires, except those to the adapter and the signal feed wire, should be completed by now. The proper adapter is selected to correspond to the power tube in the receiver. The filament and plate wires of the cable are tapped in now. The fourth wire has a three-foot extension attached to it; a clip is fastened to the end of the three-foot extension wire.

The signal feed wire is made by first slipping over the end of the signal feed wire, a one-inch length of spaghetti tubing. A lug with a 3/32" hole is then soldered to the wire. The spaghetti tubing is then slid back against the lug until only the eyelet of the lug is exposed. The signal feed wire is pulled through a hole on the other side of the base and, without removing the insulation, the wire is tied with one turn around the plate terminal of the socket.

Installation Data

For receivers using a power tube with a 2½-volt filament, a 24A tube is used, when the power tube is of the 6-volt series a type 36 tube is used.

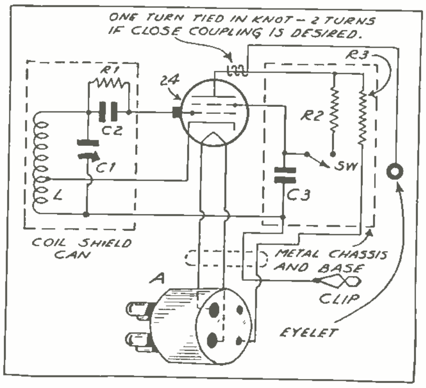
To install, place the adapter under the audio power tube. Connect the clip on the wire to the ground binding post (or the metal chassis) of the receiver. The eyelet on the end of the signal feed wire is slipped over the plate or cathode pin of the last intermediate frequency (i.f) tube.

The next operation is to adjust the beat-note oscillator for use. The receiver is switched on. The oscillator toggle switch is snapped on and a (*Continued on page* 38)

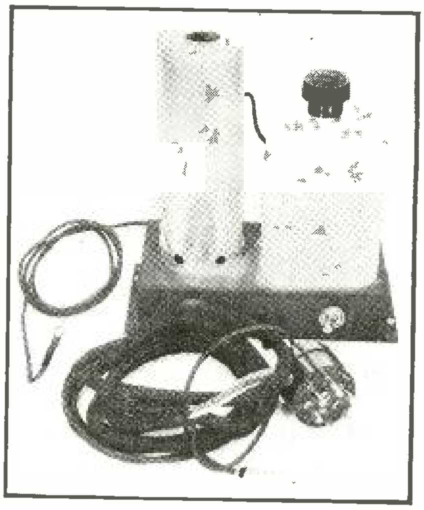
* Amplivox Laboratories.

LIST OF PARTS

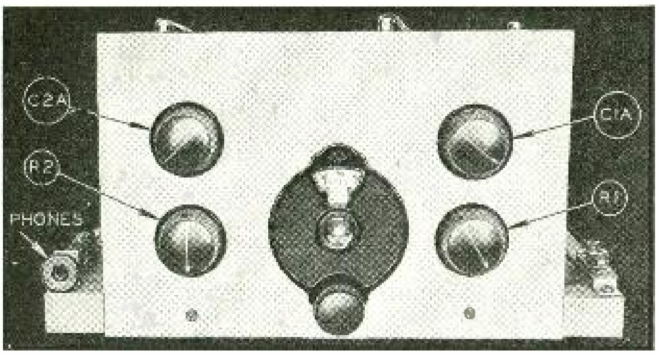
C1—Hammarlund midget type, 25 mmf. variable condenser.
C2—Polymet small .00025 mf. mica condenser.
C3—Polymet tubular .1 mf., 300-volt condenser.
L—Universal or scramble-wound coil, tapped at 1/3 of the winding for cathode connection (coil to be selected for the proper intermediate frequency).
R1—Lynch 25,000-ohm, 1-watt resistor.
R2—Lynch 100,000-ohm, 1-watt resistor.
R3—Lynch 250,000-ohm, 1-watt resistor.
SW—toggle "on-off" switch.
Grid Cap.
Knob for condenser C1.
Tube Shield.
Shield can of suitable size to house the tuning unit.
24A or 36 tube.
Lug for eyelet.
2" of spaghetti tubing.
5 feet of 4-wire color-coded cable.
Pee-Wee spring clip.
Eby 5-prong wafer socket.
Metal sub-base, 6½" by 3" by 1¼".
½" rubber grommet.
Wire and hardware.
Cinch "dummy" (insulated) lugs.
Eby male and female sections of a 4-, 5-, 6-, or 7-prong adapter, depending on type of power tube employed in the receiver.



Schematic circuit and list of parts for the beat oscillator described here.



Photograph of the oscillator. Note the adjustment on top of the can for zero beating. The tube is on the left.



Panel view of the receiver showing the controls. Regeneration is controlled by the lower two knobs.

A 4-Tube T. R. F. Receiver

A four-tube receiver in which regeneration is used in two of the stages. A buffer tube between the r.f. and detector tubes prevents interlocking. It operates from batteries and uses two-volt tubes throughout.

By Louis Martin

THE important features of a short-wave receiver depend entirely on the use to which the receiver is to be put. A large superheterodyne must have the advantages of ease of control and good quality, which are usually obtained at the sacrifice of a little efficiency and ease of construction. A simple receiver, on the other hand, has the distinguishing characteristic of high sensitivity, while the so-called advantage of quality is of lesser importance.

A superheterodyne is, without doubt, the receiver for the man whose main interest lies in tuning, while the regenerative receiver is more suitable for the individual who likes to manipulate knobs and dials until the last db, is eked out. In considering the type of regenerative receiver to construct, therefore, it is imperative that the circuit be so designed that maximum efficiency can be secured from each and every stage of amplification.

Regeneration Used

Regeneration has been employed for many years to increase the sensitivity of a receiver at the point of resonance. It is usually employed in the detector circuit, and its presence in the r.f. end of the set is more commonly regarded as a liability rather than as an asset. It is a liability merely because of the instability it causes. In other words, if controlled regeneration is installed in the r.f. as well as in the detector stage, a receiver with the highest possible sensitivity will result. This is exactly what is done in the receiver to be described.

As pointed out in previous articles on this subject (See the August issue), extreme care must be exercised in using regeneration in both the r.f. and detector stages. Unless some suitable precaution is taken to keep oscillations localized within a particular stage, interlocking will occur and completely defeat the very purpose of regeneration. Localization is obtained in this receiver by using a buffer stage between the first r.f. tube and the detector. The buffer is untuned, and, hence, will pass all signals from the r.f. to the detector tube, but will not pass any oscillations in the detector to the r.f. tube. In this manner, interlocking is prevented.

The schematic circuit of Fig. 1 tells the story. The antenna is connected to the primary of transformer T1 to ground. The first tube is regenerated by means of tickler T of transformer T1, and the strength of regeneration is varied by means of potentiometer R1. This first tube, V1, is a type 32 and hence R1 merely varies the screen-grid voltage.

The output of the first tube is coupled into the buffer V2, which is also a type 32 by means of the two chokes L1 and L2. These are small 2.5 millihenry affairs and serve the purpose very satisfactorily. Note that this circuit is not tuned at all; therefore, all signals pass right through V2 to the regenerative detector, V3. Oscillations are controlled in this circuit by the same means as was employed previously—resistor R2 varies the screen-grid voltage of V3. The tickler T of transformer T2 is connected in the more usual fashion, and the oscillations in this stage are enhanced by the addition of the filter C9-L3. Condensers C6 and R3 are the usual grid leak and grid condenser used for rectification.

The output of this tube is resistance coupled into a type 33, which then feeds either a pair of phones or a magnetic loudspeaker.

Two-Volt Tubes Used

As may be readily appreciated, two-volt tubes are used throughout. This is because these types of tubes lend themselves for use with four No. 6 dry cells. They are very easily connected and give entirely satisfactory service.

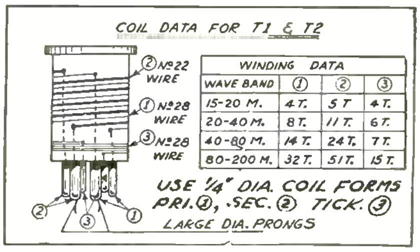
A glance at the photograph will show two trimmer condensers mounted on the panel. These are C1A and C2A, respectively. In using this receiver, it will be found that changes in the degree of regeneration will cause changes in the tuning of the particular stage. Hence, some means must be employed to compensate for this change of tuning. C1A is used for compensation in the r.f. circuit and C2A in the detector circuit. More will be said regarding the use of these controls later.

Both regeneration controls are equipped with switches. The switch on R1, labeled sw.1, turns the A battery on and off; that on R2, labeled sw.2, shuts the screen voltage off. Hence, the otherwise continuous drain through the potentiometers is removed when the set is not in operating condition.

Construction Details

The receiver is built on a baseboard 8″ x 12″. A metal panel 9½″ x 6½″ facilitates mounting the controls and reduces hand capacity effects. Looking at the rear of the set, the control on the lower left of the panel is R1; directly above it is C1A; on the upper right is C2A; and beneath it, R2. The tuning control, of course, is in the center of the panel. Isolantite sockets are used for T1 and T2, while some old non-microphonic sockets were used for V1, V2 and V3. The chokes L1 and L2 may be seen between V1 and V2, and L3 is behind the socket for T2. No directions will be given for wiring as it is felt the photographs and the schematic diagram are sufficient in themselves.

In operating the receiver, turn both switches on and wait a few seconds until the tubes heat up. Keep the regeneration control R1 at a very low value and raise R2 until the detector breaks into oscillation. Tune in a signal in the normal fashion. Undoubtedly, it will be extremely weak. Raise the setting of R1 a wee bit at a time. The signal will increase in volume. As this op-

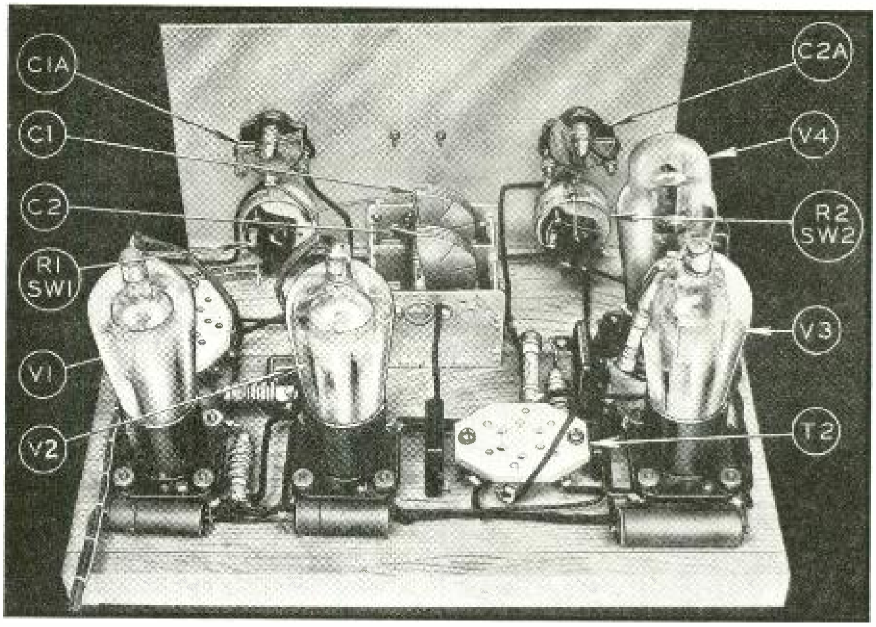


WINDING DATA			
WAVE BAND	①	②	③
15-20 M.	4 T.	5 T	4 T.
20-40 M.	8 T.	11 T.	6 T.
40-80 M.	14 T.	24 T.	7 T.
80-200 M.	32 T.	51 T.	15 T.

Coil winding data for the receiver

eration is being performed, vary the setting of either C1A or C2A in order to keep the signals tuned to resonance. This test should preferably be made on a phone signal, because then both V1 and V3 are not oscillating, but regenerating. Now increase R1 until the r.f. tube is *just* below the point of oscillation and retune C1A to compensate for the change in tuning. R2 may then be increased slightly, at the same time adjusting C2A until the detector is just below the point of oscillation. Under these conditions, it will be found that maximum signal strength is obtained.

Under no circumstances should both tubes be oscillating at the same time. If they do, a terrific audio squeal will be generated due to the slight difference frequency between the two oscillations. (This is the fundamental principle of the audio-frequency beat oscillator, and the intensity of the squeal will be appreciated by anyone who has had experience with such devices.)



Rear view showing the wiring and location of the parts.

Effect of Frequency

Of course, it will be found that the settings of the regeneration controls will vary with frequency, so that quite a bit of experience must be had before a receiver can be tuned intelligently. Once the proper procedure is mastered, signals of almost negligible strength can be nursed along, first with one control and then with another, until it is built up to surprising proportions. Care and patience are fundamental to good results with this set.

The bias recommended for the plate voltage used on the r.f. and detector stages is adjusted so that the tubes act as amplifiers. If they were detectors, rectification would occur in these stages, with a consequent loss in volume. This explains the lack of grid leak and grid condenser in the first stage, even though it is regenerative.

No method of volume control is shown. The author has found that sufficient control of volume is obtained by varying either R1 or R2, depending upon their proximity to the point of oscillation. Use the one that is *farthest* from the point of oscillation. In the event that a separate control is desired, vary the voltage on the screen grid of the buffer tube, V2. Variation of this voltage will not change the tuning of the circuit in the least.

An interesting feature resulting from the design of the set is that some band spreading is obtained by condensers C1A and C2A. These condensers are 25 mmf. units and are connected directly across the main tuning units. The author found that on the 49-meter band W8XAL and W3XAL could be tuned in and out at will without touching the main dial, a very desirable feature.

It is important that the coils be mounted above the baseboard; hence the use of the isolantite sockets for T1 and T2. It was found in one case that, when the prongs of the coils were too close to the board, difficulty was experienced in making the r.f. tube oscillate.

The grid leads to the caps of V1 and V2 were shielded, but not grounded. Grounding of the shield on V1 and V2 changed the capacitance of its tuned circuit to such an extent that ganging was impossible. These ungrounded shields give magnetic shielding, and electrostatic shielding is not required since the leads are removed from neighboring apparatus.

Wiring to the apparatus is short, and it was found convenient to cable the battery leads right to their terminal positions in the set. No tube or coil shields were used.

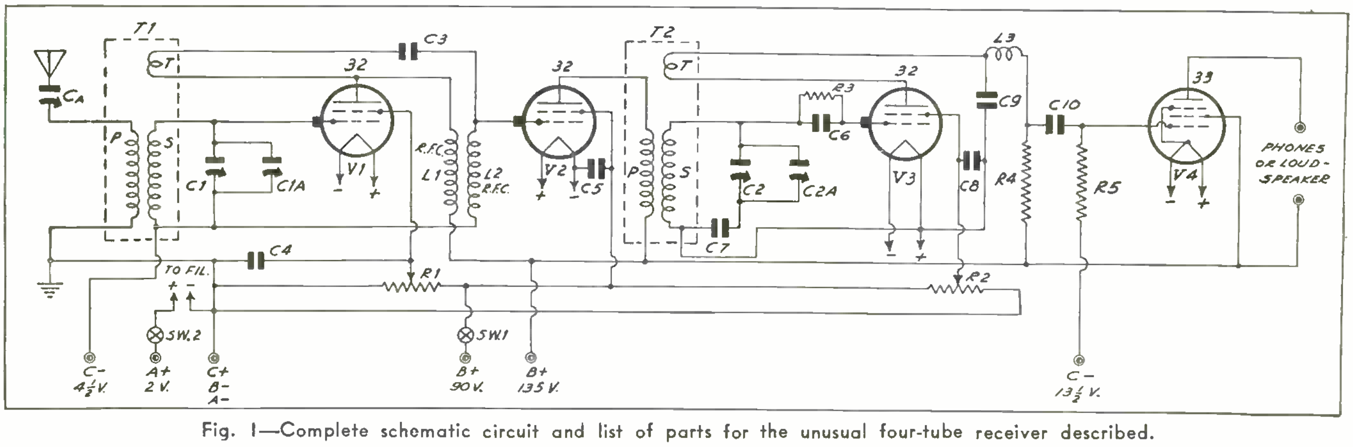
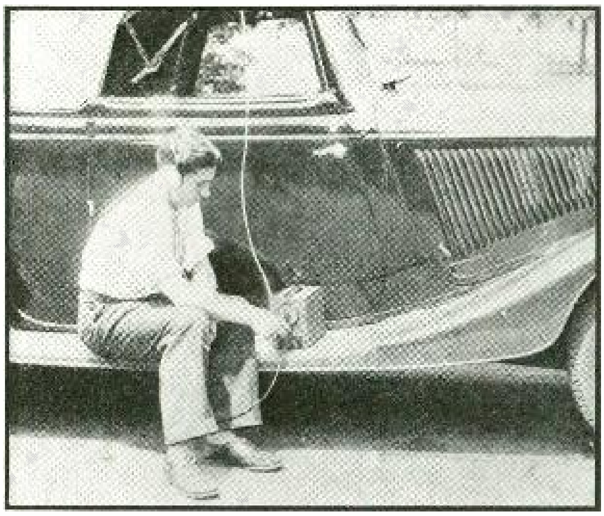


Fig. 1—Complete schematic circuit and list of parts for the unusual four-tube receiver described.

C1, C2—140 mmf. dual variable condenser, Federal.
C1A, C2A—25 mmf. midget variable condensers.
C3, C9—.00025 mf. mica condensers, Aerovox.
C4, C5, C8—.1 mf. tubular paper condensers, Sprague.
C6—.0001 mf. mica condenser, Aerovox.
C7, C10—.01 mf. mica condensers, Aerovox.
R1, R2—25,000-ohm potentiometers, Electrad.
R3—3 megohm grid leak, ½ watt, Lynch.
R4—.2 megohm grid leak, 1 watt, Lynch.
R5—1 megohm grid leak, ½ watt, Lynch.
SW1, SW2 on R1 and R2, explained in text.
T1, T2—See table for coil data.
L1, L2, L3—2.5 mh. r.f. chokes, Hammarlund.
Three four-prong sockets.
Two isolantite six-prong sockets, Hammarlund.
One five-prong socket.
One antenna ground post strip.
Three type 32 tubes, Raytheon.
One type 33 tube, Raytheon.
Four No. 6 dry cells or equivalent for A supply.
One C battery with 13½-volt tap.
Three 45-volt B batteries, Eveready.
One baseboard 8" x 12".
One panel 9½" x 6½".



The Band-Spread Portable

SUMMARY: *The summer always brings with it a desire for the outdoors, and to the radio man this means portable radio. We present, therefore, a portable short-wave receiver, designed for band-spread tuning, and perfectly adaptable as a monitor when on home grounds. All accessories are entirely self-contained, except for the phones and aerial. It is compact and can stand the knocks of travel.*

By Frank Lester (W2AMJ)*

AT the time the August, 1934 issue of SHORT WAVE RADIO appeared, the writer happened to be working on a compact portable receiver and therefore he was very much interested in the article on page 28, which described the construction of a transportable set for the car. As the portable set he had in mind at the time is now completed and as it falls in the "really portable" class mentioned by the writer of the article, he felt that a description of it might be of interest. Short-wave fans and set builders thus have the choice of two distinctly different types of portable receivers.

Thoroughly Tested

The Band-Spread Portable, as the set is called, has undergone thorough tests and has proved to be highly satisfactory in all respects. To quote the August article again: "Portable receivers are of two general classes: First, those that are really portable in the sense that they contain their own batteries and can be carried comfortably more than ten feet without dislocating the owner's shoulder"; the writer wishes to emphasize the fact that this little receiver really comes under this classification. It was carried around and tested by three different people during the terrific hot spell of the first week of July, and not one of these persons ever had the impulse to drop it quietly down the nearest manhole! The whole outfit, complete with its self-contained A and B batteries, weighs only nine pounds. Nine pounds is not very much at all to carry around; if it sounds like a lot, just weigh up your handbag the next time you pack it full of summer odds and ends for a day at the beach. You will be surprised to learn how much more than nine pounds that bag weighs.

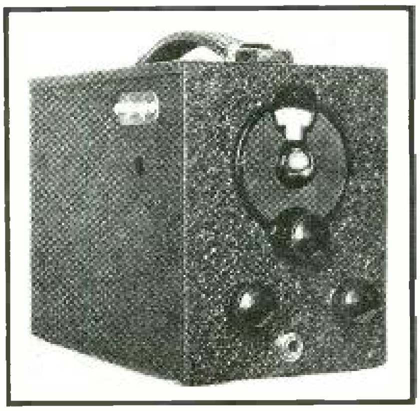
The Band-Spread Portable is built into a strong metal case measuring only 8¾" long, 6¾" high and 5¼" wide, fitted at the top with a comfortable carrying handle. The entire cabinet is finished both inside and outside in black crystalline enamel, which not only gives the instrument a pleasing appearance, but also acts, to some extent, as an insulator against the hot summer sun.

The Band-Spread Portable derives its name from its use of special band-spread coils, which make station finding a comparatively simple matter and also permit the use of the receiver as a complete amateur station monitor.

Access to the coil socket is had through a hole cut in the top of the cabinet directly under the carrying handle. This hole is covered by a hinged plate which excludes dust and dirt and also completes the shielding effect of the cabinet. This complete shielding is an important feature in the successful use of the receiver as a monitor.

The cabinet is a special spot welded job and is made in two pieces. The bottom, ends and one side form one of the sections, and the top and the other side form the other section. The two fasten together by means of 6/32 machine screws. It is necessary to remove the smaller section only in order to replace tubes or batteries.

Exactly half of the space inside the cabinet is occupied by the receiver components proper and the other half by the batteries. Two type 30 tubes are used in a good old reliable regenerative-detector-one-step-audio circuit. The filaments of the tubes are connected in series with an eight-ohm resistor, R2. This arrangement permits the use of a single, large size 4½ volt C battery for A supply. Since the total current drain for the filaments is only 60 milliamperes, the battery lasts a surprisingly long time. One such battery in an experimental model of this set survived several hundred miles of automobile travel during very hot weather and many hours of actual service. In fact, at the time this article was written, the battery had been in use for almost five weeks and, apparently, was still good for some further service. The battery employed for the purpose is 4" wide, 3" high and 1⅜" thick.



External view. It is complete as shown, except for the phones and aerial.

Batteries Used

Plate voltage is supplied by a single medium-sized 45-volt B battery. It undoubtedly will last eight to ten months in normal usage, as the current drain is only a few milliamperes. This B battery measures 5⅞" high, 4¼" wide and 2½" thick. Both batteries sit comfortably in the rear section of the cabinet without stuffing or padding of any kind.

The five-prong socket that accommodates the plug-in coil is mounted just in front of the A battery and is supported a distance of 3½" above the bottom of the cabinet by means of a couple of long brass studs. Flanking this socket are the two tubes, which come up to just about the same level. Just in front of the coil socket and under the tuning condenser C1 is the small 3½-to-1 ratio audio transformer T.

The main tuning condenser C1, of 140 mmf. capacity, is controlled by a small vernier dial. In the lower left-hand corner of the end of the cabinet is the antenna trimmer condenser, C6; in the lower right-hand corner the combined regeneration control and filament switch, R1-SW. Between the two lower knobs is a short single-circuit earphone jack, J. This is carefully insulated from

*Engineer, Wholesale Radio Service Co., Inc.

the cabinet, as the latter forms the grounded A+ side of the circuit.

The band-spread coils, which are described in an accompanying illustration, are of the double winding type. The small winding at the bottom of the form serves as the tickler, and is connected in series with the plate circuit of the detector tube, V1. The r.f. choke coil, L2, of 2.2. mh. inductance, keeps the r.f. energy out of the primary of the audio transformer.

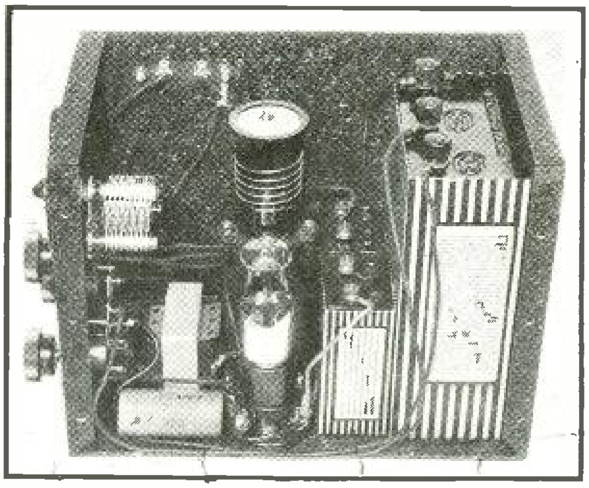
It will be observed that the main tuning condenser C1 is connected across only a portion of the entire grid or secondary winding. The tap is about a quarter of the way up from the grounded end. The variable condenser represented in the diagram as C5 is a tiny trimmer type condenser mounted directly in the end of the coil form and connected across the entire grid winding. This condenser is adjusted by means of a screw sticking out of the end of the coil. It acts as a fixed loading condenser, while condenser C1, which is connected across only a portion of the entire secondary inductance, has a relatively slight tuning effect, and therefore the entire dial movement represents only a limited frequency range; hence the "band-spread" action. Of course, the particular section of any band to be covered depends on the coil used and the settings of the individual C5 condensers.

Regeneration Control

Regeneration is controlled by the 100,000-ohm variable resistor, R1, which is connected directly in series with the B+ 22½-volt lead to the audio transformer primary. This is bypassed by a .5 mf. condenser which effectively eliminates any tendency of the resistor to be noisy. The regenerative action is smooth and quiet, and phone stations can be brought in just at the critical point of oscillation.

The secondary of the transformer is shunted by a 1 megohm registor, R4, merely for the purpose of eliminating fringe howl.

On the left side of the cabinet is a double binding-post strip for aerial and ground connections. It has been found in actual practice that most any sort of an antenna will bring in signals. Fifteen feet of insulated flexible wire draped over the roof of



The portable with its top and one side removed to show the "works." The large battery is for the B and the small one for the A supplies. One tube is on this side of the coil and the other, which cannot be seen, is on the opposite side. The tuning condenser and audio transformer are visible.

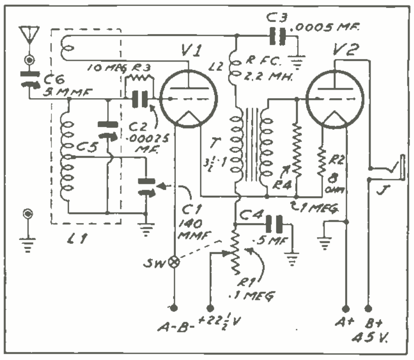
a car worked very well in some road tests and brought in programs from such foreign short-wave stations as London, Berlin, Madrid and Paris. The frame of a car, a wire fence, a fire hydrant and an iron railing have all been used successfully as "ground" connections.

A natural question that the reader will ask is, "What do you do with the extra coils, earphones and aerial wire?" In some of the original trials of this set, a cabinet that accommodated all these accessories was employed, but it was heavy and bulky and the necessity for a hinged top or side of some sort complicated the construction unnecessarily. It was found that the easiest way to dispose of the phones and the other parts was to merely stuff them in a pocket. As a matter of fact, if the set is to be carried from one place to another without being used enroute, all the coils, a roll of aerial wire and a pair of featherweight phones can all be pushed into the cabinet as it now stands. It is the work of only a few minutes to unscrew the removable section of the cabinet and to fish out these parts when the set is to be placed in service.

A Good Monitor

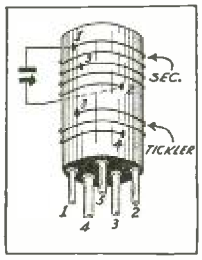
Although this particular application is rather incidental, the Band-Spread Portable makes a beautiful little monitor for the "ham" station. Because of its rather complete shielding the signal pickup by itself is very low and the whole unit can thus be placed on the operating table, quite near the transmitter, without being blocked by the latter. It can be calibrated quite readily by any of the methods described in the *A. R. R. L. Handbook*.

The Band-Spread Portable is available in either kit or completely assembled form. As the cabinet is supplied completely formed and drilled, the actual assembly and wiring work is rather slight and can be performed in a couple of evenings of casual effort. The whole instrument will work right off the bat the first time it is hooked up, except possibly for a reversed tickler. Its foolproof nature and general freedom from "bugs" are its best recommendations.



Schematic circuit and list of parts for the portable receiver described here.

L1—two-winding five-prong band-spread coils as described.
L2—2.2 mh. r.f. choke coil.
C1—140 mmf. midget variable.
C2—.00025 mf. mica grid condenser.
C3—.0005 mf. mica bypass condenser.
C4—.5 mf. paper bypass condenser.
C5—trimmer condensers built into coils.
C6—two-plate 5 mmf. antenna trimmer.
R1—100,000-ohm potentiometer.
R2—8-ohm wire-wound resistor.
R3—10-megohm grid leak.
R4—1-megohm grid leak.
J—single open circuit phone jack with insulating washers.
V1, V2—type 30 tubes.
T—3½-to-1 ratio uncased audio transformer.
Three-inch vernier dial for condenser C1, knobs for R1 and C6, double binding-post strip, five-prong socket for plug-in coil L1, and incidental hardware and mounting screws.
1—steel cabinet as specified.
1—4½-volt C battery, Burgess No. 2370.
1—45-volt B battery, Burgess No. 5308.
All parts used in this set are "Truetest."



Data and connections of the band-spread coils used.

COIL DATA TABLE

Wave Band (meters)	Secondary No. of Turns	Secondary Tap from Bottom	Primary No. of Turns	Trimmer Capacity* (mmf.)
19	4½	1¼	4¾	80
25	4½	1¼	4¾	180
31	11½	4¾	6	180
49	11½	4¾	6	180

*Fixed variable condenser. Values shown are maximum. All secondary coils are wound with No. 24 bare wire spaced to a winding length of 1¼". Ticklers are close wound with No. 28 or 30 s.c.c. wire.

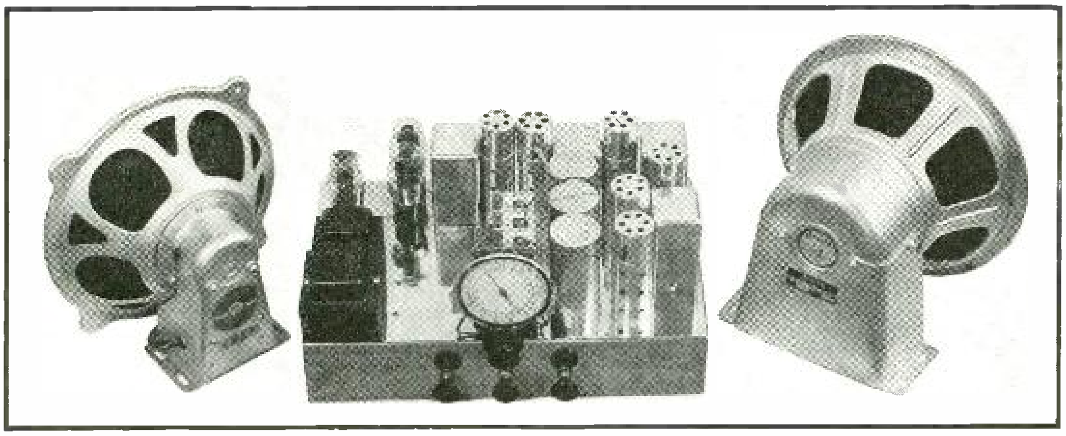


Fig. 1—The "World-Wide Nine" with two speakers, although one is quite sufficient for all ordinary purposes.

The World-Wide Nine

SUMMARY: *This article is an excellent summation of all that we have been preaching about short-wave supers. We gave this receiver a healthy going over, and can recommend it. The tuning dial will certainly attract the man who likes to tune a set and breathe at the same time—its double ratio is a decided advantage. The set has preselection, a beat oscillator and automatic volume control.*

By McMurdo Silver

CUSTOM built all-wave superheterodynes invariably cost from well over one-hundred dollars to several hundred, and such prices are fully justified in terms of superior performance and construction. From the experience gained in designing and building the Masterpiece II, it was felt that a strictly custom-built laboratory all-wave superheterodyne could be engineered and built to sell for well under one hundred dollars. This belief was based on the fact that the relatively small quantity that could be so built could be sold in the most economical possible manner—direct from laboratory to user, thus effecting a considerable saving.

So the task of finding out how to provide, in a low-priced receiver, as good or better results than are obtained today from sets costing much more was undertaken, and the result is essentially the Masterpiece II stripped only of its not vitally essential refinements.

The initial requirements in undertaking such a design are as rigid as for the Masterpiece II, and summarize substantially as follows:

(a) Sufficient sensitivity to insure reaching the lowest possible residential noise level, which means about 1.0 microvolt absolute.

(b) Absolute 10 kc. selectivity, or the ability to select one station channel at a time without interference.

(c) Fidelity, flat to 6 db. for the fundamental musical range of 30 to 4000 cycles.

(d) Sufficient undistorted power output to give ample home entertainment volume without overloading the audio system on peaks and bass excursions.

(e) Lowest possible inherent noise level in order not to vitiate the high sensitivity that is now required.

(f) Full coverage of the entire broadcast range of 540 to 23,000 kilocycles.

(g) Ease of operation and dependability.

In order to meet these general fundamental requirements, many corollary requirements must be met.

Meeting the Requirements

If requirement (a) of sensitivity is to be satisfied in an all-wave superheterodyne, a first detector and oscillator of high gain is needed, at least two i.f. stages, second detector, automatic volume control to minimize fading of weak stations, and two audio stages.

In meeting the selectivity requirement (b) two problems must be considered. First, adjacent channel selectivity will necessitate the use of at least six tuned i.f. circuits—two i.f. stages. The second problem is that of image, or repeat spot, interference. Initially, this requires a high intermediate frequency in order to facilitate image rejection. In addition, with any logical choice of i.f. between 450 and 500 kc., 465 kc. being about the best average, a tuned r.f. stage must be used on short waves for image rejection, and it will also be necessary to insure a good signal-to-noise ratio.

The requirement of good audio fidelity (c) necessitates not only good audio design and compensation for r.f. and i.f. side band cutting, but it necessitates a class A or, preferably, a class A-prime power output stage, the harmonic distortion of class B or pentode output stages being intolerable in a really fine receiver. It will also necessitate a diode, rather than a three element triode, second detector for elimination of second detector distortion. If a necessarily low gain but high quality class A or A-prime output stage is used, it must be preceded by a combination voltage amplifier and power driver stage.

Good power output, requirement (d), will involve at least eight watts of undistorted output for fairly good home entertainment volume without distortion, ten watts being preferable. It can be had from a well designed class A or A-prime output stage not skimped on transformer size or available voltage.

Requirement (e), low inherent noise, is most stringent. Noise inherent in a receiver design may originate in a number of ways, but assuming competent design and high-quality tubes and parts, it may be localized. The frequency conversion effected by the first-detector and oscillator will always produce some tube hiss, which can be minimized by operating these circuits at as high a signal level as possible. This can be effected on weak signals only by the use of a tuned r.f. stage preceding the first detector, which will not only eliminate image interference as previously indicated, but from which sufficient amplification can be obtained to permit frequency conversion to occur, even on very weak signals, at a level sufficiently high to swamp oscillator hiss.

With this done, the remaining noise will be entirely a function of overall gain, showing up as thermal agitation noise in input circuit and in input tube. This is the final limitation of usable gain, or sensitivity, in a radio receiver. The answer is to strive for a sensitivity of

The Author

Born, March 15, 1903, Geneva, New York.

Son of John Archer Silver, professor of Ancient History at Hobart College.

Got first inkling of radio in 1911 from story of *Titanic* disaster, and in 1912 could be found winding tuning coils on large sized thread spools in several layers, and making spark coils by filling cigar boxes with chunks of magnet wire cut very short and sealed, with no connections to binding post located on cover of box! Results—entirely negligible.

Co-operator of amateur station 8VM from 1913 to 1916. Moved to New York City in 1916, attending school.

First worked as runner in Wall Street brokerage house from Armistice Day 1918 to 1919. Then went to research laboratory of Westinghouse, Bloomfield, N. J., on tube development, where he wrote several technical articles published in QST and elsewhere, and assisted initial receiving and transmitting tube development, at this time building the smallest vacuum tube known today, measuring 1/2" long and 3/8" in diameter—which is still operating.

Left Westinghouse in 1920 and took night engineering course in New York. Worked for Manhattan Electrical Supply in order service and radio departments until 1922. In 1922 went to Griffin Radio Service and was largely responsible for effecting consolidation, resulting in Haynes-Griffin Radio Service. While there, developed first practical superheterodyne kit in the world—Haynes, Cockaday, and Radio Broadcast supers.

In 1924 moved to Chicago and started Silver-Marshall, Inc., developing many kits and quality parts and dominating the parts and kits business by 1929.

In 1932 established McMurdo Silver, Inc., a radio engineering laboratory.

Practical experience covers every phase of radio from receiver design to transmitter, P. A. equipment and anything related thereto.

Hobby—collecting early Colt revolvers. Had one of the finest collections in the world between 1927 and 1930. Has written extensively on this subject.

between 1/2 and 1 1/2 microvolts absolute—more than this results only in excessive noise with no gain in signal pickup, while less than this loses signals that would represent entertainment under favorable local noise conditions.

Requirement (f), full coverage, is vitally important. Full coverage includes all frequencies from 540 kc. to about 23,000 kc. (the limits of the American broadcast and foreign short-wave bands) and all services such as police, amateur, airport, ship telephone and broadcast, much of which is lost by the present "two band" receivers—four bands are needed for full coverage.

Requirement (g), ease of operation and dependability, covers much territory. In terms of controls, it necessitates as many, but no more than, necessary to obtain maximum possible results at all times. There should be one single-tuning control, with, of course, a calibrated dial, having smooth, positive and easy adjustment, and with at least two tuning ratios. One ratio can be between 4:1 and 8:1 for the broadcast-band tuning, and one ratio should be between 20:1 and 30:1 for simple, easy, station finding and ability to tune for proper tone quality of short-wave stations. These two ratios are pretty essential if best results are to be had at all, the second high ratio being essentially a simplification of band-spread tuning as used on amateur receivers.

What a Set Should Have

A volume control should be provided; and a tone control is quite essential to meet individual tastes as well as for noise reduction; of course, a solid, substantial and trouble-free wave change switch is imperative. In addition to this, an audio beat oscillator assists in locating short-wave stations. This feature, with the dual-ratio tuning dial, may make all the difference between hearing and missing foreign stations.

Upon reviewing these general requirements, we find that an all-wave receiver should have the following tube and circuit functions:

1. Tuned r.f. stage on all bands.
2. First detector and oscillator, preferably in a single tube of high conversion gain and good frequency stability, such as the 2A7 or 6A7 electron-coupled oscillator first-detector.
3. Two i.f. stages for adequate adjacent channel selectivity, operating at 465 kc. to insure image rejection in conjunction with the tuned r.f. stage. Preferably air tuned to insure permanent retention of initial alignment, sensitivity, and selectivity.
4. Automatic volume control of extended range to effectively minimize effects of fading on weak and strong signals alike.
5. Audio beat oscillator for easy location of short-wave stations, and for c.w. code reception if desired.
6. Diode second detector for mimimum distortion and adequate output.
7. First audio stage for voltage amplification and driving power for output stage.
8. Push pull class A (preferably class A-prime) audio power output stage, developing from 8 to 10 watts undistorted output, with lowest possible harmonic distortion at average home volume levels.
9. Dependable, trouble-free power supply turning out adequate power for operation of the entire receiver without undue heating or strain on its components.
10. Loudspeaker large enough to insure good fidelity over fundamental musical range and good electric-to-sound conversion efficiency in order not to waste, in conversion, audio power previously developed.

To leave much unsaid in order to conserve space, a receiver to embody all of the above important features will need nine tubes, which may best be 58 tuned r.f. stage, 2A7 electron-coupled oscillator and first detector, two 58 i.f. amplifiers, 55 diode second detector, diode automatic volume control and class A triode first audio stage, two 2A5 pentodes operated, not as pentodes, but as high-mu class A-prime power triodes, and one 5Z3 rectifier.

Having pursued the reasoning briefly outlined above, it is time to consider the old Chinese proverb that "one picture is worth a thousand words," and examine a specific receiver embodying these desired features by means of pictures, a circuit diagram and the fewest possible words.

The completed receiver is illustrated, with its optional 12" dynamic speakers in Fig. 1, while its circuit diagram appears in Fig. 2. At the

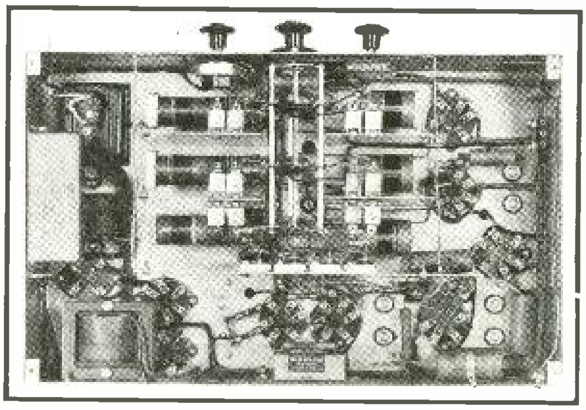


Fig. 3

Under view of the receiver. The coil arrangement is particularly important. Note their placement with respect to the switches and the shielding between the coils. A bottom plate completes the shielding on all sides. Cable wiring is used.

center of the chassis is seen the three-gang tuning condenser, with its calibrated airplane dial, which tunes the 58 screen-grid tuned r.f. stage and the 2A7 first-detector and electron-coupled oscillator circuits. At its right, from front to rear, are the r.f., first detector and oscillator inductances for the broadcast band, while the 58 r.f. amplifier and 2A7 first detector electron-coupled oscillator are just to the right of these inductance shields. From extreme right front to left rear, the shields and tubes are: first i.f. transformer; 58 first i.f. amplifier tube; second i.f. transformer; second 58 i.f. tube; third i.f. transformer; 55 diode second detector, diode A.V.C. and triode first audio tube; 58 electron-coupled audio beat-oscillator tube; beat-oscillator coil and condenser assembly in a shield similar to that used for i.f. transformers; two 2A5 class A-prime triode power output tubes; 5Z3 rectifier tube; and, at the left front, the power transformer, and filter choke.

The controls are: lower left, noiseless, tapered volume control and on-off switch; lower center, four position wave-change switch; above it, the beat-oscillator toggle switch; and lower right, the tone control. Immediately below the airplane dial are seen two concentric knobs: the larger one is for 8:1 ratio broadcast band tuning; the top, or smaller knob, is the 30:1 ratio tuning adjustment for use on short-waves, and is probably as sweet a control as has ever been developed for short-wave use.

The four frequency ranges of the receiver are:

540 to 1500 kc.
1500 to 4500 kc.
4000 to 13,000 kc.
9000 to 23,000 kc.

It will be noted that the 31 and 25 meter bands (9500 kc. and 11,800 kc.) are covered by both of the last two bands. Actually, however, the third (yellow) band will give much better results on 31 and 25 meters, due to the much lower tuning capacity in use, than will the fourth (orange) band. This is a very important point, and has been carefully considered in the design.

Reason for Overlap

The two reasons for the considerable overlap between the third and fourth bands are: first, 23,000 kc. represents the high-frequency limit of the short-wave broadcast spectrum, and tuning higher in frequency yields no more stations; second, setting 23,000 kc. as the top end of the fourth band allows the important 19-meter broadcast band to be tuned by a satisfactorily low value of tuning capacity to insure maximum sensitivity on this band. A fifth band, 150 to 400 kc., can be incorporated in the receiver for European use, but is of no value elsewhere in the world.

On very short waves, it is impossible to measure accurately the gain of the r.f. stage; but that its gain is quite considerable is evidenced by tuning in a weak short-wave station and then shifting the antenna lead-in from the r.f. stage primary to the detector primary—a considerable drop in signal will be noted. This r.f. gain is very important, for it permits operation of the first detector-oscillator at a high signal level in order to eliminate noise due to oscillator hiss, which becomes excessive when the first detector is forced to operate on a very weak signal.

From the circuit diagram of Fig. 2, it will be noted that not only is each of the three tuned input circuits (r.f, detector and oscillator) tuned by a separate section of the three-gang condenser, but each of the total of twelve individual circuits (three to each of the four bands) is individually padded or trimmed to insure accurate tracking throughout the entire tuning range of the set. In Fig. 3, the high frequency trimmer capacities are seen close to the wave change switch, just above the separate short-wave coils, where leads can be kept very short and direct.

The four oscillator low-frequency padding condensers are located just behind the oscillator coils on the rear coil shield positions. The combination of this total of sixteen align-

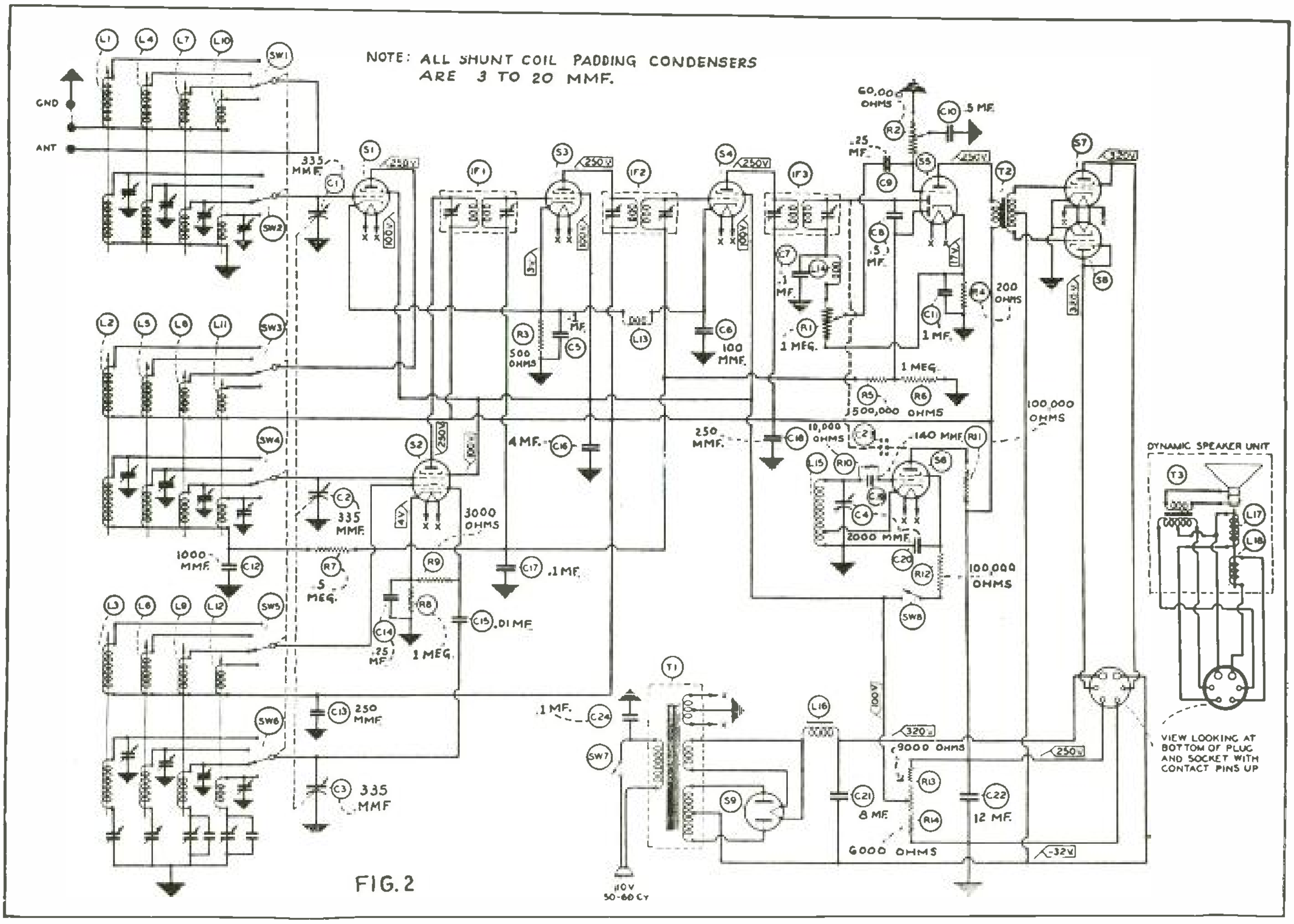


Fig. 2—Complete schematic circuit with all values marked. Note the voltages at various points throughout the set.

ment trimmers (four for each wave band) insures not only the accurate tracking of all three circuits for maximum amplification and minimum noise, but also the ability to maintain very accurate dial calibration for all four bands. This calibration accuracy is to plus or minus one percent, or to less than 1/16" of error in dial scale reading, at worst, and represents an unusually high order of accuracy today.

It can be seen from Fig. 2 that separate antenna primaries are used for all bands, with both ends brought out to antenna binding posts. Thus, a doublet antenna may be used, or, the conventional single wire antenna if preferred.

The I.F. Amplifier

Following the first detector is the two stage, 465 kc., i.f. amplifier, employing Litz coils and air dielectric tuning condensers. They are a very important feature, for compression mica condensers in this portion of the circuit would not only fail to hold alignment due to vibration in shipment, but would also shift and deteriorate with humidity and temperature changes. Only air tuned i.f. transformers will hold alignment and sensitivity and selectivity over long periods of time. The i.f. transformers used, with type 58 tubes, will show a maximum gain of from 270 to over 300 times per stage. All of this gain is not used or needed, and a portion of it is eliminated by increasing spacing between individual transformer coils, which also increases selectivity considerably.

The last of the three dual tuned i.f. transformers feeds the two diode plates of the 55 tube. One diode serves as second detector, the rectified signal voltage appearing across volume control potentiometer R1, from whence the audio signal is fed to the grid of the audio triode in the 55 bulb for audio amplification. The remaining diode plate of the 55 tube functions for automatic volume control, developing a rectified voltage across resistor R6, which is dependent entirely on the strength of the received signal. This voltage is filtered by resistors R5 and R7 and condensers C12 and C17, and fed to the control grids of the first detector and two i.f. tubes to automatically regulate sensitivity and volume. It will be seen that this automatic volume control voltage is not applied to the r.f. amplifier tube, it being desirable, as previously stated, to keep its amplification high at all times in order to prevent the introduction of oscillator hiss by virtue of operating the first-detector oscillator circuits at too low a signal level.

In addition to plate, screen, cathode and incidental bypass and isolation circuits and condensers in this, as in all superheterodynes, there arises an interesting point. In all a.c. operated short-wave superheterodynes, there is a strong tendency toward "modulation hum," or the appearance of a pronounced a.c. hum on all short-wave station carriers tuned in. Some of this can be eliminated by electrostatic shielding of power transformers as is done in practically all receivers today, but the balance must be removed by individual treatment for each different type of receiver. This particular point is only too often overlooked, for it does not show up regularly—it invariably appears only after a design has been completed and has left the laboratory. Modulation hum in the present case is eliminated by electrostatic shielding in the power transformer and by condenser C24, as well as by careful proportioning of all other filter circuits.

The triode audio amplifier of the 55 tube develops sufficient output to supply the power necessary for the positive grid excursions required to drive the 2A5 tubes operated in push-pull class A-prime (sometimes called class AB) to a full ten-watts output without distortion due to overloading.

The Audio Amplifier

Class A-prime operation consists of operation of a pair of triodes in push-pull with fairly high plate voltage and increased, but fixed, bias voltage, and arranging to feed them sufficient power through a low resistance audio transformer to permit of sufficient positive grid excursion to utilize the full straight portion of their Eg-Ip curves. Such operation reduces the harmonic distortion at low power outputs even below that available with straight class A operation, and, at the same time, permits of obtaining about twice the power available from class A operation without distortion.

Thus, a pair of 2A5 pentodes operated as pentodes will develop ordinarily six-watts output, but with excessive harmonic distortion. Operating the same tubes, not as pentodes, but as triodes, permits obtaining 10 or more watts at no greater plate dissipation, and with substantially no harmonic distortion.

Good filtration is provided in a choke input filter for good voltage regulation by one very large high inductance filter choke—the two-section speaker field and twenty microfarads of dry electrolytic capacity. The power supply uses a 5Z3 high vacuum rectifier tube having a low voltage drop in order to supply the full 350 volts at 120 ma. required for operation of the receiver and its class A-prime output stage without the need of excessive power transformer secondary voltage.

Such then, is a brief description of an all-wave receiver designed with the single purpose of giving the greatest possible performance per dollar that could be obtained by painstakingly, careful design.

(Readers are referred to past issues of SHORT WAVE RADIO for further discussion of these points.—*Tech. Dir.*)

Armstrong's I. R. E. Medal

ALTHOUGH the United States Supreme Court has affirmed its previous award of the oscillating vacuum tube to Dr. Lee de Forest against the claims of Major Edwin H. Armstrong, it is interesting to note that in the opinion of the leading radio engineers of the country, Major Armstrong is still credited with the origination of this most important radio development.

When the Supreme Court decision was announced, the Major felt that the medal which had been awarded to him in 1917 for his work in this field, was not rightfully his. He requested permission from the Institute of Radio Engineers (who had made the original award) to return the medal, and received the following reply:

"By the unanimous opinion of the Board of Directors of the Institute of Radio Engineers, you are informed:

"First: That it is their belief that the Medal of Honor of the Institute was awarded to you by the board in 1917 with a citation of substantially the following import:

"That the Medal of Honor be awarded to Edwin Howard Armstrong for his engineering and scientific achievements in relation to regeneration and the generation of oscillations by vacuum tubes.

"Second: That the present Board of Directors, with full consideration of the great value and outstanding quality of the original scientific work of yourself and of the present high esteem and repute in which you are held by the membership of the institute and themselves, hereby strongly affirms the original award, and similarly reaffirms the sense of what it believes to have been the original citation."

Ruling of the F. R. C.

The Federal Radio Commission on June 5, 1934, approved the following modification of Rule 407:

"407. An applicant for Class C amateur operator's privileges must have his application signed in the presence of a person authorized to administer oaths, by (1) a licensed radiotelegraph operator other than an amateur operator possessing only the Class C privileges or former temporary amateur class license, or (2) by a person who can show evidence of employment as a radiotelegraph operator in the Government service of the United States. In either case the radiotelegraph code examiner shall attest to the applicant's ability to send and receive messages in plain language in the continental Morse code (5 characters to the word) at a speed of not less than 10 words per minute. The code certification may be omitted if the applicant can show proof of code ability in accordance with the preceding rule."

The Tuned Antenna for Short-Wave Receivers

SUMMARY: *Tuned antennas have been the subject of conversation for years. The advantages and disadvantages of tuning the antenna system are well known: the advantages are increased signal strength and selectivity; the main disadvantage is that a separate tuning control is required. Of course, the length of the aerial has a determining effect, too. Mr. Kruse gives us the real "low-down" here.*

By Robert S. Kruse*

FOR short-wave reception, a tuned antenna offers some very important advantages which are not obtained in the 550-1500 kc. "standard" broadcast band.

As you know, tuned antennas for 550-1500 kc. reception have essentially disappeared. They did give improved signal strength in this band, but were a nuisance, since the large tuning-ratio required in this band (1500 is 3 times 500; hence, the tuning ratio is 3/1) brought with it an aggravating problem. Either you had to add an extra tuning control for the antenna or else you had to "track" the antenna tuning with that of the other tuned circuits in the receiver.

This problem would not have been a difficult one to solve if users of receivers could have been persuaded to employ a standard size antenna. Every maker or seller of receivers knows that, even today, broadcast receivers come back to the store because they are noisy—with a 15-foot antenna—or even with the lighting wires for an antenna or because they encounter interference—with a 300-foot antenna. Accordingly when high-power broadcasting came along to raise the signal strength, and a.c. tubes came along to permit high receiver sensitivity, well, we fellows in the designing game simply said, "Let's forget the tuned antenna. We can get along without it now."

Despite the enthusiastic yarns I may tell you—or you may tell me—short-wave signals are a *long* ways from being equal to local broadcast signals. The field strengths are measurable in microvolts instead of millivolts—merely a pompous way of saying that the signals are perhaps, 1/1000 as strong on the average. Unless we wish reception to be decent only on the occasions of "freak" transmission (when the brags are born), we may well consider every means for improving signals without raising noise also. Such a device is antenna tuning.

The Rubber Antenna

Would it not be nice to own a trick antenna that became very large when a signal arrived, but shrank right down when a noise came along? Absurd, of course, but that **is** roughly what the tuned antenna does. For noise, it stays at its natural size; but for signals to which it is tuned, it acts essentially like a *very* much larger untuned antenna. Gains of 10 to 1 are common. To produce such a gain by other means we must do one of the following:

1. Increase the transmitter power 100 times.
2. Invent some method of increasing receiver sensitivity without amplifying noise. (We don't know how to do this without damaging the music, or voice, although we can do it for telegraphic signals by using the Robinson stenode, as is done in many amateur radio stations.)
3. Move to a more favored receiving point.

The Tuning Control

Tuning the antenna will naturally suggest the addition of a tuning control. Fortunately, this does not appear in the same sense as in the 550-1500 kc. band. If it did, I should simply abandon the argument right here! I've headached over that puzzle too much in years gone by; nor has anyone yet offered a wholly good solution.

Fortunately, our short-wave bands are *narrower* than the 550-1500 kc. broadcasting band.

No, that statement isn't tail foremost. I realize perfectly well that it is customary to say that the s.w. bands are wider; but this customary statement arises from channel-assignment considerations and is a dismal failure when one is trying to cast light on a tuning-sharpness problem. This is easily explained by an example.

Case No. 1—The ordinary broadcast band is usually stated to be "1000 kc. wide, and, therefore, able to accommodate 100 station-channels." This tells us nothing whatever about the antenna tuning. For *that*, we are better informed when we consider the "tuning ratio," which is the ratio of the high frequency (1500) to the low frequency (550). This ratio is evidently 3 (almost). Now, no tuned circuit can respond equally to a 3/1 range—and I care not if you think in meters, kilocycles, megacycles or kopeks. Even antennas tune too sharply for such a feat, hence their tuning must be varied with that of the rest of the set, or else we must adopt the customary broadcast receiver practice of putting the antenna tuning entirely outside the range of the receiver, so that it is at least equally bad across the band.

Case No. 2—Consider a band of 14,000 to 16,000 kc. The "kilocycle thinker" will say this is "2000 kc. wide, and, therefore, able to accommodate 200 station channels, or twice as many as the standard broadcast band." Again—he has told us less than nothing about our antenna problem, instead, he has *misled* us into thinking that the problem is harder than for the b.c. band, which is the opposite of the truth.

Now, consider the tuning-ratio needed to cover this band. It is 16,000/14,000, which is 1.14 instead of the 3 we found before. Thus, from the tuning-ratio standpoint, the short-wave band is indeed much narrower, though it contains twice as many cycles.

Antenna Selectivity

Let us see what this viewpoint will do for our tuned-antenna problem. A tuning ratio of 1/1.14 translated into the broadcast band is about the strip from WEAF, at 660 kc., to WSB, at 740 kc., with the center marked by WLW. This is only about 1/12th of the band, and we can pick up ready-made evidence from several places to the effect that the *antenna* would give acceptable response over that range if tuned to WLW.

First, we find in transmitting work that short-wave antennas work tolerably well 5% off tune in both directions—which is 665 to 735 kc. if we started at WLW—a good check on our wishes. Again, if you will recall what the "single circuit tuner" acted like when the regeneration was cut out, you will have more direct evidence that a receiving antenna tunes broadly. It begins to look as if we can park the antenna tuning and then walk around the neighborhood by means of the set's tuning.

If one is interested in certain narrow bands only, the problem is just

* Consulting Engineer.

about solved, since the narrow bands (amateur and police) can be covered in just this way by means of one or two settings of the antenna tuning control. For transmitting amateurs, the problem is about solved, while the advantages of better signals without an increase in noise is retained.

For the man who listens to only a certain few foreign broadcast stations, the same arrangement serves, although tuned to other spots. Suggestions as to antennas and constants of coils and condensers are given elsewhere in this story.

On the other hand, the more serious listener will resent being tied down to a few bands, whether they be police, amateur, aircraft, international broadcast or telegraphic. For him, the antenna, like the receiver, must have a continuous tuning range, not because he intends to make it "track" or intends to wiggle it for every signal, but simply to enable him to light at any spot that sounds promising, no matter what sort of a band—or outside of any bands at all. That is why two sets of values are shown in the table.

Marconi Antennas

The simplest sort of an arrangement, if one is *not* troubled with noise, is the ancient Marconi antenna, just as used on our broadcast receivers in former days, and somewhat like that used on present standard-wave broadcast receivers. The Marconi antenna always goes to earth through a coil-and-condenser combination. For our present purpose, this is a series-combination, and the coil is coupled *loosely* to the first tuned circuit in the receiver in one of several ways. This antenna has no anti-noise features beyond that of bringing up the signals relatively by resonance.

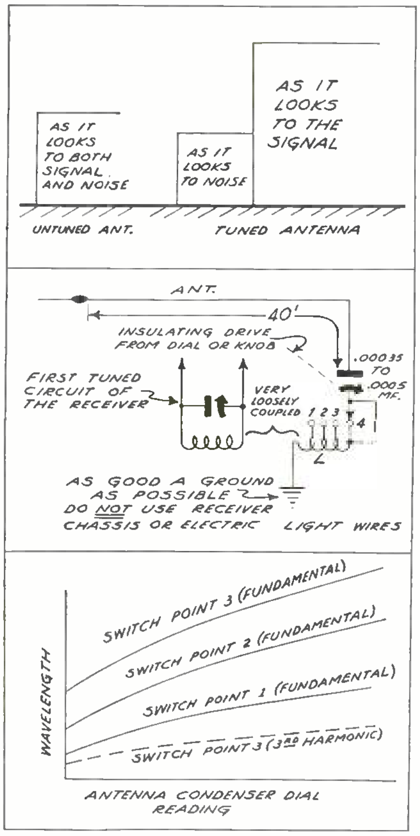
In choosing the length of the antenna, we have only two things to worry about. We must not make the antenna too small, or it will be unable to pick up enough signal. On the other hand, we must not make it too large, or else we will not be able to "get down" to our shorter waves, except by working the antenna at a very high harmonic, which is undesirable from a receiving standpoint, though quite O.K. for sending.

Let us assume that we wish to tune from 13 to 80 meters, and then let us estimate the proper antenna length. Our first thought, to make the antenna ¼ wavelength long for 13 meters and load as necessary is not a good one, because this antenna is so short that it will be very noisy. On the other hand, an antenna whose length is 80/4 meters (66 plus feet) will be hard to get into some back yards, and when working at 13 meters will be operating at its 5th or 7th harmonic, not a favorable receiving condition. If, instead, we choose an antenna about 40 feet long, we shall probably be better off, barring noise problems, for which see the Hertz antenna a bit further on.

Our 40-foot antenna is 12 meters long, and unloaded tunes to something like 48 meters when worked Marconi fashion. We can readily load it to 80 meters, and, on the other hand, with a series variable condenser we can readily "shorten" it (electrically speaking) to about 2/3 of its original tune, which is to say about 32 meters. Wishing to go to 13 meters, we must evidently work at a harmonic.

We have left the range of 13 to 32 meters, as yet uncovered. Multiplying this by 3, we find that an antenna tuning from 39 to 96 meters will cover the range when working on its third harmonic, which is not bad for receiving purposes. Thus, we emerge with a total antenna tuning range of 32 to 96 meters to cover a received-signal wavelength range of 13 to 80 meters. The 40-foot antenna (fundamental 48 meters) can be loaded nicely to 100 meters, or to 150 for that matter; hence the range is easily covered. Coils etc., are suggested under the diagram.

It may seem confusing to tune an affair which is sometimes working at its fundamental and sometimes at the 3rd harmonic, but it is hard only if one insists on trying to "figure it out." Instead, use a little healthy cut-and-try. Hearing a signal, first adjust the receiver, then the antenna *loosely coupled to the receiver*. Somewhere, the antenna condenser and switch will "bump up" the signal. Record that setting. Who cares whether the antenna is tuned to the wave or to 3 times the wave? If you do care, you may draw up a calibration chart like that sketched, but it isn't essential.



Center: The tuned Marconi antenna. L may have 33 turns No. 26 d.s.c. wire on a tube base tapped at 13, 20, 26 and 33, counting from the ground end. The switch points are connected as follows: 1, to 13th turn; 2, to 20th turn; 3, to 26th turn; and 4, to 33rd turn. A jumper is connected to the switch arm from the 33rd turn. Lower: calibration curve of the system for different positions of the switch arm. See text for details.

Coupling Must Be Loose

The *loose* coupling of receiver to antenna has been stressed, but needs more attention. We are so used to off-tune, or tuneless, antennas that we always jam the receiver coupling up tight from habit—many receivers not even offering a choice in the matter these days. This will not answer with a tuned antenna; separations of several inches between the tuned antenna coil and the first tuned circuit of the receiver are commonly the best, though some trying should be necessary. This loose coupling helps the noise also, but it may be necessary to close up the coupling while hunting signals.

In a regenerative receiver, a tuned antenna complicates things a great deal unless there is a tuned r.f. stage, because the regeneration will vary widely as the antenna is tuned. However the regenerative receiver without t.r.f. never hears *anything* distant except through sheer operating skill! Perhaps the noise-reduction will compensate for one more adjustment.

In receivers which do not expose sufficiently the tuned coil of the first stage to permit waving an antenna coil around it, we must try another dodge, common in transmission, but less often used in receiving. This dodge involves the use of a "link circuit" to couple the tuned antenna coil to the first tuned coil of the receiver. The diagram explains this well enough.

In a few receivers this is not possible because someone has dredged up out of the dark past some sort of a "fixed input," "resistance input," "choke input" or other medieval type of antenna coupler. One of my correspondents in Texas says that by pouring the case full of concrete such a receiver can be made into a good boat-anchor.

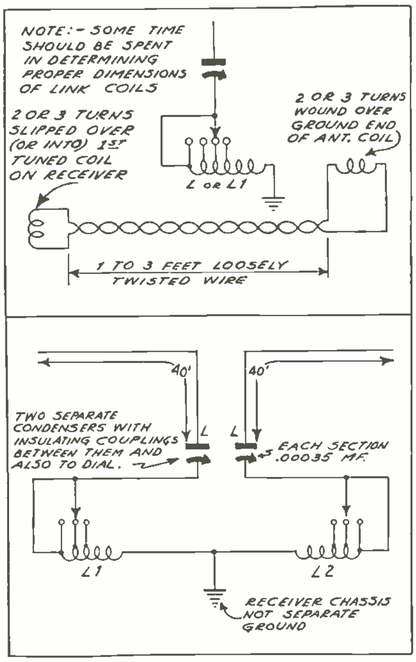
Hertz Antennas

Where noise is a serious problem, one naturally turns to those antennas which are balanced to ground, and have twin downleads. If tunability is desired, the downlead should have two wires spaced apart, not twisted together.

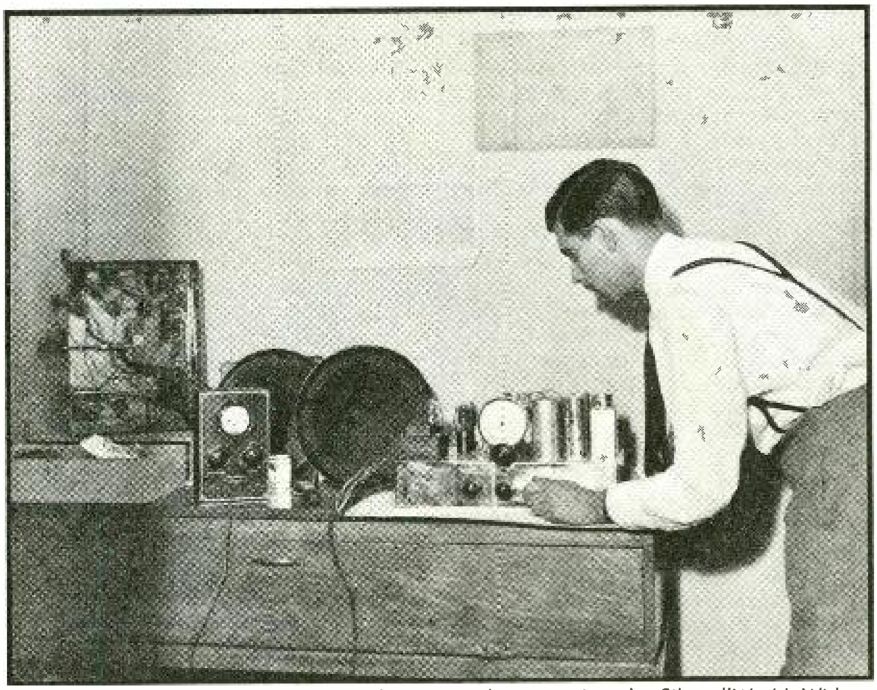
The simplest form to be derived from the Marconi antenna already discussed would be to use two wires, two condensers, and two coils, just like those we described for the Marconi antenna; to put the coils end to end with the nearest ends joined and "grounded" to the receiver chassis;

to tie the two tuning condensers together with an insulating coupling and then to run the wires parallel for perhaps 20 feet; and then to bend them apart to go off horizontally in opposite directions for 20 feet each, again giving us a 40 foot wire-length—this time plus a 20 foot downlead of two wires as just described. This will be perfectly workable, but the dimensions may not suit your yard or your fancy. If so make the lead 15 feet and the top 50 feet, or the lead 25 feet and the top 30 feet. I'd suggest not wandering much beyond that for this particular wire-length.

Should a long downlead be necessary to get the antenna-top out of the noise or into a relatively unshielded location, we can go into higher harmonic operation without the damaging effects mentioned in conjunction with the Marconi antenna. This is possible because our added part is non-radiating and hence harmless from our present viewpoint. Not knowing how much length you wish to add, I'll make no specific recommendations, only suggesting that you again resort to the scheme mentioned before—twist the antenna condenser and switch until a definite "bump" in the signal is found. If the bump is uncertain, *resonance has not been encountered* or your downlead has accidentally been made of a length such as to bring a high-voltage part into your antenna coil, which should be in a high-current region. The remedy for this is to lengthen the downlead some more—not by winding the downlead around the neighborhood, but by simply inserting series coils in each lead. Such coils are noted as "loading coils—see text," under the diagram of that antenna.



Above: the link circuit. Lower: The tuned Hertz. L1 and L2 same as for Marconi antenna; separate by few inches. Coupling to set mainly through L1. Loading coils at L, L to have one-half as many turns as either L1 or L2. See text.



A corner of the lab.; our technical director is shown putting the Silver "World Wide Nine" through the ropes.

Our Laboratory

EVERY receiver or piece of apparatus described in this magazine undergoes a test by our technical department. A receiver, for example, is supposed to be a world beater; enthusiastic accounts of reception from all parts of the world accompany the manuscript. The author or designer—whoever submits the manuscript—pours forth all his pet theories of receiver design, and then proceeds to show how they have been worked into *the* set.

If the receiver shows signs of having some merits, it is transferred to our technical director for test. Testing a receiver does not merely mean putting it on the air and listening for signals. The fact that a radio receiver picks up radio signals is no criterion at all! Such things as ease of tuning, smoothness of regeneration control, if any, dead spots, quality (yes, good fidelity is an asset!) and sensitivity are taken into consideration.

Sensitivity is a difficult thing to test unless measurements are made. Furthermore, sensitivity depends to a certain extent upon the number of tubes in the receiver. To say that one set is more sensitive than another is meaningless unless the designs of the sets are taken into consideration. Two-tube sets are compared against other two-tube sets, all three-tube receivers are compared, etc. In this manner, we can get an excellent idea of the relative merits of any given receiver.

Our laboratory is complete enough to enable us to make all types of ordinary tests. Voltmeters, ohmmeters, milliammeters, separate power units, dry batteries, various sorts of A cells, magnetic and dynamic speakers and a long list of additional equipment are readily available.

Every receiver described in this magazine is tested by us. There are no exceptions to this rule, and it goes for home-built as well as commercial apparatus.

The mere fact that the schematic circuit of a receiver is normal does not necessarily mean that the receiver as built is normal. The placement of the parts or the location of some of the wiring may be such as to make the set critical in operation. Supers give us the most trouble. Squeals and howls come in at almost every point on the dial in a poorly designed set. The oscillator coil radiates all over the chassis in many; in others, tracking is about as constant as the profile of the Rocky Mountains.

Receivers which are just a trifle hard to handle are turned over to one or two laymen for operating reports. It may be easy for us, who test about five sets a week, to handle a tricky receiver; but it may be extremely difficult for some of our readers to pull a signal out of some that we have tried. By getting an impartial report from a not-too-technical "tuner," we can get a fine idea of the stability of doubtful receivers.

Portable sets are taken out in the field and tried under actual operating conditions. Testing a portable in the lab is about as effective as merely studying the schematic—you never know what it will do in action.

We have had a little trouble with some a.c.-d.c. receivers brought to us. It seems that the builders only tested them on d.c., so that when we tried them on a.c., they hummed like fog horns.

The Theory of the RCA Antenna System

Installation data were given in our July issue; now, we present the theory of the system.

OUR July, 1934, issue contained an article on the double doublet—a new RCA noise-reducing antenna system of rather unique construction. This article dealt mainly with the method of installation, and gave no theoretical data at all. Since the appearance of this issue, many questions have been asked: for instance, what is in the mysterious little box that connects between the transmission line and the receiver? Why must the length of the transmission line be held within the critical values specified? How are the 29- and 16½-foot doublet lengths determined? What determines the length of the transmission line, etc.? We are indebted to the RCA-Victor Company for the answers to these questions.

Fundamental Idea

The fundamental principle upon which all noise-reducing antennas work is that the horizontal section should be installed in a noise-free location, leaving the transposed lead-in to do the coupling between aerial and receiver and balance out any noise which may be induced in the lead-in. It is seen, therefore, that all of the noise reduction must take place in the lead-in. There are two general types of lead-ins, the transposed or twisted type, and the shielded type. The shielded line is not very effective at high frequencies because the shield must be grounded every few feet, which is a practical impossibility. The balanced line is not hampered by this obstacle, and when used in conjunction with a suitable transformer, is capable of eliminating or balancing out the noise induced therein.

Every wire in free space has a definite impedance at a definite frequency, just as any coil-and-condenser combination has a definite impedance at a definite frequency. This holds true for two wires as well as for one. Furthermore, this impedance, called the "characteristic impedance" of a line, is greater, in the case of two wires, the greater they are spaced, and the smaller the wires themselves.

If a high-frequency voltage is applied between the ends of two parallel wires, a current will flow, and the amount of this current will depend upon the characteristic impedance of the line, just as the amount of current flowing in a resistor depends upon the value of the resistor. If the value of the characteristic impedance is known, and if a fixed resistance equal to this value is connected between the two wires at the far end, the amount of current that will flow in the line will be practically independent of the frequency impressed, so long as the voltage applied is the same. However, if the terminating impedance is different from the characteristic impedance, the current through the line will vary with frequency, the curve of current passing through a series of hills and valleys corresponding to resonance points in the line.

The RCA antenna system has a characteristic impedance of 180 ohms, which was chosen because this value was about equal to the average input impedance of most short-wave receivers and because it is about equal to the average impedance of the double doublet antenna over the short-wave spectrum.

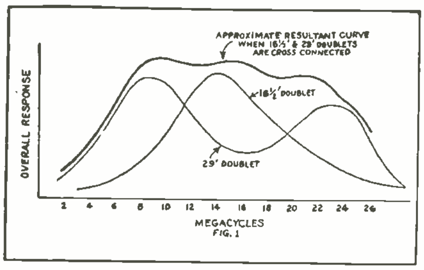
An exact match between the line and antenna impedance cannot be obtained. For this reason, the transmission curve does have a series of minor peaks and valleys. The line length specified was found by varying its length until a transmission peak occurred at each of the important short-wave broadcast bands.

Why the "Double" Doublet?

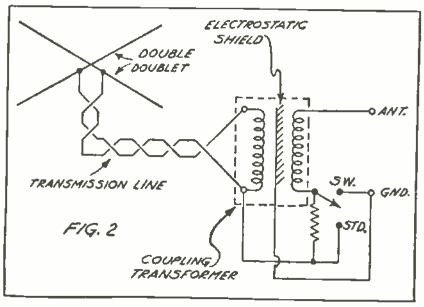
It is well known that a half-wave doublet is a very efficient collector of short-wave signals, although it is best at or near its resonant point. It is clear, therefore, that if two dissimilar doublets can be connected to the transmission line, then the overall response of the two will be quite uniform over a wider range of frequencies than when using a single doublet, provided that there is no mutual interaction between the two.

This accounts for the rather unique connection of the doublet. The left arm of the long one connects to the right arm of the short one, and vice versa. The connection must be made this way in order that the voltages induced in both doublets shall be additive midway between their respective resonant points.

If consideration is given to the fact that the long and short arms that are connected together and to the transmission line may be regarded as a single wire antenna, then it will be found upon calculation that, at the point chosen for the connection of the transmission line, the impedance of the antenna is slightly higher than that of the transmission line. At the resonant frequencies of either the long or short doublet the antenna impedance is less than the line impedance. Hence, the value chosen represents a happy compromise. The performance of the double doublet compared to that of single doublets is shown in the curves of Fig. 1.



Resonance curves of each and both doublets. Note the location of the peaks.



Connection of the transmission line to the coupling transformer. The switch merely cuts out the doublet connection.

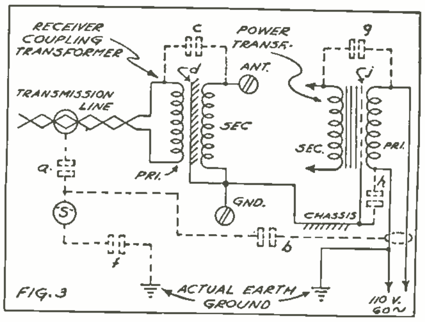


Diagram showing the use of the shield.

It is seen from these curves that the 29-foot doublet is resonant at 8 and 24 megacycles; the 16½-foot doublet is resonant at 14 megacycles.

A very important part in noise elimination is played by the coupling transformer. When considering how this transformer works, it should be remembered that there are two distinct types of signals which must be dealt with—"in-phase" and "out-of-phase" signals. In-phase signals are those which produce voltages at the set end of the line which are equal in polarity. That is, the voltages across the primary of the transformer (see Fig. 2) are positive at the same time and negative at the same time. Since there is no difference in potential, no current can flow through the transformer, and, hence, in-phase signals cannot be heard. Out-of-phase signals, on the other hand, are defined as those which produce a positive and a negative

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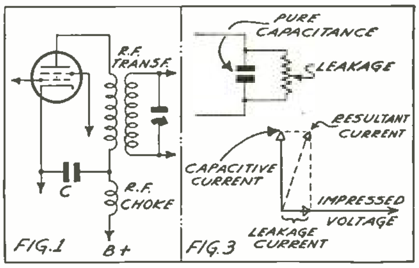
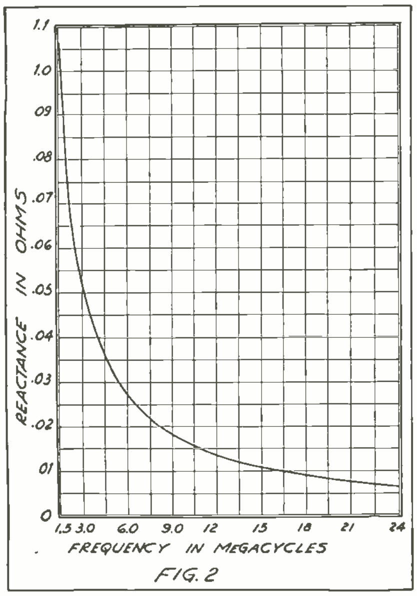


Left, simple circuit of a decoupling filter; right, effect of leakage.



Curve showing the variation of reactance of a .01 mf. condenser throughout the short-wave band. The curve is a hyperbola.

The Bypass Condenser

SUMMARY: *The bypass condenser is one of the least considered, and at the same time one of the most important, parts of the short-wave receiver. The simple explanation below gives the high-lights of the action of the bypass condenser and stresses some of its important characteristics.*

IT is surprising how much attention can be paid to good coil construction, short wiring, and accurate lining, and how little attention can be paid by the same constructors to the bypass condenser. The reason for this disproportionate division of attention is not quite clear. Neither a coil nor a condenser nor the wiring in itself makes a radio set work; it is the action of each *and* the interaction of all of them which results in the detection or amplification of a signal.

The bypass condenser has received scant attention during the last five years. In many cases, a cardboard tube with two leads and a manufacturer's stamp of approval is sufficient for the constructor. This is an unfortunate state of affairs, for a condenser which may be perfectly good on one frequency may be entirely inadequate at another.

The rule of thumb method used by many is to employ paper condensers on the frequencies below about 1500 kc. and to employ mica condensers in the high frequency, short-wave, sections of the receiver. This rule is a very good one, but, unfortunately, does not result in the most economical solution to the problem.

A condenser, to be effective as a bypassing unit, must have a very small reactance at the frequency at which it is to work. In the usual run of receivers extending from about 1500 to 20,000 kc., a bypass condenser must be nearly as effective at 1500 as at 20,000 kc.

At first glance, it appears that this condition cannot exist, since the reactance of a condenser decreases as the frequency increases. However, when the action of the bypass condenser is considered with relation to the circuit in which it is placed, it will be seen that a properly chosen value of capacitance will show little change in bypassing action over the wide range of frequencies covered by the modern short-wave receiver. The circuit of Fig 1 will help to clarify this statement.

Decoupling Filter

A tetrode is shown connected with a transformer in its plate circuit. In this plate circuit are shown an r.f. choke and a bypass condenser, C. The fundamental purpose of this choke-condenser filter circuit is to provide a low impedance path from the plate of the tube through the r.f. transformer primary through C to cathode. The purpose of the choke is to help force the current through C rather than through the B+ lead.

The value of C is so chosen that, with a given choke, its reactance is considerably lower than the impedance of the path through the choke. Fig. 2 shows the reactance of a .01 mf. condenser from 1500 to 20,000 kc. The reactance at 1500 kc. is .106 ohm and at 20,000 kc. is approximately .0075 ohm. The reactance of the choke, which is usually about 2.5 millihenries at 1500 kc., is 23,550 ohms. The impedance of the path through C, therefore, is considerably less than that through the B+ line. At any frequency higher than 1500 kc. the impedance of the B+ line goes up, while that through C goes down, and the bypassing action is more than sufficient. In fact, with a 2.5 millihenry choke connected as shown, the value of C can be reduced to about .0001 mf. with excellent filtering action.

All this holds true only if the bypass condenser is perfect—no leakage. In the event that leakage does take place in the condenser, or in the event that the dielectric itself requires power, the effective capacity of the condenser is reduced and the bypassing action suffers accordingly.

There are various types of losses in a condenser which can contribute to power loss. This power loss may be due to either imperfection of the dielectric or to the resistance of the metal plates or leads; the latter is extremely small and may be entirely neglected. That due to imperfection in the dielectric may be further classified under the headings of leakage and dielectric absorption.

Leakage, of course, is due to an actual flow of current through the dielectric from one plate to another. The square of this current multiplied by the leakage in ohms gives the power loss in watts. This leakage may be represented by a resistance in parallel with a pure capacitance, as shown in Fig. 3. The current through the condenser leads the impressed voltage by 90 degrees, and that through the leakage resistance is in phase with this voltage. The total line current is the sum of both and is also shown in Fig. 3.

In a pure condenser, the current and voltage differ by 90 degrees. In an imperfect condenser, the current and voltage differ by something less than 90 degrees. This difference is technically called the "phase difference of the condenser" (about the same as power factor) and is a measure of the power loss in the condenser.

Dielectric Absorption

When a condenser is connected to a battery, the instantaneous charge is followed by the flow of a small and steadily decreasing current into the condenser. The additional charge seems to be absorbed by the dielectric. Similarly, the instantaneous discharge of a condenser is followed by a continuously decreasing current. The condenser does not become fully charged immediately, nor does it completely discharge immediately when its terminals are shorted, but several discharges may be secured when the condenser possesses dielectric absorption. This absorption manifests itself in a heating of the dielectric and its value may be measured together with the power loss due to leakage.

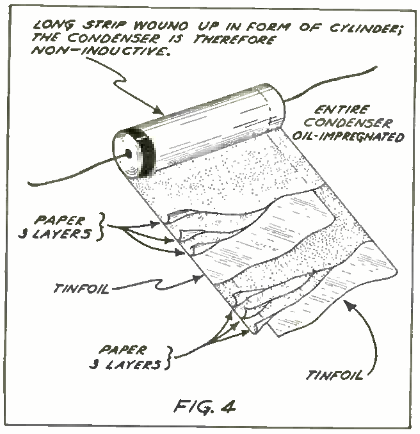
The power loss in a condenser increases with frequency—most of the data available seem to show that it varies directly with frequency.

The loss in the dielectric is dependent almost entirely on the type of material used and not on the volume used for a given capacitance. Suppose we have a condenser of a given capacitance, with a given thickness of dielectric. Now suppose that we wish to reduce the dielectric loss by doubling the thickness. Then, in order to keep the capacitance the same, we must double the area of the plates, which means quadrupling the volume of dielectric used. The total loss in the condenser, therefore, is substantially constant. At a given frequency the dielectric loss varies as the square of the impressed voltage.

Condensers using glass, paper, rubber or mica for the dielectric have some losses, although this loss in a well-constructed mica condenser is very small; in a poor paper condenser it may be extremely high. Dry oil is, in general, a very good dielectric with low losses; the oil having the added advantage in that a disruptive breakdown, due to too much voltage, does not spoil it, the oil repairing itself with time unless sufficient arcing has occurred to produce considerable carbonization.

It must be recalled that many materials lose their insulating properties rapidly as the temperature rises. In fact, if too much voltage should be applied to the terminals of a condenser having a solid dielectric, a slight arcing over may occur. This arcing will heat the dielectric at the point of puncture, reducing its insulating properties, which results in an increase in current and, therefore, arcing. The effect, of course, is cumulative, and eventually means the complete breakdown of the unit.

Good mica condensers have a power factor as low as .0001, while various paper condensers have power factors considerably in excess. A high grade of mineral oil or castor



Simple sketch showing the construction of the oil-impregnated byposs condenser described in this article. See text for details.

oil has extremely low losses and possesses the distinct advantage of being capable of healing itself in the event of breakdown.

For short-wave use, as was previously mentioned, the mica condenser is used because of its low losses. Paper condensers, in general, exhibit so much loss at 20 megacycles that one manufacturer several years ago was forced to shunt one with a small capacity mica unit in order that the mica condenser do the bypassing at the high frequencies. Paper condensers, more commonly known as the tubular type, are composed of alternate strips of paper and tinfoil of the proper length and rolled into a cylinder as shown in Fig. 4. The loosely wound condenser is put into a tank which can be heated and evacuated; this process removes most of the air and moisture from the condenser. Hot paraffin wax is admitted at the bottom of the tank, submerging the condensers. Thus, the paper becomes coated with wax and the result is a paraffin-paper condenser. A small bead of moisture or an air bubble may cause the condenser to break down at a voltage considerably lower than that at which it is rated.

There has recently been made available by Sprague a condenser similar in construction to the paper unit, with the exception that it is oil, instead of wax, impregnated. This results in a unit which, from sizes between .005 and .05 mf. is about one-half the physical size of mica condensers, and one-third the size of a mica condenser in capacitances of about .1 mf. The power factor of these oil impregnated units is better than the best types of paper condensers and better than a poor mica condenser, although not quite as good as high-grade micas. At 1 kc. these units have a power factor of less than .004; at 10 megacycles, the power factor is but .02. It is interesting to note that, at 1000 kc., mica, depending upon the type, has power factors varying from .0001 to .07 and paraffin has a power factor of about .097.

These new condensers will prove extremely valuable to set constructors who wish high capacity units of good quality for use in short-wave receivers. We understand that their working voltage is 1000 volts d.c. continuous operation.—*L. M.*

New Rulings of the Federal Radio Commission

On June 22, 1934, the Federal Radio Commission adopted the following Rules and Regulations of interest to amateur experimenters:

30a. Additional examining cities. —The following is a list of cities where examinations will be held for radio operators' licenses in addition to Washington, D. C., and the radio district offices of the Commission. Other cities may also be designated from time to time for the purpose of conducting commercial and Class A amateur operators' examinations only. (See Rules 2, 404, 408 and Part V).

Schenectady, N. Y.
Winston-Salem, N. C.
Nashville, Tenn.
San Antonio, Tex.
Oklahoma City, Okla.
Des Moines, Iowa
St. Louis, Mo.
Pittsburgh, Pa.
Cleveland, Ohio
Cincinnati, Ohio
Columbus, Ohio.

Examinations for commercial and Class A amateur privileges will be conducted not more than twice per year in the following cities, which are not to be construed as examining cities under the rules which apply for Class B and C amateur privileges:

Albuquerque, New Mexico
Billings, Montana
Bismarck, North Dakota
Boise, Idaho
Butte, Montana
Jacksonville, Florida
Little Rock, Arkansas
Phoenix, Arizona
Salt Lake City, Utah
Spokane, Washington.

Rule 368. Licenses for mobile stations and portable-mobile stations will not be granted to amateurs for operation on frequencies below 56,000 kilocycles. However, the licensee of a fixed amateur station may operate portable amateur stations (Rule 192) in accordance with the provisions of Rules 384, 386 and 387, and also portable and portable-mobile amateur stations (Rules 192 and 192a) on authorized amateur frequencies above 56,000 kilocycles in accordance with Rules 384 and 386, but without regard to Rule 387.

Rule 374a. The licensee of an amateur station may, subject to change upon further order, operate amateur stations on any frequency above 110,000 kilocycles, (2.72 meters) without separate licenses therefore, provided:

(1) That such operation in every respect complies with the Commission's rules governing the operation of amateur stations in the amateur service.

(2) That records are maintained of all transmissions in accordance with the provisions of Rule 386.

Rule 384. An operator of an amateur station shall transmit its assigned call at least once during each fifteen minutes of operation and at the end of each transmission. In addition, an operator of an amateur portable or portable-mobile radio-telegraph station shall transmit immediately after the call of the station, the break sign (BT) followed by the number of the amateur call area in which the portable or portable-mobile amateur station is then operating, as for example:

Example 1. Portable or portable-mobile amateur station operating in the third amateur call area calls a fixed amateur station:

W1ABC W1ABC W1ABC DE W2DEF BT3 W2DEF BT3 W2DEF BT3 AR

Example 2. Fixed amateur station answers the portable or portable-mobile amateur station:

(*Continued on page* 38)

High Power from type 45 Tubes

SUMMARY: *Complete data for securing up to 19 watts output from a pair of 45's are given in this excellent article. The discussion of the method and results obtained is especially enlightening. Distortion is 5%.*

BECAUSE of its use for so many years as a class A amplifier with a power output rating of only two watts, the 45 is generally regarded as being incapable of handling the high output required of modern receivers. The facts are, however, that the type 45 can be used in push-pull amplifier combinations to provide from 12 to 19 watts output with a total harmonic content of five per cent or less. This output is obtained by the use of a plate voltage of 275 volts (the maximum value) and by supplying some driving power to the grids of the 45's.

During an investigation of the merits of 45's as power output tubes, we operated them as class A, class AB, and class B amplifiers and obtained power output as high as 19 watts. Under the simplest circuit conditions, however, power output of 12 to 13 watts can be expected.

Driver Stage

To drive the 45's, the triode 56 and the triode-connected 59 are suitable tubes. Both the 56 and 59 are heater-cathode types of tubes having 2.5-volt heaters which afford freedom from hum. Since both types have relatively low plate impedances, the primary inductance of the interstage transformer can be made high enough to obtain good fidelity.

Table 1 shows how the driver tubes were used and gives the values of plate-to-plate load, the input-transformer ratio, and the input-transformer efficiency for each single and dual driver combination. Where two driver tubes were used, they were connected in push-pull. The driver plate voltage was 250 volts in all cases. The grid-bias voltage was supplied from batteries and was —13.5 and —28 volts for the 56 and 59, respectively. The driver can be operated self-biased with no appreciable increase in distortion. The data for Table 1 showing the current and voltage relations for the 45 vs. the driver input signal were taken under optimum conditions determined with the driver at the grid-current point—the point where grid current starts to flow.

The data of Table 1 show that for a given grid-bias voltage, the power output obtained is approximately the same whether the driver stage uses one or two tubes. This is because one driver tube will supply enough power to operate the 45's at or under their dissipation limit of 10 watts. A driver stage consisting of a 56 or two 56's is preferable in most cases to one employing a 59, because the power sensitivity of the 56 is better than that of the 59. The choice of a single or dual 56 driver stage depends on the method of input coupling to the driver, the overall sensitivity (available input signal), the interstage coupling-transformer design, and the permissible higher-order harmonics.

The single 56 driver stage gives twice the power sensitivity of the dual stage and can be resistance-coupled to the preceding stage. Furthermore, the percentage of higher-order harmonics is about the same as for the dual stage.

With a dual stage, in comparison with a single stage, the interstage-coupling transformer can be of better design at the same cost or can provide the same fidelity at lower cost. The fidelity is good in either case. The coupling of a dual stage to a single preceding stage requires a transformer or an inverter arrangement. Let us consider the output stage.

Output Stage

A push-pull output stage of 45's was operated under conditions for class A, class AB, and class B service in order to ascertain the complete possibilities of the tubes at a plate voltage of 275 volts. The results of these measurements are shown by the data of Table 1.

R_c and R_b: The total series resistance in the plate circuit of the 45's consists of: (1) r_p, the plate resistance of the tube; (2) R_p, the load resistance; (3) R_c, the equivalent series resistance of the grid supply; and (4) R_b, the equivalent series resistance of the plate power supply. It will be noted that R_c in self-biased circuits is the grid-bias resistor.

When R_c and R_b are zero, the best plate voltage regulation and the maximum power output are obtained. It is, therefore, advantageous to use fixed bias instead of self bias and to have R_b as small as possible. If a voltage source of approximately zero resistance is used in place of the regular power supply and resistance is then introduced in series with this voltage source until it has the same voltage regulation as the power supply, the resistance added to the circuit would be the equivalent internal

TABLE I

INDEX	DRIVER	BIAS METHOD for 45's	DRIVER STAGE		INPUT TRANSFORMER		OUTPUT STAGE: 2 - 45's with Plate Volts = 275										POWER OUTPUT		HARMONICS	
			Input Signal RMS Volts (per tube)	Plate-to-Plate Load Ohms	Primary / 1/2 Secondary	Efficiency Per cent	Zero-Signal Grid Bias Volts	Max.-Signal Grid Bias Volts	Grid-Supply Resistance (R_c) Ohms	Plate-Supply Resistance (R_b) Ohms	Grid Input Peak Power Milliwatts	Grid Input Peak Volts (per tube)	D-C Grid Current Ma. (per tube)	Max.-Signal • Plate Current Ma. (per tube)	Plate-to-Plate Load Ohms	Max.-Signal Plate Volts	At Grid-Current Point Watts	At Max.-Signal Watts	Total Per cent	Higher-Order Per cent
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1b	2-56•	Fixed	9.25	122600	3.33:1.0	81.0	-56	-56	0	0	680	95.5	1.56	65.0	4240	—	5.3	17.2	5	1.8
1c	2-56•	Fixed	9.25	86400	2.76:1.0	85.4	-64	-64	0	0	887	107.5	1.88	71.0	3400	—	5.3	18.8	5	2.0
1d	2-56•	Fixed	9.25	71700	2.35:1.0	88.3	-76	-76	0	0	1000	119.5	2.00	68.0	3490	—	5.0	19.1	5	4.0
2b	2-56•	Self	9.25	93100	2.50:1.0	86.0	-56	-75.5	775	0	820	110.9	1.96	47.0	5420	256	4.5	13.2	5	2.3
2c	2-56•	Self	9.25	68000	2.76:1.0	88.8	-56	-70.5	775	500	1124	105.0	2.00	43.0	6000	252	5.2	13.2	5	2.4
2d	2-56•	Self	9.25	68600	2.76:1.0	88.1	-56	-69.5	775	1000	1110	105.0	2.00	43.0	5810	246	5.2	12.7	5	2.5
3b	1-56•	Fixed	9.35	33100	1.54:1.0	79.6	-56	-56	0	0	486	91.5	1.25	66.5	3900	—	5.5	17.0	5	1.3
3c	1-56•	Fixed	9.10	18200	1.18:1.0	87.8	-68	-68	0	0	656	97.5	1.37	69.0	3200	—	5.0	18.2	5	2.2
4a	1-56•	Self	9.25	31500	1.29:1.0	80.8	-56	-74.5	775	0	473	104.3	1.21	47.5	4710	257	5.3	12.6	5	3.3
4b	1-56•	Self	9.25	33600	1.38:1.0	80.6	-56	-70.5	775	500	461	99.6	1.35	45.0	5060	250	4.8	11.9	5	2.0
4c	1-56•	Self	9.25	33300	1.48:1.0	79.7	-56	-68	775	1000	464	93.3	1.33	42.0	5520	250	4.7	11.2	5	1.5
5a	1-59°	Self	19.6	—	1.33:1.0	—	-56	-75	775	0	—	—	2.20	41.0	7350	—	7.3	12.8	5	—
5b	2-59°	Self	19.6	41200	2.42:1.0	92.0	-56	-76	775	0	1940	118.8	3.50	46.0	6020	—	7.6	14.7	5	3.9

• Plate volts = 250 and Grid volts = -13.5
° Plate volts = 250 and Grid volts = -28.0

Note 1. If d.c. is used on filaments of 45's, the 775 values of R_c in Column 10 should be 760 ohms.

Note 2. Higher-order harmonics of Column 21 include 10% of fifth and all higher harmonics.

resistance R_b. In practice, this value is determined by plotting the voltage regulation curve of the power supply and measuring the slope of the line joining the voltage outputs at the zero signal and maximum-signal operating conditions. The scope of this line represents R_b, the equivalent d.c. resistance of the power supply.

19 Watts Output

Optimum Operation with Two Driver Tubes: The first group, 1b to 1d, represents ideal conditions for two 45's driven by two 56's. The grid bias and plate voltage were both taken from a battery supply so that the resistance in both plate circuit and cathode circuit is minimum. This condition is expressed by $R_c = 0$ and $R_b = 0$. It is to be noted that under these operating conditions the optimum power output of 17 to 19 watts is obtained.

Normal grid-bias voltage for the 45 with a plate supply of 275 volts is —56 volts. In 1b to 1d, operation is shown with grid-bias voltages from —56 to —76 volts. Operation under the conditions of 1b is as a class A amplifier drawing grid current after power output exceeds 5.3 watts. Under the conditions of 1c, operation is as an overbiased amplifier with grid current starting when the power output is 5.3 watts. For 1d, the 45's are initially biased to 5 milliamperes plate current and operation is class B with grid current beyond 5.0 watts of power output.

The Bias Resistor

Self-Biased Operation with Two Driver Tubes: Group 2 illustrates the more practical self-bias method of operation. The greatest power output was obtained with a bias of —56 volts; hence, this grid-bias value was used as the operating bias for determining the data given in 2b, 2c and 2d. Of these conditions, that of 2c is the most practical because R_b with a value of 500 ohms represents the approximate equivalent resistance of a power supply using a type 5Z3 rectifier. Rc, the grid-supply resistance, is 775 ohms for all three cases. The resistance affecting plate-supply regulation is equal to $R_b + R_c$. The power output obtained under these conditions is seen to be 13.2 watts with maximum signal. Semi-fixed bias operation with two driver tubes would provide power output intermediate to that obtained with the fixed-bias method and the self-bias method of 1 and 2. Such operation can be provided by taking the bias voltage from the drop across the speaker field or a choke in the power supply.

A Single 56 Driver

Optimum Operation with a Single 56 Driver: Group 3 corresponds to Group 1 but applies to a single 56 driver. The data show that approximately the same power output can be realized with a single driver as with a dual driver and, furthermore, that there is some reduction in higher-order harmonics, or sizzle. In this group and in Group 4, only half the input signal to the driver tube is required as compared to that required for cases where two driver tubes are used.

Self-Biased Operation with a Single 56 Driver: Group 4 corresponds to Group 2 in that it applies to self-biased operation. However, a single driver is used. This gives only a slight reduction in power output as compared with two driver tubes. Sizzle varies over a wider range in this case than it did for the corresponding case with two drivers and is less in 4b than in 2c. The designer should choose between 2c and 4b and select the circuit best suited to his particular design requirements.

Self-Biased Operation with One or Two 59 Driver Tubes: Operating conditions for the 45's with one or two 59's in the driver stage are shown in 5a and 5b. The 59's are connected as triodes and used as a class A amplifier. Although the 59's are operated well below their maximum output, a comparatively high driver-input signal is required to obtain sufficient signal to drive the 45's to their distortion limit. The higher-order harmonics are usually slightly greater than for the 56 as a driver. Two 59 driver tubes give approximately one watt greater output than two 56 driver tubes under similar self-bias conditions.

Separate Bias Unit

Effects of R_c and R_b with Fixed-Bias Operation: The resistance R_c has a greater influence on the power output than R_b. This is particularly noticeable as the power output approaches maximum and is illustrated by the data of Table I. Observe, for instance, 2b and 2c, which show identical power outputs. In both of these cases, R_c = 775 ohms, but R_b = 0 ohms in one case and 500 ohms in the other case. Notice also 4a and 4b in which there is but 0.7 watt difference in the power output for a difference of 500 ohms in R_b; then notice the difference of 4 watts in power output between the fixed-bias condition and the self-bias condition of 1b and 2b, and the difference of 4.4 watts between the fixed-bias condition and the self-bias condition of 3b and 4a. Each comparison illustrates the point that a change in R_b will not materially affect the power output but that a reduction of R_c from 775 ohms to zero will allow an increase in power of approximately 30% over that obtained with self bias.

Thus, if fixed-bias operation can be had, 17 watts of audio output can be expected from two 45's. In order to obtain a fixed bias, a separate filament-type triode, preferably a 26 or 01A, can be used as a rectifier to supply a bias voltage substantially unaffected by the plate current of the 45's. The grid bias for all of the conditions mentioned is the normal value of —56 volts. Should still greater output be desired, it can be obtained by providing higher fixed-bias voltage in accordance with 1c, 1d and 3c and by operating the amplifier class AB or class B. 1c and 3c illustrate class AB operation, while 1d illustrates class B operation.

Distortion Less Than 5% Obtained

Selection of Tubes for Output Stage: The pair of 45 tubes used in this investigation had average characteristics. The question naturally arises as to whether or not the tubes should be matched to obtain the reported results. In order to determine this, 45's were selected whose plate currents differed from the rated value by plus and minus 35 per cent. These tubes were operated in pairs under the conditions of 4b with a single 56 driver, self-biased at —56 volts and with R_b = 500 ohms. The distortion did not exceed 7% for any combination of tubes. The zero-signal and maximum-signal grid bias and plate voltage departed less than 5% from the values obtained with the average pair. There was but a slight increase in the higher-order harmonics.

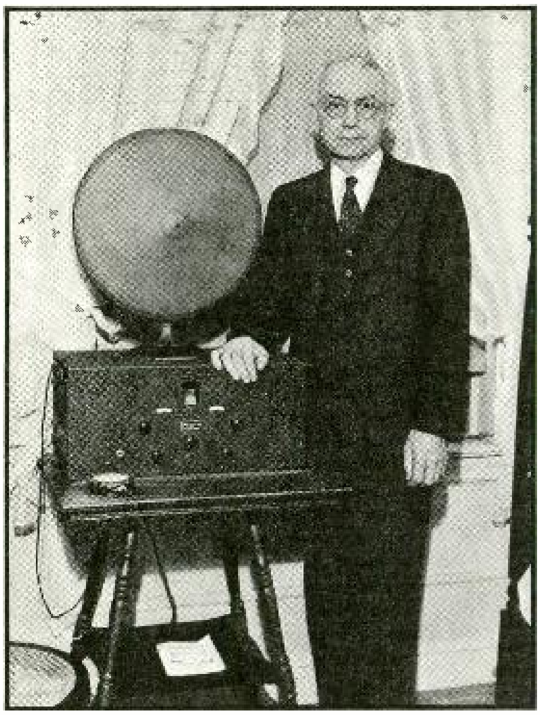
Plate-to-Plate Load: When using self bias, it is necessary to use a higher value of plate-to-plate load resistance than with fixed bias or semi-fixed bias in order to lessen plate-current swings, limit distortion, and prevent plate current cut-off at negative signal swings.

The plate-to-plate load is specified for each operating condition shown in the discussion and should be followed fairly closely. Too great a deviation from the specified load will change the operating conditions. For instance, should the plate-to-plate load be too low, the tube dissipation may exceed the maximum rated value of 10 watts; should the plate-to-plate load be too high, the full power output will not be realized. For either case the ratio of the interstage transformer would not be optimum.

Conclusion

As an output tube, the 45 when used in push-pull arrangements and operated beyond its grid-current point can provide power output of 12 to 13 watts for the simplest circuit conditions with comparatively low plate voltage of 275 volts, low distortion, low plate-current swings with resultant economy of transformer design, small input signal to driver, and low cost of tubes and amplifier components. If the user desires power output of the order of 17 watts or greater, it can be obtained by the use of an additional tube to provide the fixed-bias voltage.

—RCA Radiotron Co.



Foreign Station Department

Conducted By J. B. L. Hinds

Our Station-Department Conductor beside the operating table. Mr. Hinds welcomes letters from other readers reporting reception results.

AMONG the many letters received to date from listeners, I particularly noted those of Mr. C. D. Hall of Chillicothe, Ohio, and Mr. Harry J. Wood of Hartford, Connecticut, the first from just this side of what I term as the "Middle West," where I was born and raised, and the second from the "East," where I now reside and receive.

In comparing the stations received by each, I note the Connecticut reception practically agrees with the writer's reception. In Ohio, the 16- and 19-meter bands appear to be dead, only the local United States stations being received, although they report such stations as HBL, VK2ME, VK3ME, GSB, GSC, EAQ, DJC and DJD as coming in nicely.

Poor Reception in West

It is peculiar that such stations on the 16- and 19-meter bands as PHI, 2RO, GSG, DJB, GSF and Pontoise are not coming in some 500 miles to the west of us, but are being received here with wonderful volume, 2RO being exceptionally strong. I note, further, that reception from southern countries in Ohio agrees with that in the East; only, apparently, more of these stations are being received more regularly in the East than in Ohio. I particularly noted that TGW, Guatemala, is listed as occasionally being received there. Doubtless, this station may have been received as others claim to have received it during the past year, but information from reliable sources indicates that this station has not been on the air for the past couple of years.

In this connection, I wish to emphasize the importance of not making sure that you had received a station until you actually have proof. I am not casting any reflections whatsoever, as I thought I had TGW on three or four occasions, but have never been able to obtain a verification or even a reply to my reports. All listeners, therefore, should keep this station on their receiver until they obtain information as to its identity.

It is appreciated that, in many cases, no word of English is spoken throughout the program; and, in such cases, it is difficult to learn just what station is being received unless the wavelength is known, and even then you can be wrong. A great number of stations broadcasting today, however, at some time in their broadcast, *do* give information in some way, usually in English, but at definite periods of 15 minutes, half hour or hour, and in some cases only at the termination of the broadcast.

It would be interesting to know if many listeners make a practice of listening to conversations of coast stations with ships at sea and attempt to secure verifications. The writer does not pay much attention to this feature, as verifications are hard to obtain. I have one verification from a ship company to a test program some 1,000 miles out at sea.

Another type of broadcast of interest is that from ships. It is well to keep in touch with the wonderful advances in this branch of radio, but there is not much real enjoyment in listening to one side of a two-way conversation unless you are fortunate enough to listen on both wavelengths used.

I have been requested to list those countries which maintain more than one frequency for broadcasting programs. United States, England, France, Germany, Holland, U.S.S.R., League of Nations, Vatican and Japan all use two or more frequencies, some using the two frequencies simultaneously, others using one and interchanging. Some countries pick the high frequencies and remain on them, others use a low and high.

The switch from one frequency to the other is usually determined by weather or operating conditions, and it is believed that no set rule is followed by all. Italy broadcasts on 25.40 meters regularly, but has an outlet on special occasions through the medium of IRM and IRW (30.52 and 15.37 meters, respectively).

A similar condition exists as regards telephone and coast stations. About the same practice is followed in their operation.

PHI, Huizen, Holland, uses 16.88 and 25.57 meters, both low waves. They use 16.88 meters in our summer months and 25.57 meters during our winter months. They have been transmitting for some weeks on 16.88 and with excellent results.

Verifications from Japan

Interest in new stations on the air seems to center, lately, on Japan, numerous reports of reception in all parts of the United States and some verifications having been received. J1AA is being reported again on 30.49 meters and on 38.07 meters. New phone and broadcasting stations JVQ, 40.16 meters; JVE, 19.15; JYT, 22.04; JYS, 30.49; JVM, 27.93; and JVN, 28.14 relaying JVM.

A great many listeners in the Metropolitan area of New York are reporting JVM as being on the air each morning as late as 7:00 A.M., Eastern Standard Time, broadcasting talks and musical programs. The writer has received this stranger, JVM (if those are his call letters) for several mornings on 27.93 meters. The reports of others in this locality agree with what I have heard. We have made reception reports and await a verification; if they are received we will know whether the call letters are correct.

The talks are in what I would term Japanese, and the music peculiar, but interesting. Possibly, if we listen long enough, they will speak some word of English in their announcements. The carrier holds up fairly well, but is quite jerky. Some code at times creeps in, and parked automobiles with idling motors, along with electrical interference from without and through the house line, help to disturb the reception. So I am not yet claiming Japan as another country from which I have received a verification.

And speaking of interference, it is too bad that we cannot get business firms to prevail upon their truck drivers to stop their motors for 15 or 20 minutes when standing in front of your apartment building or home. Could they not save some expense for gas this way? There *might* be some necessity for allowing a motor to run in extremely cold weather, but not now—at least to my mind. I think all listeners will agree with me, also, that the interference usually occurs just when you are about to get the announcement!

Station XETE, Mexico City, seems to be settled on 31.25 meters, and is heard there quite often rebroadcasting the programs of long-wave station XEAL. They are using their old yellow verification card bearing the call letters, in large type, X.E.T.E., but writing in between these letters the call letters of station X.E.A.L. They are on the air from 2:00 P.M. to 2:00 A.M. daily.

Later advice from WORLD RADIO states that LCL (or LKJI), Jeloy, Norway, is now broadcasting on 31.43 meters from 11:00 A.M. to 5:00 P.M., and is being heard in England with excellent signal strength. This station, formerly operated on 42.92 and 48.94 meters. The verification of the writer was on 42.92 meters.

Verification cards from CJRO, Winnipeg, Manitoba, Canada, the new call letters of the station operated by James Richardson and Sons, Ltd., with studios in the Royal Alexandra Hotel, show that CJRO on 61.50 kc., operates daily, simultaneously with CJRX, on 11,720 kc. (approximately 48.78 and 25.53 meters, respectively), from 8:00 P.M. to 12 midnight, Eastern Standard Time, carrying Canadian Radio Commission's programs. Both stations transmit with 2000 watts power. CJRX is the pioneer short-wave broadcast station in Canada, and the first station in Canada to provide regular daily broadcasts of concert programs.

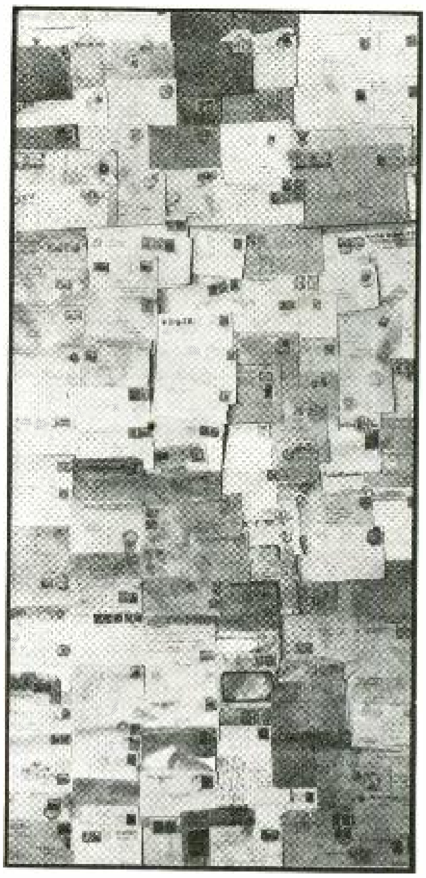
Late verifications from HC2RL, Guayaquil, Ecuador, gives its schedule as follows: Sundays, 5:45 to 7:45 P.M.; Tuesday, 9:15 to 11:15 P.M., 150 watts output, 100% modulation. They begin and close the programs with the Ecuadorian anthem.

CT1AA, Lisbon, Portugal, is back regularly and coming in strong, steady and clear into North America on its old 31.25-meter spot after testing out on 19 meters. A late verification gives its schedule 4:30 to 7:00 P.M., although they appear to be signing off at 7:00 P.M., Eastern Daylight Saving Time. They are still using as intervnal signal three cuckoo calls and operating with 2 kw. power.

A verification letter from HJ5ABC, LaVoz de Colombia, Cali, Colombia, states they are on nightly on 52 meters with 15 watts power. The writer tuned for this stranger several evenings before learning its identity.

It is assumed that the majority of listeners know that the silence of COC, Havana, Cuba, was caused by the plant being destroyed by fire about June 1st. Advice from them states that they are rebuilding the station and will be back on the air on 49.96 meters in six or eight weeks with increased power. Address P. O. Box 98, Havana, Cuba.

Letter from Señor Enrique Guerrerro, Station Manager, states that XEBT's short-wave transmitter operates on 500 watts power from 7:00 P.M. to 1:00 A.M. daily (sometimes later than 1:00 A.M.), on 49.40 meters, rebroadcasting programs of long-wave station XEB. They soon expect to increase the power of XEBT to 100 watts. They enclose with their verification letter a very neat folder of artists, orchestras and studios.



Mr. Hinds took some of the envelopes in which veries are received, tacked them on a card, and had them "shot." The result is very impressive.

Señor Guerrerro formerly resided for several years in the metropolitan area, where he has many warm friends.

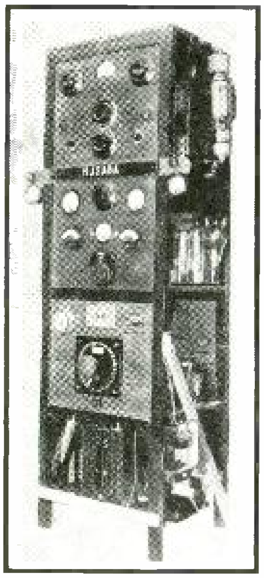
Occasional transmissions are being made by YVQ, Maracay, Venezuela, on 44.96 meters, rebroadcasting programs of note from YV3RC, formerly YV3BC.

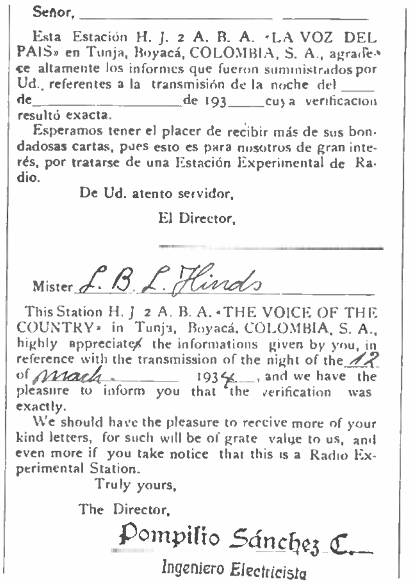
Am in receipt of a verification for one of these recent broadcasts, and it is a real verification, bearing the stamp of the operating company, Servicio Radiotelegrafico de Los Venezuela. These rebroadcasts are transmitted with a wonderful signal, clear and free of noise, and much information of value regarding the country is given. The English language is used throughout.

Since the new transmitter of HJ3ABD (Cali 16, No. 5-40, Bogota, Colombia), on 40.55 meters, was installed, they are getting out nightly with wonderful effect and radiating some excellent music and song. Sufficient English is used in announcements to enable one to follow and and enjoy their programs.

The call letters of YV3BC, Caracas, Venezuela, have been changed to YV3RC and those of YV1BC, at same location, changed to YV2RC.

PDV, 24.88 meters, Kootwijk, Holland, is being used quite often, of late, in broadcasting special pro-





Señor, ____________

Esta Estación H. J. 2 A. B. A. «LA VOZ DEL PAIS» en Tunja, Boyacá, COLOMBIA, S. A., agradece altamente los informes que fueron suministrados por Ud., referentes a la transmisión de la noche del ____ de ____________ de 193____ cuya verificacion resultó exacta.

Esperamos tener el placer de recibir más de sus bondadosas cartas, pues esto es para nosotros de gran interés, por tratarse de una Estación Experimental de Radio.

De Ud. atento servidor,

El Director,

Mister L. B. L. Hinds

This Station H. J 2 A. B. A. «THE VOICE OF THE COUNTRY» in Tunja, Boyacá, COLOMBIA, S. A., highly appreciates the informations given by you, in reference with the transmission of the night of the 12 of March 1934, and we have the pleasure to inform you that the verification was exactly.

We should have the pleasure to receive more of your kind letters, for such will be of grate value to us, and even more if you take notice that this is a Radio Experimental Station.

Truly yours,

The Director,

Pompilio Sánchez C.

Ingeniero Electricista

A verification from HJ2ABA. The photograph on the left is on one side of the card and the printing on the other. HJ2ABA evidently receives a lot of English mail, for the printing is in both Spanish and English. Note that only the English section is filled in.

A rather unique one! Evidently, Director Jones has a sense of humor. Note that one end of the antenna is supported by means of a "sky hook," thus dispensing with one mast.

grams. The writer listened to such a broadcast on this band on Saturday, June 2, 1934. This broadcast was around 1:00 P.M. and consisted of a speech in the Holland language, followed by songs by a very large mixed choir of wonderful voices.

RNE, Moscow, U. S. S. R., 25 meters, is being heard at times in the East. They are on the air Saturday night 10 to 11 P.M. and Sunday 6 to 7 and 10 to 11 A.M., Eastern Standard Time, according to advice received from U. S. S. R. Station RNI, Moscow, 19.95 meters, is also being heard during the early mornings with musical programs. No one has reported receiving RV59, Moscow, on 50 meters, since the winter months.

ORK, Brussels, Belgium, is broadcasting programs to the Belgian Congo 1:45 to 3:15 P.M., on 29.04 meters.

VK3LR, Melbourne, Australia, is still being heard here every week day on 31.31 meters between 3:15 to 7:30 A.M. The signal is none too strong; hence, the programs are hard to follow intelligently.

PSK, Rio de Janeiro, Brazil, is on the air daily from 5:30 to 6:10 or 6:15 P.M., broadcasting news items of interest in French, English and Spanish. The writer has not heard this station with their usual musical program lately, and which usually lasted until 7:30 P.M.

OXY, Shamleback, Denmark, is reported broadcasting now on 31.40 meters and being heard regularly in England. No reports have been received of its being heard here recently, but it was heard at certain times some months ago.

Has any one heard W4XB, Miami, Florida, lately on 49.67 meters? Information from reliable sources indicate that this station is not operating, as no one has reported receiving it of late.

The early evening dance periods, coming in nightly over GSD through the British Broadcastng Company, are recordings of selections played by the popular London orchestras of Henry Hall, Charlie Kunz, Lew Stone and Roy Fox, and were you not advised that they were recordings, you would not guess it.

They are delightful periods, but, of course, are late periods in London. The songbird employed nightly is a mechanical one and represents the English nightingale. It is used often during rest intervals between dances.

WORLD RADIO states that the Iceland Posts and Telegraphs Administration have ordered new Marconi short-wave transmitters and receivers to be erected at Reykjavik, Iceland, which are to be used for radiotelephone communication between all parts of Iceland and Great Britain.

They also state that VUB, Bombay, India, is making tests and sending test programs on 31.36 meters from 11:00 A.M. to 12:30 P.M., Eastern Standard Time.

Some one inquires as to what kind of reception we should have in August.

I can see no reason why we should not expect the present good reception to continue. The signals from Europe are increasing in volume while those from South American countries are coming in nicely. The signals from Australia and Asia are coming in with very good strength. Those on lower meters from U. S. S. R. are heard occasionally, but we cannot expect any good signal strength from that region until Fall.

In conclusion, let me urge readers of SHORT WAVE RADIO to send in reports of reception, in a given period, say for the month of July, showing stations received and comments as to signal strength, etc., so that comparisons may be made for the different sections of United States and Canada. They will be abstracted and commented on in these columns. Your own receiving experiences will be beneficial. Any inquiries will be gladly received and answered. If you desire a personal reply, be sure to enclose a self-addressed, stamped envelope. Letters should be addressed to Mr. J. B. L. Hinds, c/o SHORT WAVE RADIO, 1123 Broadway, New York City, New York.

The more reports received the better, as the writer feels that an interchange of ideas will greatly benefit and interest all short-wave listeners. We are having very good reception here in the East, and desire to learn directly from you just what stations you are receiving regularly and occasionally. Do not hesitate to ask any question you may wish or make any report which you believe will be of interest.

(If there are any technical questions, please address your inquiries to the Technical Director of this magazine.)

Transmissions from Bombay, India

ON the 30th of May, 1934, the first radio program was transmitted from Bombay via station VUB, the first broadcast station in India. This was a preliminary step in the inauguration of an all-India broadcasting service, and was followed soon after by the opening of station VUC, in Calcutta.

Because of the tremendous size of the country, which is as great in area as all of Europe less Russia, the establishment of a broadcasting service that would cover the entire territory presented a problem of no mean proportion. The most important question to be solved was whether to operate a high-powered station on the high wavelengths, with the disadvantage of atmospheric disturbances which are quite considerable due to the tropical climate, or to use lower power on the high frequencies, with the corresponding disadvantages of fading and skip-distance effects. The ideal solution was found in providing a simultaneous dual service on medium and short-wave channels.

Station VUB, operating on a frequency of 9565 kc. (31.36 meters), employs the facilities of the beam telephone transmitter at Kirkee. The studio is located at Bombay, and the programs are relayed by land wire, a distance of 120 miles to Kirkee, which represents a greater studio-to-transmitter separation than any other station in the world.

VUB broadcasts every Wednesday and Saturday between the hours of 11.00 A.M. and 1.00 P.M. E.S.T., with a power of 4.5 kilowatts.

Station VUC, whose studio is situated at Calcutta, broadcasts daily between the hours of 2.30 and 5.00 A.M.; 8.30 and 11.00 A.M.; and 9.30 and 10.30 P.M., E. S. T. It operates at a frequency of 6110 kc. (49.10 meters) and is controlled, as is the Bombay station, by the government of India.

The Editors of SHORT WAVE RADIO will appreciate reports from listeners-in who have logged these new stations.

Direct-from-station Data

NOTICE: *Some months ago we wrote practically every foreign broadcast station for information about their transmitters, operating times, etc. The data given in this department have been received from the stations themselves, and, therefore, may be regarded as being pretty accurate. This department will continue from month to month. All times given are E. S. T.*

Zeesen Stations

The German short-wave transmitter located at Zeesen, near Berlin, maintains a comprehensive schedule which includes regular programs to all parts of the globe. This is done by means of directional antenna systems, which divide the world into seven zones as shown in the map.

The hours of transmission are arranged to coincide with best reception hours within the various territories. Thus, the first zone includes North and Central America, and the broadcasts take place during the hours of 7.45—11.00 A. M., 5.00—6.15 P. M., and 6.45—10.30 P. M. Programs are sent out in German and English.

An interesting view of the short-wave plant at Zeesen is shown in the photograph below. The station operates on a power of 7 kilowatts.

Listeners who hear these stations are invited to communicate their impressions of the broadcasts to the studio; verifications and reports will be sent on request.

Station KILS

The call letters KILS have been assigned to the Columbia Broadcasting System for its temporary station in northwestern Alaska, above the Arctic Circle. This station is the final link in a chain which brings together the Arctic and Antarctic regions of the world in a spectacular two-way radiophone broadcast service. The other end of the chain is station KFZ at Little America, the base of the Byrd Antarctic Expedition.

Signals from KILS are relayed across the 17,000 mile circuit via Point Reyes, California; Rocky Point, New York; KFZ, Little America. For the return broadcast, an additional relay point at Buenos Aires is used. Communication between these two most distant points on the Earth's periphery is carried on every Wednesday night as part of the regular Byrd broadcast programs.

CP 5, CP 6 and CP 7

The highest broadcasting station in the world is located just outside of La Paz in Bolivia, at an altitude of 4089 meters above sea level.

Using a power of 1 kw. and operating on a frequency of 6080 kc. (49.3 meters), the station has been received all over the world, using the call letters CP5.

For daylight transmission the frequency and call letters are changed as follows:

CP6 on 9120 kc. (32.8 meters)
CP7 on 15,300 kc. (19.6 meters)

The station may be recognized by its identifying signal: "CP4 and CP5 Radio 'Illimani,' La Paz, Bolivia."

Station VQ7LO

Station VQ7LO, Nairobi, Kenya Colony, Africa, submits the following schedule of operation:

Monday, 5.45-6.15 A.M., 11.00 A.M.-noon; Tuesday, 3.00-4.00 A.M., 11.00 A.M.-noon; Wednesday, 5.45-6.15 A.M., 11.00 A.M.-noon; Thursday, 8.00-9.00 A.M.; 11.00 A.M.-noon; Friday, 5.45-6.15 A.M., 11.00 A.M.-noon; Saturday, 11.00 A.M.-3.00 P.M.; Sunday, 10.45 A.M.-noon.

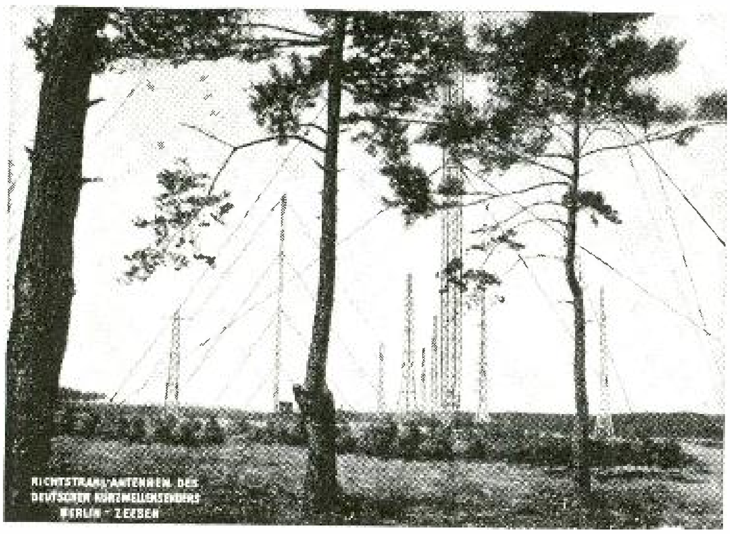
Programs consist mainly of musical recordings, interspersed with occasional relays of the British Empire Station. News bulletins are given twice daily, and, occasionally, public functions are also broadcast.

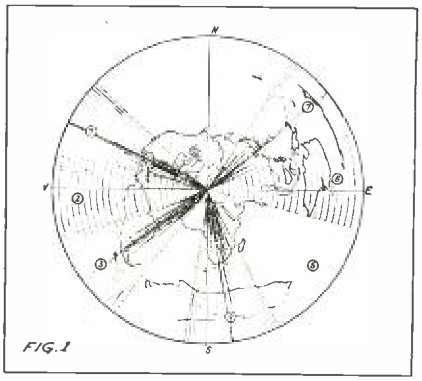
The station operates on a frequency of 6060 kc. and is located at Kabete, about five miles from and nearly 1000 feet above Nairobi.

Startz on Trip

Mr. Edward Startz, the famous linguistic announcer and studio manager of station PHI at Hilversum, Holland, who is well known to short-wave listeners the world over as the man who announces programs in five languages, will be off the air for a period of three months, during which time he will go on an extensive tour through the Dutch East Indies. He will take with him an interesting educational radio film which will be shown in about thirty places throughout Java, Sumatra, Borneo and Celebes.

During the absence of Mr. Startz, a member of the station's technical staff will announce the programs in Dutch and English.

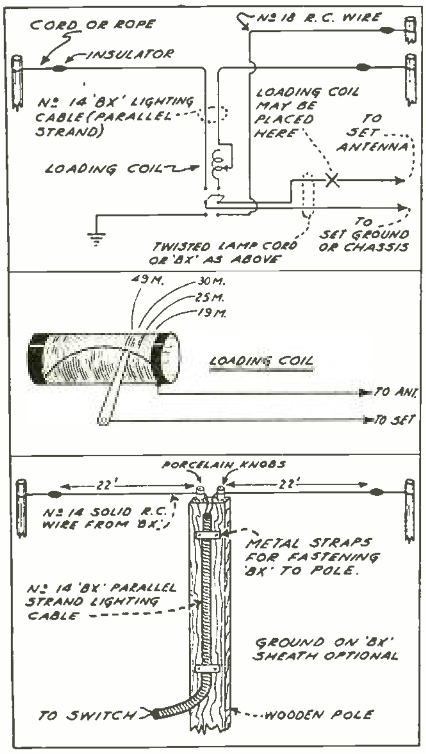




Left, the antenna system at the Zeesen stations near Berlin; right, a map showing the territory covered by each of the zones of operation. Seven kw. is used.

Antenna Notes for the Beginner

By H. E. Lichtenstein



Three separate circuits showing the author's installation. No other aerial wire is required when the system shown in the lower diagram is employed. See the text.

WHILE these notes are intended primarily for the apartment-house dweller who wishes to receive foreign broadcasts along with local stations, there is no reason why those living out of reach of electrical disturbances should not be able to apply this article to their sets with considerable improvement in reception.

The writer lives on the ninth floor of a twelve-story semi-steel apartment in the heart of the city. There are two trolley lines passing the house, a subway and thousands of automobiles at all hours of the day and night. Naturally, there are also further disturbances from flashing signs, bells and buzzers, etc.

Results Obtained

What results is the writer getting? Well, England, Germany and France may be depended upon every night for consistent reception that is fairly quiet and understandable. Then there are some nights when there is difficulty in telling these stations from locals. The writer learned that the Winter was particularly mild in Little America, and also listened to some details of a broadcast program that was going to be put on from there. It was quite thrilling to listen to these men, in the trackless waste near the South Pole, talking in matter-of-fact manner of their activities. No, this did not come direct, but apparently from some relay station on about 29 meters, located, probably, in South America. There is plenty on the air of interest, and the writer believes he receives his fair share of it, from 16 meters up. This includes all domestic and foreign broadcast bands, all amateur bands, transatlantic phone, airplane and police-call bands, and radio-beacons.

If you are not getting proper results comparable to these, the principles here outlined may get them for you as they have for the writer. Results cannot be guaranteed, but they are worth trying.

Now for the principles. The writer has attempted to make use of practically every device known for noise elimination, and found this—*THAT WHATEVER MEANS WILL INCREASE THE SIGNAL STRENGTH SELECTIVELY WILL REDUCE NOISE BY RAISING THE SIGNAL STRENGTH ABOVE THE NOISE LEVEL.*

Losses in Installation

There are many losses in signal strength in the average installation, resulting in the necessity for turning up the volume control and bringing in noise along with the signal. Elimination of these losses consists of:

1. Accurate lining of the condensers.
2. Peaking or "tuning" the aerial to the received frequency.

Noises also come in on the short-wave bands from the lead-in. These may be minimized by:

3. A double aerial, whose lead-in causes these received noises to "buck" one another.
4. Shielding the lead-in.

Too much cannot be said about the alignment of the condensers. A slight variation will cause a great reduction in signal strength, so it is a good idea to have a good radio service man check the alignment at different frequencies unless you can do this yourself. It is not a particularly difficult thing to do, but it takes time and patience, particularly if your source of signal is variable, as it is likely to be if you are using a broadcast signal which fades in and out.

Once you are certain that your set is working at maximum efficiency on received signals, the next step is to bring the maximum signal to the set, and this is done very simply by the writer by using a sliding loading coil, or inductance, in the aerial. There is some question as whether this operates as an antenna tuner or an impedence coupler, but the main thing that interests us is that it works and as these little gadgets may be bought for about 50 cents in any radio store, it should be of interest, as it is the only apparatus that is used between the antenna and the set.

Now, for the installation itself:

The writer uses two aerials. One is a plain single wire aerial and ground. The other is a shielded double aerial.

The double aerial is a piece of No. 14 B.X. (lighting) cable. This may be bought at any electric store from 2½ cents up to 5 cents a foot, depending on quantity.

To install, first cut the metal sheath 22 feet from one end and slip the sheath off the two wires. This will give a shielded lead-in with 22 feet of double wire extending from one end. Now fasten the B.X. to a pole on the roof at least ten feet in height above obstructions. Tape the end of the B.X. where the wires come out to keep out rain, and then fasten a glass or porcelain insulator to the end of each wire. Now tie these wires in a straight line, horizontally, if possible, with the top of the pole, using strong cord or thin rope to tie them, the insulator being between the cord and the 22-foot wire.

Direction of Antenna

Because the antenna is slightly directional, it should receive East and West signals best when the wires run in a North and South direction. However, mechanical considerations should be given preference during erection, as the antenna will receive in all directions, and it is better to keep it clear of obstructions and away from noise-producing or noise-conducting elements than to depend on directional qualities. The sketches accompanying will show the antenna system clearly.

The single aerial is of the conventional type, and the only advice the writer can give is to use ordinary single rubber-covered wire—the kind that has a cotton braid over the rubber cover and which may be bought for 1c a foot. This idea varies a little from theory; but, for practical purposes, it will be found that where the wire runs down the wall of an apartment house, the bare wire sometimes used will leak away energy in wet weather. In addition during windy weather, the bare wire has a peculiar noisy effect.

Many "grating" and "crackling" noises will be eliminated if rubber-covered wire is used for antenna and lead-in. It is always a good idea to keep the end of the antenna three or four feet away from the anchorage, using cord or rope to anchor with.

The writer uses ordinary window strip conductors where the lead-in terminates, although it would be better, if convenient, to bring in the lead-in through porcelain tubes.

Where the double lead-in terminates, the writer uses a d.p.d.t. switch. The accompanying sketch shows the connections. The set is located two feet from the switch, and the conductors are ordinary twisted lamp cord. If the set is located more than three feet from the end of the lead-in, use B.X. for the double conductor. Note that the B.X. is made of two No. 14 parallel wires in all cases. If unshielded wire is used between the lead-in and the set, they must be twisted. If, however, you use twisted telephone B.X., results are not likely to be as good as with the parallel B.X. Therefore, wherever the wires are shielded, they should be parallel.

One question that bothers many people is where to connect the second wire of the double aerial in an a.c.-d.c. set which has only *one* connection point (the aerial) on the set. The answer is simple—the second wire goes to the *chassis*. The writer uses a battery clip and fastens the wire to the chassis by any convenient projection—in his case, the clip that holds one of the tube shields.

A word of caution, however. In some sets, a direct ground will cause a short circuit and blow the fuse and possibly burn out the set or several tubes. Therefore, it is wise to first test the ground to the chassis with a test-lamp. If the ground-to-chassis circuit is open, the lamp will not light, and it is all right to connect the ground to the chassis. If the circuit is closed, and the lamp lights, you will have to insert a small fixed condenser between the ground and chassis—the condenser should be not less than .0005 mf. capacity.

If your set has a ground connection post, the second wire is connected to that.

The operation of the set is simple. On bands of 49 meters and above, use the single wire and ground. On bands below, use the double wire. On the 25-meter band, you will find a certain point on the sliding loading coil which will bring in the signal best. This will always be the same for this band. A different point will be found for the 30-meter band. The setting of the coil is not critical. The sliding coils, or perhaps better described as a coil with a sliding contact, are sold in all radio shops as "antenna eliminators." The one the writer uses is called the "Du-Wa," and has two coils and sliders. The writer has only one connected, and the other is therefore "surplus baggage."

The price paid was 69c, but the writer has seen others marked 50c and the McCrory and Kresge chain stores sell single coils for 25c. In any event, the slider must go *ALL THE WAY TO THE END OF THE COIL*, because on the shorter wave lengths, it may be necessary to use only the last turn or two on the coil. Some of these coils are made so that the slider misses the last few turns, and, while you can alter the coil easily enough, you will save yourself the trouble of alteration if you can get one that works all the way.

On the writer's installation, the coil is used *ON THE DOUBLE ANTENNA ONLY*. However, it may be connected in the single antenna also, but I suggest that before making the connections permanent, both connections be tried. If the single antenna is improved by the coil, leave it connected between the switch and the set, to be used on both aerials. If it does not improve the single antenna, connect it between the double aerial and the switch as shown in the diagram on the previous page.

Some Notes on the 2A7 Pentagrid Converter

A PECULIAR, though not unusual, effect has been reported in connection with the use of the 2A7 and 6A7 tubes as electron-coupled oscillators in superheterodynes. This effect is the tendency of the signal on the control grid to change the frequency of oscillation of the triode portion of the tube.

Briefly, it was found that if the frequency of the oscillator be adjusted to a given value and the frequency of the signal on the control grid be varied, the oscillator frequency, supposedly constant, will shift, first decreasing and then increasing below and above its normal value. This condition does not contribute toward good superheterodyne performance.

This action was explained as being due to the division of current in the tube between the oscillator "plate" and the screen (grids 3 and 5 surrounding the control grid). In other words, during those portions of the signal cycle when the grid is negative, there is a diminution of the plate current. The space charge surrounding the signal grid, therefore, increases, and the screen and triode-anode currents increase. The opposite effect takes place when the grid is positive.

This means that a voltage is induced on the oscillator plate of the same frequency as that impressed on the signal grid, and the effect of this voltage is to tend to synchronize the oscillator and signal frequencies.

At very large negative biases on the signal grid, the plate current remains substantially constant for small variations in the bias; but, when the control grid has a bias of about 5 volts, small variations in the bias change the total plate current, and it is this change of current which divides between the screen and oscillator plate.

There are several methods of preventing this change of current from affecting the triode plate. One method proposed is to bypass the oscillator plate to ground, thus keeping the signal frequency out of the circuit—in other words, using an electron-coupled circuit. This connection necessitates keeping the cathode of the tube at higher-than-ground r.f. potential.

The position of the cathode tap on the coil is not at all critical. For the standard broadcast band, it is recommended that it be 11% of the total number of turns from the bottom end of the coil. The only disadvantage of this connection is that the small bias which develops between cathode and ground reduces the effective transfer conductance of the signal portion of the tube, which means less gain. The decrease in gain, though, is sacrificed to obtain stability.

Still another interesting effect manifests itself when using this type of tube. Because of the capacity existing between oscillator plate and control grid, the oscillator induces a voltage on the control (signal) grid. This voltage, which is of the same frequency as the oscillator voltage, reacts on the oscillator plate in exactly the same manner that the signal did—only, this time the induced oscillator voltage *is* the signal. This voltage on the signal grid leads the oscillator voltage on the triode plate by 90°; hence, the change in plate current resulting from this signal makes the oscillator peaks occur just a little sooner than they ordinarily would. In plain English, the capacity between the grid and the oscillator plate raises the oscillator frequency.

When measuring the frequency of your 2A7 or 6A7 oscillator, therefore, be sure that the signal circuit is fully connected.

Instead of compensating for the shift in oscillator frequency in the external circuit, it has been suggested that the tube structure be changed slightly so as to decrease the capacity between elements. This decreased capacity would have the effect of preventing the frequency shift and, at the same time, prevent the electron coupling between elements that causes the synchronization to take place.

A little reflection will show that the intermediate frequency selected has a great deal to do with the shift in oscillator frequency. If the i.f. is small, then the signal frequency is always close to that of the oscillator, and synchronization will tend to occur. On the other hand, with a large i.f., the separation between the oscillator and signal frequencies may be large enough to prevent appreciable shifting.

Revised Police List

(by call letters)

Call Letters	Location	Freq.
KGZV	Aberdeen, Wash.	2414
WPDO	Akron, Ohio	2458
WPGH	Albany, N. Y.	2414
KGZX	Albuquerque, N. M.	2414
WPED	Arlington, Mass.	1712
WPDY	Atlanta, Ga.	2414
WPDN	Auburn, N. Y.	2382
KGHU	Austin, Tex.	2382
KGPS	Bakersfield, Cal.	2414
WPFH	Baltimore, Md.	2414
WPCA	Bay City, Mich.	2466
KGPJ	Beaumont, Tex.	1712
KSW	Berkeley, Cal.	1658
WPGL	Binghamton, N. Y.	2442
WPFM	Birmingham, Ala.	2382
WPFW	Bridgeport, Conn.	2466
WMJ	Buffalo, N. Y.	2422
KGOZ	Cedar Rapids, Ia.	2466
KGZF	Chanute, Kans.	2450
WPDV	Charlotte, N. C.	2458
WPDB	Chicago, Ill.	1712
WPDC	Chicago, Ill.	1712
WPDD	Chicago, Ill.	1712
WKDU	Cincinnati, O.	1706
WPFP	Clarksburg, W. Va.	2490
WRBH	Cleveland, O.	2458
KGZP	Coffeyville, Kans.	2450
WPFI	Columbus, Ga.	2414
WPGQ	Columbus, Ohio	1682
WPGK	Cranston, R. I.	2466
KVP	Dallas, Tex.	1712
KGPN	Davenport, Ia.	2466
WPDM	Dayton, Ohio	2430
KGPX	Denver, Colo.	2442
WCK	Belle Isle (Det.) Mich.	2414
WPDX	Detroit, Mich.	2414
KGZG	Des Moines, Ia.	2466
WPDW	Washington, D. C.	2422
WPEI	E. Providence, R. I.	1712
KGZM	El Paso, Tex.	2414
WPDF	Flint, Mich.	2466
WPDZ	Ft. Wayne, Ind.	2490
WPDI	Columbus, Ohio	2430
KGZA	Fresno, Cal.	2414
WPEB	Grand Rapids, Mich.	2442
WRDR	Grosse Point, Mich.	2414
WPFK	Hackensack, N. J.	2430
WMO	Highland Park, Mich.	2414
KGPQ	Honolulu, T. H.	2450
WPGO	Huntington, N. Y.	2490
WMDZ	Indianapolis, Ind.	2442
WPGZ	Johnson City, Tenn.	2474
WPFG	Jacksonville, Fla.	2442
KGPE	Kansas City, Mo.	2422
KGZH	Klamath Falls, Ore.	2382
WPFO	Knoxville, Tenn.	2474
WPDT	Kokomo, Ind.	2490
WPDL	Lansing, Mich.	2442
KGHG	Las Vegas, Nev.	2474
WPET	Lexington, Ky.	1706
KGZU	Lincoln, Neb.	2490
KGHZ	Little Rock, Ark.	2406
KGPL	Los Angeles, Cal.	1712
WPDE	Louisville, Ky.	2442
KGZW	Lubbock, Tex.	2458
WPEC	Memphis, Tenn.	2466
WPFZ	Miami, Fla.	2442
WPDK	Milwaukee, Wis.	2450
KGPB	Minneapolis, Minn.	2430
WPGP	Muncie, Ind.	2442
WPFC	Muskegon, Mich.	2442
WPGS	Mineola, N. Y.	2490
WPFN	Fairhaven, Mass.	1712
WPEK	New Orleans, La.	2430
WPFA	Newton, Mass.	1712
WPEE	Brooklyn, N. Y.	2450
WPEF	New York, N. Y.	2450
WPEG	New York, N. Y.	2450
KGPH	Oklahoma City, Okla.	2450
KGPI	Omaha, Neb.	2466
WPFX	Palm Beach, Fla.	2442
KGHK	Palo Alto, Calif.	1674
KGJX	Pasadena, Calif.	1712
WPFV	Pawtucket, R. I.	2466
WPDF	Philadelphia, Pa.	2474
KGZJ	Phoenix, Ariz.	2430
WPDU	Pittsburgh, Pa.	1712
WPGB	Port Huron, Mich.	2466
WPFU	Portland, Me.	2422
WPGF	Providence, R. I.	1712
KGPP	Portland, Ore.	2442
WPGI	Portsmouth, Ohio	2430
WPDH	Richmond, Ind.	2442
WPFE	Reading, Pa.	2442
WPDR	Rochester, N. Y.	2422
WPGD	Rockford, Ill.	2458
WPES	Saginaw, Mich.	2442
KGPC	St. Louis, Mo.	1706
WPDS	St. Paul, Minn.	2430
WGZR	Salem, Ore.	2442
KGPW	Salt Lake City, Utah	2406
KGZO	Santa Barbara, Cal.	2414
KGZT	Santa Cruz, Cal.	1674
KGZE	San Antonio, Tex.	2482
KGZY	San Bernardino, Cal.	1712
KGZD	San Diego, Cal.	2490
KGPD	San Francisco, Cal.	2466
KGPM	San Jose, Cal.	1674
KGPF	Santa Fe, N. Mex.	2414
KGPA	Seattle, Wash.	2414
KGPK	Sioux City, Ia.	2466
WPEH	Somerville, Mass.	1712
WPGN	South Bend, Ind.	2490
KGHS	Spokane, Wash.	2414
WPFQ	Swarthmore, Pa.	2474
WPEA	Syracuse, N. Y.	2382
KGZN	Tacoma, Wash.	2414
WRDQ	Toledo, Ohio	2474
KGZC	Topeka, Kans.	2422
WPDA	Tulare, Cal.	2414
KGPO	Tulsa, Okla.	2450
WPGJ	Utica, N. Y.	2414
KGPG	Vallejo, Cal.	2422
KGZQ	Waco, Tex.	1712
KGZI	Wichita Falls, Tex.	2458
KGPZ	Wichita, Kans.	2450
WPEM	Woonsocket, R. I.	2466
WPGX	Worcester, Mass.	2466
WPDG	Youngstown, Ohio	2458

CONSTRUCTION PERMITS ISSUED FOR MUNICIPAL POLICE STATIONS

Call Letters	Location	Freq.
KGHU	Austin, Tex.	2382
WPFS	Asheville, N. C.	2474

Call Letters	Location	Freq.
KGHN	Hutchinson, Kansas	2450
WPGM	La Grange, Ga.	2414
KGHP	Lawton, Okla.	2466
KGHJ	Long Beach, Cal.	2490
KGPR	Minneapolis, Minn.	2430
WPGW	Mobile, Ala.	2382
WPGT	New Castle, Pa.	2482
KGHX	Santa Ana, Cal.	2490
KGHM	Reno, Nev.	2474
WPGE	Shreveport, La.	2430
KGHV	Corpus Christi, Tex.	2382
KGHY	Whittier, Cal.	1712
WPGV	Boston, Mass.	1712
WPGU	Cohasset, Mass.	1712

LICENSED STATE POLICE STATIONS

Call Letters	Location	Freq.
KGHO	Des Moines, Ia.	1682
WMP	Framingham, Mass.	1666
WPEL	Middleboro, Mass.	1666
WPEW	Northampton, Mass.	1666
WPEV	Portable, Mass.	1666
WRDS	E. Lansing, Mich.	1666
WPGC	S. Schenectady, N. Y.	1658
WPGG	Findlay, Ohio	1682
WBA	Harrisburg, Pa.	190
WBR	Butler, Pa.	190
WDX	Wyoming, Pa.	190
WJL	Greenburg, Pa.	190
WMB	W. Reading, Pa.	190
KGZE	San Antonio, Tex.	1658
KGHA, KGHB, KGHC, KGHD	Highway Portable & Mobile, Seattle, Wash	2490

CONSTRUCTION PERMITS FOR STATE POLICE STATIONS

Call Letters	Location	Freq.
WPGQ	Columbus, O.	1682
KGHE	Snoqualmie Pass, Wash.	2490
KGHQ	Chinook Pass, Wash.	2490
KGHR	Mobile, Wash.	2490

Denton Trophy Awarded

THE Denton Trophy Contest for the year 1933-1934 has drawn to a close, and all the verifications finally have been approved by the examining committee. It will be remembered that the contest was conducted under the auspices of the International Short Wave Club to further interest in short-wave reception throughout the world. How well the contest succeeded has been proven by the fact that contestants from England, the Argentine, Cuba, Japan and other important countries entered and sent their verifications to the Trophy Committee.

The first prize, which is the Denton Trophy, was won for the year 1933-1934 by Mr. H. S. Bradley, of Hamilton, N. Y. The judging committee credited Mr. Bradley with 101 verifications. Mr. Bradley is to be complimented on his receiving ability.

The second prize, which is a silver medal, was awarded to Raymond M. Marti of Puerto Rico. He was credited with 87 verifications by the judging committee.

The third prize, also a silver medal, goes to Mr. C. H. Armstrong, of Atlanta, Ga. Mr. Armstrong was credited with 82 verifications, and his excellent record placed him in line for the third award mentioned.

The names of the next three contestants in line were Mr. A. Stitzinger, of Pennsylvania, with 81 credits; Mr. J. B. L. Hinds, of Yonkers, N. Y., with 79 credits; and Mr. Arthur Lunn, of Maplewood, N. J., with 74 credits. These three and the following 94 contestants will receive a very attractive parchment certificate on which is inscribed his name and record in the first International Short Wave Contest.

It is impossible at this time to give the names and the totals of other contestants entering. However, the Committee will publish this information in greater detail in the very near future.

The special judging committee was selected for its ability to speak and read most of the foreign languages commonly used in international correspondence. For example, one member of the committee spoke French very fluently, another German, another Italian, etc. This was done so that every letter, no matter in what language it was written, could be interpreted properly.

As there were thousands of verifications to be read, and each one

(Continued on page 39)

New World List of Stations

THE following list has been restricted as much as possible to stations that use radio telephony in one form or another. Among these are regular relay broadcasting stations, commercial point-to-point radiophones, and numerous experimental stations that use voice as well as code transmission, and are, therefore, understandable to any short-wave or all-wave set owner regardless of whether or not he knows the code.

This list has been compiled from many sources, which are not always in complete agreement. The licensing regulations in some countries are rather lax and influential station owners are known to pick their own call letters and operating frequencies, sometimes in defiance of international assignments. It is not unusual to receive two different letters from the same Central or South American station during the one week, the letters giving altogether conflicting information!

The frequencies are given in megacycles rather than in kilocycles because the present trend is toward the use of the former unit. Readers accustomed to working with kilocycles can readily swing from kilocycles to megacycles, or vice versa, as the difference between the two units is merely a matter of the decimal point's position. Thus, 15.12 megacycles is the same as 15,120 kilocycles. The corresponding wavelengths in meters are given in all cases, as there are still many people, particularly "old timers" just getting back into the short-wave game, who still find it easier to think in terms of meters than in kilocycles or megacycles.

For the benefit of new readers, we might mention that a Grand List of the Short Wave Stations of the World, arranged alphabetically according to call letters, was printed on page 12 of the April, 1934, issue.

There appears, also, in this issue a New List of Police Frequencies, arranged alphabetically by names of cities, as well as a List of Best Short Wave Stations.

Megacycles	Meters	Call	Location	Dial	Dial
60.20	4.98	W3XAY	Philadelphia, Pa.		
60.00	5.0	W3XE	Philadelphia, Pa.		
		W6XAO	Los Angeles, Calif.		
		W8XAN	Jackson, Mich.		
		W8XF	Pontiac, Mich.		
		W8XL	Cuyahoga Hts., Ohio		
		W9XE	Marion, Ind.		
		W1XW	Milton, Mass.		
		W2XAK	New York, N. Y.		
		W2XF	New York, N. Y.		
		W2XR	Rocky Point, N. Y.		
		W3XAD	Camden, N. J.		
		W6XAQ	Phoenix, Ariz.		
54.20	5.53	W3XAY	Philadelphia, Pa.		
53.80	5.57	W3XAY	Philadelphia, Pa.		
51.40	5.83	W6XAQ	Phoenix, Ariz.		
		W6XC	San Francisco, Cal.		
		W8XAC	Lincoln Park, Mich.		
		W1XW	Milton, Mass.		
48.50	6.18	W3XE	Philadelphia, Pa.		
		W6XAO	Los Angeles, Cal.		
		W8XAN	Jackson, Mich.		
		W8XF	Pontiac, Mich.		
		W8XL	Cuyahoga Hts., Mich		
		W9XE	Marion, Ind.		
		W2XAK	New York, N. Y.		
		W2XF	New York, N. Y.		
		W2XR	Rocky Point, N. Y.		
		W3XAD	Camden, N. J.		
48.20	6.22	W3XAY	Philadelphia, Pa.		
47.80	6.27	W3XAY	Philadelphia, Pa.		
43.00	6.97	W3XE	Philadelphia, Pa.		
		W6XAO	Los Angeles, Calif.		
		W8XAN	Jackson, Mich.		
		W8XF	Pontiac, Mich.		
		W8XL	Cuyahoga Hts., Ohio		
		W9XE	Marion, Ind.		
		W1XG	Boston, Mass.		
		W2XAK	New York, N. Y.		
		W2XF	New York, N. Y.		
		W2XR	Rocky Point, N. Y.		
		W3XAD	Camden, N. J.		
42.20	7.10	W3XAY	Philadelphia, Pa.		
41.80	7.17	W3XAY	Philadelphia, Pa.		
41.00	7.32	W1XW	Milton, Mass.		
		W2XV	Clifton, N. J.		
		W6XC	San Francisco, Cal.		
		W8XAC	Lincoln Park, Mich.		
40.60	7.38	W2XV	Clifton, N. J.		
40.10	7.48	W2XV	Clifton, N. J.		
38.60	7.77	W2XV	Clifton, N. J.		
37.60	7.98	W2XV	Clifton, N. J.		
37.10	8.09	W2XV	Clifton, N. J.		
35.80	8.38	W3XAY	Philadelphia, Pa.		
35.60	8.43	W2XV	Clifton, N. J.		
34.60	8.67	W2XV	Clifton, N. J.		
		W3XAR	Haverford, Pa.		
		W2XAC	Lincoln Park, Mich.		
		W2XES	Englewood, N. J.		
33.10	9.06	W2XV	Clifton, N. J.		
31.60	9.49	W2XV	Clifton, N. J.		
31.10	9.65	W2XV	Clifton, N. J.		
30.20	9.93	W3XAY	Philadelphia, Pa.		
30.10	9.97	W2XV	Clifton, N. J.		
27.80	10.79	W6XD	Palo Alto, Cal.		
25.70	11.67	W2XBC	New Brunswick, N. J.		
24.00	12.50	W6XQ	San Francisco, Cal.		
22.30	13.45	GBU	Rugby, England		
21.54	13.93	W8XK	Pittsburgh, Pa		
21.47	13.97	GSH	Daventry, England		
21.46	13.98	W1XAL	Boston, Mass.		
21.42	14.0	W2XDJ	Deal, N. J.		
21.41	14.01	WKK	Lawrenceville, N. J.		
21.40	14.02	WLO	Lawrenceville, N. J.		
21.16	14.17	LSL	Buenos Aires, Argen.		
21.13	14.19	LSM	Buenos Aires, Argen.		
21.08	14.23	PSA	Rio de Janeiro, Brazil		
21.06	14.24	KWN	Dixon, Cal.		
		WKA	Lawrenceville, N. J.		
21.02	14.27	LSN	Buenos Aires, Argen.		
21.00	14.28	OKO	Podebrady, Czechoslovakia		
20.73	14.47	LSY	Buenos Aires, Argen.		
20.68	14.5	FSR	Paris, France		
		LSN	Buenos Aires, Argen.		
20.67	14.54	PMB	Bandoeng, Java		
20.38	14.72	GAA	Rugby, England		
20.04	14.97	OPL	Leopoldsville, Belgian Congo		
		DHO	Nauen, Germany		
19.95	15.03	LSG	Buenos Aires, Argen.		
		DIH	Nauen, Germany		
19.90	15.07	LSG	Buenos Aires, Argen.		
19.85	15.11	WMI	Deal, N. J.		
19.83	15.12	FTD	St. Assise, France		
19.69	15.24	CEC	Santiago, Chile		
19.54	15.25	IRW	Rome, Italy		
19.50	15.38	LSQ	Buenos Aires, Argen.		
19.38	15.48	WOP	Ocean Gate, N. J.		
		WKN	Lawrenceville, N. J.		
19.35	15.5	FTM	St. Assise, France		
19.27	15.57	PPU	Rio de Janeiro, Brazil		
19.22	15.61	WKF	Lawrenceville, N. J.		
19.24	15.59	DFA	Nauen, Germany		
19.21	15.61	ORG	Brussels, Belgium		
19.20	15.62	WNC	Deal, N. J.		
19.02	15.77	WKW	Rocky Point, N. Y.		
18.97	15.81	GAG	Rugby, England		
18.96	15.82	LSR	Buenos Aires, Argen.		
18.90	15.78	HBF	Pragins, Switzerland		
18.81	15.95	PLE	Bandoeng, Java		
18.68	16.06	OCI	Lima, Peru		
18.62	16.11	GBU	Rugby, England		
		GAU	Rugby, England		
		GBJ	Bodmin, England		
18.54	16.18	VWY	Poona, India		
18.52	16.19	DFB	Nauen, Germany		
18.46	16.25	HJY	Bogota, Colombia		
18.41	16.29	GAS	Rugby, England		
18.40	16.30	PCK	Kootwijk, Holland		
18.37	16.33	PMC	Bandoeng, Java		
18.35	16.35	WLA	Lawrenceville, N. J.		
18.31	16.38	FZS	Saigon, Indo-China		
		GBS	Rugby, England		
18.30	16.39	YVR	Maracay, Venezuela		
18.24	16.44	FRE	St. Assise, France		
		FRO	St. Assise, France		
		CP5	La Paz, Bolivia		
18.20	16.48	PLE	Bandoeng, Java		
18.17	16.51	CGA	Quebec, Canada		
18.13	16.55	LSY	Buenos Aires, Argen.		
18.05	16.62	KQJ	Bolinas, Cal.		
17.85	16.80	W2XAO	Long Island City, N.Y.		
		PLF	Bandoeng, Java		
17.83	16.82	PCV	Kootwijk, Holland		
17.78	16.87	W3XAL	Bound Brook, N. J.		
		W8XK	E. Pittsburgh, Pa.		
		W9XAA	Chicago, Ill.		
		W9XF	Chicago, Ill.		
17.77	16.88	PHI	Huizen, Holland		
		GSG	Daventry, England		
17.76	16.89	DJE	Zeesen, Germany		

Mega-cycles	Meters	Call	Location	Dial	Dial
17.75	16.92	HSP	Bangkok, Siam		
17.54	17.10	VWY	Poona, India		
17.31	17.33	W3XL	Bound Brook, N. J.		
17.30	17.34	W9XL	Anoka, Minn.		
		W8XL	Dayton, Ohio		
17.27	17.37	DAF	Norden, Germany		
17.11	17.52	W2XDO	Ocean Gate, N. J.		
		WOO	Ocean Gate, N. J.		
17.08	17.56	GBC	Rugby, England		
16.33	18.37	WLK	Lawrenceville, N. J.		
16.30	18.4	PCL	Kootwijk, Holland		
		WLO	Lawrenceville, N. J.		
16.20	18.5	FZR	Saigon, Indo-China		
16.15	18.56	GBX	Rugby, England		
16.10	16.57	GBK	Bodmin, England		
16.06	18.68	NAA	Arlington, Va.		
16.04	18.71	KKP	Kauhuku, T. H.		
15.95	18.8	PLG	Bandoeng, Java		
15.86	18.91	FTK	St. Assise, France		
		CEC	Santiago, Chile		
15.76	19.03	JYT	Tokio, Japan		
15.69	19.12	FTK	St. Assise, France		
15.66	19.15	JVE	Tokio, Japan		
15.62	19.19	OCJ	Lima, Peru		
15.49	19.36	J1AA	Tokio, Japan		
15.42	19.46	KWO	Dixon, Cal.		
15.35	19.54	KWU	Dixon, Cal.		
15.34	19.55	W2XAD	Schenectady, N. Y.		
15.33	19.56	W2XAD	Schenectady, N. Y.		
15.30	19.6	OXY	Lyngby, Denmark		
		CP7	La Paz, Bolivia		
15.27	19.64	W2XE	Wayne, N. J.		
15.25	19.67	W1XAL	Boston, Mass.		
15.24	19.68	FYA	Pontoise, (Paris) Fr.		
		RIM	Tashkent, U.S.S.R.		
15.21	19.72	W8XK	E. Pittsburgh, Pa.		
15.20	19.74	DJB	Zeesen, Germany		
15.14	19.81	GSF	Daventry, England		
15.12	19.83	HVJ	Vatican City, Italy		
15.11	19.84	HVJ	Vatican City, Italy		
15.04	19.94	RKI	Moscow, U.S.S.R.		
15.03	19.95	RNI	Moscow, U. S. S. R.		
15.00	19.99	CM6XJ	Central Tuinucu, Cuba		
14.70	20.27	WKU	Rocky Point, N. Y.		
		W2XBJ	Rocky Point, N. Y.		
14.62	20.5	XDA	Mexico City, Mex.		
14.56	20.6	HBJ	Pragins, Switzerland		
14.53	20.65	LSA	Buenos Aires, Argen.		
		LSN	Buenos Aires, Argen.		
14.50	20.69	YNA	Managua, Nicaragua		
		TGA	Guatemala City, C.A.		
		TIR	Cartago, Costa Rica		
14.48	20.7	GBW	Rugby, England		
		WNC	Deal, N. J.		
14.47	20.73	WMF	Lawrenceville, N. J.		
14.15	21.17	KKZ	Bolinas, Calif.		
14.11	21.26	YV2AM	Maracaibo, Venezuela		
13.87	21.63	WIY	Rocky Point, N. Y.		
13.78	21.77	KKW	Bolinas, Cal.		
13.75	21.82	CGA	Quebec, Canada		
13.6	22.06	JYK	Tokio, Japan		
13.58	22.09	GBB	Rugby, England		
13.50	22.48	YVQ	Maracay, Venezuela		
13.48	22.26	WAJ	Rocky Point, N. Y.		
13.40	22.38	WND	Deal, N. J.		
13.39	22.4	WMA	Lawrenceville, N. J.		
13.34	22.55	CGA	Quebec, Canada		
13.09	22.93	J1AA	Tokio, Japan		
12.83	23.32	CN R	Rabat, Morocco		
12.85	23.35	W9XL	Anoka, Minn.		
		W2XO	Schenectady, N. Y.		
		W2XCU	Rocky Point, N. Y.		
		HJC	Barranquilla, Colombia		
12.825	23.39	CNR	Rabat, Morocco		
12.80	23.45	IAC	Pisa, Italy		
12.78	23.46	GBC	Rugby, England		
12.40	24.19	DAF	Norden, Germany		
12.29	24.41	GBU	Rugby, England		
12.25	24.46	GBS	Rugby, England		
		PLM	Bandoeng, Java		
12.229	24.53	CT1AA	Lisbon, Portugal		
12.15	24.68	FQO	St. Assise, France		
		FQE	St. Assise, France		
		GBS	Rugby, England		
12.06	24.88	PDV	Kootwijk, Holland		
12.045	24.89	NAA	Arlington, Va.		
		NSS	Annapolis, Md.		
12.00	25.0	FZG	Saigon, Indo-China		
		RNE	Moscow, U. S. S. R.		
11.95	25.10	FTA	St. Assise, France		
11.945	25.13	KKQ	Bolinas, Calif.		
11.905	25.2	FYA	Pontoise (Paris) Fr.		
11.90	25.21	FZS	Saigon, Indo-China		
11.88	25.25	FYA	Paris, France		
		W9XF	Chicago, Ill.		
11.87	25.27	W8XK	E. Pittsburgh, Pa.		
11.865	25.28	GSE	Daventry, England		
11.84	25.34	W9XAO	Chicago, Ill.		
11.83	25.36	W2XE	Wayne, N. J.		
		W9XAA	Chicago, Ill.		

Mega-cycles	Meters	Call	Location	Dial	Dial
11.81	25.4	I2RO	Rome, Italy		
11.80	25.42	VE9GW	Ontario, Canada		
11.79	25.45	W1XAL	Boston, Mass.		
11.78	25.47	VE9DR	Quebec, Canada		
11.76	25.51	DJD	Zeesen, Germany		
		XDA	Mexico City, Mex.		
11.75	25.53	GSD	Daventry, England		
11.73	25.58	PHI	Huizen, Holland		
11.72	25.53	CJRX	Winnipeg, Canada		
11.72	25.58	VE9JR	Winnipeg, Canada		
11.705	25.63	FYA	Paris, France		
		KIO	Kauhuku, T. H.		
11.69	25.65	YVQ	Maracay, Venezuela		
11.67	25.68	KIO	Kauhuku, T. H.		
11.66	27.73	PPQ	Rio de Janeiro, Brazil		
11.54	26.0	XAM	Merida, Yucatan		
11.49	26.1	GBK	Bodmin, England		
11.47	26.15	IBDK	S. S. Elettra		
11.435	26.22	DHC	Nauen, Germany		
11.34	26.44	DAN	Nordreich, Germany		
11.18	26.83	CT3AQ	Funchal, Madeira		
10.99	27.3	ZLT	Wellington, N. Z.		
10.84	27.67	KWV	Dixon, Cal.		
10.77	28.04	GBP	Rugby, England		
10.74	27.93	JVM	Tokio, Japan		
10.68	28.09	WNB	Lawrenceville, N. J.		
10.67	28.12	CEC	Santiago, Chile		
10.66	28.14	JVN	Tokio, Japan		
10.63	28.2	PLR	Bandoeng, Java		
10.61	28.28	WEA	Rocky Point, N. Y.		
10.578	28.36	FYB	Paris, France		
10.55	28.44	WOK	Lawrenceville, N. J.		
10.54	28.46	WLO	Lawrenceville, N. J.		
10.52	28.51	VK2ME	Sydney, Australia		
		VLK	Sydney, Australia		
10.46	28.68	LSL	Buenos Aires, Argen.		
10.41	28.8	PDK	Kootwijk, Holland		
10.41	28.82	LSY	Buenos Aires, Argen.		
		KES	Bolinas, Cal.		
		KEZ	Bolinas, Cal.		
10.40	28.85	KWZ	Dixon, Cal.		
10.39	28.87	GBX	Rugby, England		
10.36	28.96	PMN	Bandoeng, Java		
10.35	28.98	LSX	Buenos Aires, Argen.		
10.33	29.04	ORK	Brussels, Belgium		
10.30	29.12	LSL	Buenos Aires, Argen.		
10.29	29.15	DIQ	Nauen, Germany		
10.22	29.35	PSH	Rio de Janeiro, Brazil		
10.15	29.54	DIS	Nauen, Germany		
10.14	29.58	OPM	Leopoldsville, Belgian Congo		
10.10	29.7	EHY	Madrid, Spain		
10.07	29.79	VRT	Hamilton, Bermuda		
10.05	29.83	SUV	Cairo, Egypt		
10.00	30.00	EAQ	Madrid, Spain		
9.98	27.59	VLJ	Sydney, Australia		
9.97	30.09	KAZ	Manila, P. I.		
9.95	30.15	GBU	Rugby, England		
		GCU	Rugby, England		
9.93	30.2	HJY	Bogota, Colombia		
9.89	30.3	LSA	Buenos Aires, Argen.		
		WON	Lawrenceville, N. J.		
9.86	30.43	EAQ	Madrid, Spain		
9.84	30.49	JYS	Tokio, Japan		
9.83	30.52	IRW	Rome, Italy		
9.80	30.6	GCW	Rugby, England		
9.79	30.64	GBW	Rugby, England		
9.76	30.74	VK2ME	Sydney, Australia		
		VLK	Sydney, Australia		
9.75	30.77	WOF	Lawrenceville, N. J.		
		WNC	Deal, N. J.		
9.71	30.9	GCA	Rugby, England		
9.675	31.0	TI4NRH	Costa Rica, C. A.		
9.64	31.12	HSP2	Bangkok, Siam		
9.62	31.19	DGU	Nauen, Germany		
9.60	31.25	CT1AA	Lisbon, Portugal		
		XETE	Mexico City, Mex.		
		LGN	Bergen, Norway		
		LQA	Buenos Aires, Argen.		
9.595	31.27	HBL	Geneva, Switzerland		
9.59	31.28	W3XAU	Philadelphia, Pa.		
		VK2ME	Sydney, Australia		
		WEF	Rocky Point, N. Y.		
		WKJ	Rocky Point, N. Y.		
9.585	31.3	GSC	Daventry, England		
		VK3LR	Melbourne, Australia		
9.58	31.32	3WXAU	Philadelphia, Pa.		
		W3XE	Philadelphia, Pa.		
9.57	31.35	W1XAZ	Springfield, Mass.		
9.56	31.36	VUB	Bombay, India		
		SRI	Poznan, Poland		
		W8XK	E. Pittsburgh, Pa.		
9.56	31.38	DJA	Zeesen, Germany		
9.54	31.43	LCL	Jeloy, Norway		
9.52	31.51	OXY	Skamlebaek, Denmark		
9.53	31.48	W2XAF	Schenectady, N. Y.		
9.51	31.55	YV3RC	Caracas, Venezuela		
		GSB	Daventry, England		
		VK3ME	Melbourne, Australia		
		VK3LR	Melbourne, Australia		
9.493	31.6	OXY	Skamlebaek, Denmark		

Mega-cycles	Meters	Call	Location	Dial	Dial
		SRI	Posnan, Poland		
9.48	31.63	PLW	Bandoeng, Java		
9.45	31.74	WES	Rocky Point, N. Y.		
9.42	31.86	PLV	Bandoeng, Java		
9.40	31.9	XDC	Mexico City, Mex.		
9.33	32.15	CGA	Quebec, Canada		
9.31	32.22	GBC	Rugby, England		
9.30	32.26	CNR	Rabat, Morrocco		
9.28	32.33	GCB	Rugby, England		
9.25	32.4	GBK	Bodmin, England		
9.23	32.5	FLJ	Paris, France		
9.17	32.72	WNA	Lawrenceville, N. J.		
9.14	32.82	YVR	Maracay, Venezuela		
9.12	32.8	CP6	La Paz, Bolivia		
9.02	33.26	GCS	Rugby, England		
9.02	33.26	KEJ	Kaukuku, T. H.		
8.95	33.52	WEC	Rocky Point, N. Y.		
8.93	33.59	WEC	Rocky Point, N. Y.		
8.872	33.81	NPO	Cavite, P. I.		
8.79	34.13	TIR	Cartago, Costa Rica		
8.69	34.35	W2XAC	Schenectady N. Y.		
8.68	34.56	GBC	Rugby, England		
8.65	34.68	W4XG	Miami, Fla.		
		W3XX	Washington, D. C.		
—		W3XE	Baltimore, Md.		
8.65	34.68	VE9BY	London, Ont., Canada		
		W2XCU	Rocky Point, N. Y.		
		W8XAG	Dayton, Ohio		
8.63	34.74	W2XDO	Ocean Gate, N. J.		
		WOO	Ocean Gate, N. J.		
8.55	35.09	WOO	Ocean Gate, N. J.		
8.47	35.42	DAF	Norden, Germany		
8.45	35.5	PRAG	Porto Alegre, Brazil		
8.38	35.8	IAC	Pisa, Italy		
8.19	36.63	PSK	Rio de Janeiro, Brazil		
8.186	36.65	PRA3	Rio de Janeiro, Brazil		
8.12	36.92	PLW	Bandoeng, Java		
8.11	37.0	HCJB	Quito, Ecuador		
8.035	37.33	CNR	Rabat, Morocco		
7.88	38.07	JYR	Tokio, Japan		
7.83	38.3	PDU	Kootwijk, Holland		
7.797	38.47	HBP	Switzerland		
7.77	38.6	FTF	St. Assise, France		
		PCK	Kootwijk, Holland		
7.612	39.41	X2GA	Nuevo Laredo, Mexico		
		HKF	Bogota, Colombia		
7.61	39.42	KWX	Dixon, Calif.		
7.56	39.65	KWY	Dixon, Calif.		
7.556	39.70	HKF	Bogota, Colombia		
7.52	39.89	KDK	Kauhuku, T. H.		
7.52	39.89	KKH	Kauhuku, T. H.		
7.47	40.16	HJB	Bogota, Colombia		
7.47	40.16	JVQ	Tokio, Japan		
7.444	40.3	HPB	Geneva, Switzerland		
7.40	40.55	HJ3ABD	Bogota, Colombia		
		WEM	Rocky Point, N. Y.		
7.39	37.8	DOA	Doeberitz, Germany		
7.23	41.5	DOA	Doeberitz, Germany		
7.22	41.55	HKE	Bogota, Colombia		
7.20	41.6	EA8AB	Canary Islands		
7.15	41.9	HJ4ABB	Manizales, Colombia		
7.14	42.02	HKX	Bogota, Colombia		
		CT1AA	Lisbon, Portugal		
6.977	43.0	EAR	Madrid, Spain		
6.94	43.23	WEB	Rocky Point, N. Y.		
6.90	43.48	GDS	Rugby, England		
6.88	43.6	LCL	Oslo, Norway		
6.86	43.73	KEL	Bolinas, Cal.		
6.84	43.86	HAT2	Budapest, Hungary		
		CFA	Drummondville, Quebec, Canada		
6.753	44.4	WHD	Deal, N. J.		
6.75	44.41	WOA	Lawrenceville, N. J.		
6.68	44.91	DGK	Nauen, Germany		
6.67	44.96	YVQ	Maracay, Venezuela		
6.667	45	TGW	Guatemala City, Central America		
		F8KR	Constantine, Algeria		
		HC2RL	Guayaquil, Ecuador		
6.66	45.05	TGW	Guatemala City, C.A.		
		HKM	Bogota, Colombia		
6.65	45.1	IAC	Pisa, Italy		
6.62	45.31	PRADO	Rio Bamba, Ecuador		
6.61	45.38	RW72	Moscow, U. S. S. R.		
6.61	45.38	REN	Moscow, U. S. S. R.		
6.60	45.45	F8KR	Constantine, Algeria		
6.515	46.05	WOO	Ocean Gate, N. J.		
6.447	46.53	HJ1ABB	Barranquilla, Col.		
6.425	46.69	VE9BY	London, Ont., Canada		
6.425	46.69	W3XL	Bound Brook, N. J.		
		W9XC	Anoka, Minn.		
6.38	47.02	HC1DR	Quito, Ecuador		
		HJ5ABD	Cali, Colombia		
6.335	47.35	VE9AP	Drummondville, Can.		
6.27	47.81	HKC	Bogota, Colombia		
6.25	48.0	HJ3ABF	Bogota, Colombia		
		CN8MC	Casa Blanca, Morocco		
6.243	48.05	HKD	Bogota, Colombia		
6.18	48.5	TGW	Guatemala City, C. A		
6.17	48.6	HJ3ABI	Bogota, Colombia		
		FTX	St. Assise, France		
6.167	48.65	XIF	Mexico City, Mex.		
6.15	48.78	YV3RC	Caracas, Venezuela		
6.15	48.78	CJRO	Winnipeg, Manitoba, Canada		
6.147	48.80	VE9CL	Winnipeg, Canada		
6.14	48.86	W8XK	Pittsburgh, Pa.		
6.13	48.94	YV11BMO	Caracas, Venezuela		
		YV3RC	Caracas, Venezuela		
6.127	48.95	HJ4ABE	Bogota, Colombia		
6.125	48.98	VE9HX	Halifax, N. S., Canada		
6.122	49.0	JB	Johannesburg, S. Africa		
6.12	49.02	W2XE	Wayne, N. J.		
		VE9HK	Halifax, N. S., Can.		
6.11	49.09	VE9HX	Halifax, N. S., Can.		
		VE9CG	Calgary Alt., Canada		
		VUC	Calcutta, India		
		YNA	Managua, Nicaragua		
6.10	49.18	W3XAL	Bound Brook, N. J.		
		W9XF	Chicago, Ill.		
		VE9CF	Halifax, N. S., Can.		
6.095	49.22	VE9GW	Bowmanville, Ont., Can.		
6.09	49.26	VE9BJ	St. John, N. Bruns'k		
6.080	49.3	CP5	La Paz, Bolivia		
6.08	49.34	W9XAA	Chicago, Ill.		
6.074	49.39	YV5BMO	Maracaibo, Venezuela		
6.073	49.4	OXY	Skamlebaek, Denmark		
6.072	49.4	OER2	Vienna, Austria		
		YV2AM	Maracaibo, Venezuela		
6.07	49.4	VE9CS	Vancouver, B. C., Can		
6.069	49.43	VE9CS	Vancouver, B. C.		
		JB	Johannesburg, S. Africa		
6.065	49.46	SAJ	Motola, Sweden		
6.06	49.5	W8XAL	Cincinnati, Ohio		
		VQ7LO	Nairobi, Kenya		
		W3XAU	Philadelphia, Pa.		
		OXY	Skamlebaek, Denmark		
		W3XAV	Philadelphia, Pa.		
		CP5	La Paz, Bolivia		
		CMC1	Havana, Cuba		
6.05	49.59	GSA	Daventry, England		
		VE9CF	Halifax, N. S., Can.		
6.04	49.67	W1XAL	Boston, Mass.		
		W4XB	Miami Beach, Fla.		
		PK3AN	Sourabaya, Java		
		W1XL	Boston, Mass.		
6.03	49.75	VE9CA	Calgary, Alta., Can.		
6.023	49.2	XEW	Mexico City, Mex.		
6.02	49.4	XEBT	Mexico City, Mex.		
6.12	49.8	YV2RC	Caracas, Venezuela		
6.02	49.83	DJC	Zeesen, Germany		
6.01	49.92	COC	Havana, Cuba		
6.005	49.96	VE9DR	Montreal, Canada		
		VE9CU	Calgary, Alta, Can.		
6.00	50.0	FIGA	Tananarive, Madag.		
		EAJ25	Barcelona, Spain		
		RV59	Moscow, U. S. S. R.		
		VQ7LO	Nairobi, Kenya, Af.		
		ZGE	Kuala, Lumpur, Malay States		
5.969	50.26	HVJ	Vatican City, Italy		
5.94	50.5	TGX	Guatemala City, C. A		
5.93	50.59	HJ4ABG	Medellin, Colombia		
5.90	50.85	HKO	Medellin, Colombia		
5.88	51.02	HJ2ABA	Tunja, Colombia		
5.857	51.22	XDA	Mexico City, Mex.		
5.85	51.26	WOB	Lawrenceville, N. J.		
5.80	51.75	HJ1ABB	Barranquilla, Col.		
5.71	52.5	VE9CL	Winnipeg, Canada		
5.692	52.7	FIQA	Tananarive, Madag.		
5.68	52.8	VK3LR	Melbourne, Australia		
4.66	53.0	HJ5ABC	Cali, Colombia		
5.26	57.03	WGN	Rocky Point, N. Y.		
5.17	58.03	PMY	Bandoeng, Java		
5.145	58.31	OK1MPT	Prague, Czechoslovakia		
5.07	59.08	WON	Lawrenceville, N. J.		
4.98	60.24	GBC	Rugby, England		
4.84	61.98	GDW	Rugby, England		
4.81	62.3	HKE	Bogota, Colombia		
4.795	62.56	W9XAM	Elgin, Ill.		
		VE9BY	London, Ont., Can.		
		W3XZ	Washington, D. C.		
4.78	62.7	CGA	Quebec, Canada		
4.75	63.16	WOO	Ocean Gate, N. J.		
4.75	63.16	WKF	Lawrenceville, N. J.		
4.70	63.79	W1XAB	Portland, Me.		
4.51	66.5	VPN	Nassau, Bahamas		
4.43	67.5	DOA	Doeberitz, Germany		
4.40	68.17	DFA	Nauen, Germany		
4.32	69.44	G6RX	Rugby, England		
4.273	70.2	RV15	Khabarovsk, Siberia, U. S. S. R.		
4.13	72.63	DAF	Nordeish, Germany		
4.116	72.8	WOO	Ocean Gate, N. J.		
4.11	73.0	HCJB	Quito, Ecuador		
4.105	74.72	HAA	Arlington, Va.		
3.75	80.0	I3RO	Rome, Italy		
3.75	80.0	CT1CT	Lisbon, Portugal		
		FGKR	Constantine, Algeria		

Best Short Wave Stations

The list below has been compiled from various sources, which have been checked up as closely as the difficulties of international correspondence permit. While it is not 100% accurate (no s.w. station lists of any kind are!), it will be found very useful as a foreign station tuning guide. It was drawn up by Mr. J. B. L. Hinds. The figures at the extreme left are wavelength in meters; next to them, frequency in megacycles. Readers are invited to send in additions or corrections based on their own reception experiences. Other readers will appreciate your help.

World wide stations that send programs: B, Broadcast; E, Experimental; P, Telephone stations.

EUROPE

Meters	Mega-Cycles	Call
13.97	21.47	B, GSH, Daventry, England, 6.00 to 8.30 a.m.
16.30	18.40	P, PCK, Kootwijk, Holland, about 7.00 a.m.
16.86	17.79	B, GSG, Daventry, England, 6.00-8.30 a.m., 8.45 a.m.-10.45 a.m.
16.88	17.77	B, PHI, Huizen, Holland, MWF 7.30-9.30 a.m., Sat. & Sun. 7.30-11.00 a.m.
19.68	15.25	B, Pontoise, France, 7 to 10 a.m.
19.73	15.20	B, DJB, Berlin, Germany, 4.00-5.30 a.m.; 8-11 a.m.; 12.20-2.30 a.m.
19.82	15.13	B, GSF, Daventry, England, 8.45-12.45 p.m.
9.84	15.11	B, HVJ, Vatican City, Daily 5.00 to 5.15 a.m.—Sat. 10-10.30 a.m.
25.00	12.00	B, RNE, Moscow, U.S.S.R., Sat. 10-11 p.m.; Sun. 6-7, 10-11 a.m.; Mon., Wed. and Fri. 10-11 a.m.
25.20	11.90	B, Pontoise, France, 10.15 a.m. to 1.15 p.m.—2.00 to 5.00 p.m.
25.28	11.86	B, GSE, Daventry, England, 10.45 a.m.-12.45 p.m.
25.40	11.81	B, 2RO, Rome, Italy, 11.30 a.m.-12.30 p.m.—1.15-6.00 p.m.
25.51	11.76	B, DJD, Berlin, Germany, 5.00-10.30 p.m.; 12.15-4.00 p.m.
25.53	11.75	B, GSB, Daventry, England, 11.30 p.m.-1.30 a.m.; 1.00-3.30 p.m.; 6.00-8.05 p.m.
25.63	11.71	B, Pontoise, France, 2.00-11 p.m.
29.04	10.33	E, ORK, Brussels, Belgium, 1.-45-3.15 p.m.
30.40	9.87	B, EAQ, Madrid, Spain, Daily 5.15-7.00 p.m., Sat. 12 noon-2.00, Sat. & Sun. 7.00-7.30 I.B.S.
30.52	9.83	E, IRM, Rome, Italy, Afternoons, irregular.
31.25	9.60	B, CT1AA, Lisbon, Portugal, Tues. & Fridays 4.30-7.00 p.m.
31.27	9.59	B, HBL, Geneva, Switzerland, Saturdays 5.30-6.15 p.m., Sun. same hours, irregular.
31.30	9.58	B, GSC, Daventry, England, 6.00-8.00 p.m.
31.38	9.57	B, DJA, Berlin, Germany, 4.00-5.30 a.m., 8-11 a.m.; 5.00-8.15 p.m.
31.40	9.57	B, OXY, Skamleback, Denmark, 2.00-6.00 p.m.
31.43	9.56	B, LCL, Jeloy, Norway, 11.00 a.m.-5.00 p.m.
31.55	9.51	B, GSB, Daventry, England, 11.30 p.m.-1.30 a.m.; 1.00-3.30 p.m
38.47	7.80	B, HBP, Geneva, Switzerland, Saturdays 5.30-6.15 p.m.—Sundays same hours, irregular.
42.92	6.99	B, LCL, Jeloy, Norway, Relays Oslo 11 a.m.-6 p.m.
43.86	6.84	B, HAS, Budapest, Hungary, 3.00-5.30 p.m. irregular.
45.38	6.61	B, REN, Moscow, U. S. S. R., 2.00-6.00 p.m.
49.40	6.07	B, OXY, Skamleback, Denmark, 2.00-6.30 p.m.
49.83	6.02	B, DJC, Berlin, Germany, 8.45-10.30 p.m.; 12.15-4.00 p.m.
50.00	6.00	B, RV59, Moscow, U. S. S. R., 2.00-6.00 p.m.
60.30	4.97	E, G6RX, Rugby, England, 8.00-10.00 p.m., irregular.
69.44	4.32	E, G6RX, Rugby, England, 7.00-10.00 p.m.

ASIA

Meters	Mega-Cycles	Call
16.50	18.18	P, PMC, Bandoeng, Java, 3.10-9.20 a.m.
19.03	15.76	E, JYT, Kemikawa, Japan, 6.00-7.00 a.m.
20.03	14.98	P, KAY, Manila, Philippine Islands 5-7 a.m.—7-8 p.m.
27.93	10.38	B, JVM, Nagaski, Japan, 4.30-7.30 a.m.
30.40	9.87	E, JYT, Kemikawa, Japan, 4-7 a.m.
48.92	6.13	B, ZGE, Kula Lumpur, Malaya States, daily 8-10 a.m.
49.10	6.11	B, VUC, Calcutta, India, 9.30 a.m.-12 noon, Sat. 11.45 p.m. to 3.00 a.m.
49.42	6.07	B, PK1WK, Bandoeng, Java, Sat. 8.50-10.15 p.m.; Sun. 5-6 a.m.; daily except Sun., 4.15-6.00 a.m.
49.90	6.01	B, ZHI, Singapore, Sat. 11.00 p.m.-1.30 a.m.; Sun. 5.30-7.00 a.m., 11.00 p.m.-1.30 a.m.; Tues. and Wed. 11.00 p.m.-1.30 a.m.
58.00	5.17	B, PMY, Bandoeng, Java, Sat. 8.30 p.m.-1.30 a.m.; Sun., Mon., Tues., Wed. and Thurs. midnight - 2.30 p.m.; Mon., Tues., Wed., Thurs and Fri. 4.30-9.30 a.m.; Fri. 10.30 p.m.-2.30 a.m.; Sat. 4.30 a.m.-10.30 a.m.
60.00	5.00	B, PK3BR, Surabaya, Java, Mon.-Sat. 4.30-7.00 a.m.
60.00	5.00	B, PK3GH, Surabaya, Java, daily 7.30-8.30 p.m.; 4.30-5.30 a.m.
62.00	4.84	B, PK1KR, Batavia, Java, Mon., Wed. and Sat. 7.30-9.30 a.m.
76.00	3.94	B, PK3JL, Malang, Java, Sat. 10.30 p.m.-1.00 a.m.; Sun., Tues., Wed., Thurs. and Fri. midnight-1.00 a.m.; Mon. midnight-12.30 a.m.; Fri. and Sat. 6.30-9.00 a.m.

AFRICA

Meters	Mega-Cycles	Call
23.38	12.83	B, CNR, Rabat, Morocco, Sundays 7.30-9.00 a.m.
29.58	10.14	P, OPM, Leopoldville, Belgian Congo, 9-11 a.m.—3-6 p.m.
37.33	8.05	B, CNR, Rabat, Morocco, Sunday 2.30-5.00 p.m.
49.00	6.12	B, Johannesburg, 4-6 a.m.—8-10.30 a.m.—11 a.m.-3.40 p.m.
49.50	6.06	B, VQ7LO, Nairobi, Kenya Colony, 11 a.m.-2 p.m.

UNITED STATES

Meters	Mega-Cycles	Call
16.87	17.78	B, W3XAL, Bound Brook, N. J., 9.00 a.m. to 3 p.m.
19.56	15.34	B, W2XAD, Schenectady, N. Y. M.W.F. 1.30-2.30 p.m., Sun. 1.00-3.00 p.m.
19.64	15.27	B, W2XE, Wayne, N. J., 10 a.m.-12 noon.
19.72	15.21	B, W8XK, Pittsburgh, Pa. 9 a.m.-3.15 p.m.
25.27	11.87	B, W8XK, Pittsburgh, Pa., 3.30-9.00 p.m.
25.36	11.83	B, W2XE, Wayne, N. J., 2.00-4.00 p.m.
31.28	9.59	B, W3XAU, Philadelphia, Pa., 11 a.m.-5.00 p.m., irregular.
31.36	9.57	B, WIXAZ, Boston, Mass., 6.00 a.m. to midnight.
31.49	9.53	B, W2XAF, Schenectady, N.Y., 6.45 to 10.00 p.m.
46.69	6.43	B, W3XL, Bound Brook, N. J., Friday and Saturday 6.00-12 midnight.
48.86	6.14	B, W8XK, Pittsburgh, Pa., 3.30 p.m.-1.00 a.m.
49.02	6.12	B, W2XE, Wayne, N. J., 5.00-10.00 p.m.
49.18	6.10	B, W3XAL, Bound Brook, N. J., Mon., Wed., Sat., 4 p.m.-12 midnight.
49.18	6.10	B, W9XF, Chicago, Ill., 3.30-7.30 p.m., 8.30 p.m.-1.30 a.m.
49.34	6.08	B, W9XAA, Chicago, Ill., 1-6 p.m. Sundays; week nights, irregular.
49.50	6.06	B, W3XAU, Philadelphia, Pa., 7 p.m. to midnight.
49.50	6.06	B, W8XAL, Cincinnatti, Ohio, 6.30-7.00 p.m., 10.00 p.m.-2.00 a.m.
49.67	6.04	B, WIXAL, Boston, Mass., 6.00-7 p.m.
49.67	6.04	B, W4XB, Miami, Florida, Sat., 6.00-11 p.m.

SOUTH AMERICA

Meters	Mega-Cycles	Call
19.19	15.62	P, OCJ, Lima, Peru, about 2 p.m., irregular.
25.73	11.66	E, PPQ, Rio de Janeiro, Brazil, 7-9.00 p.m., irregular.
27.35	10.97	P, OCI, Lima, Peru, 8-10 p.m., evenings, irregular.
28.98	10.35	E, LSX, Buenos Aires, Argentina, Thurs. and Fri. 8.00-10.00 p.m.; Sat. 10.00 p.m., irregular.
30.30	9.90	P, LSN, Buenos Aires, Argentina, 6. p.m.-6.a.m. irregular.
36.65	8.19	B, PSK, Rio de Janeiro, Brazil. 5.30-6.-15 p.m.
40.55	7.40	B, HJ3ABD, Bogota, Colombia, 7.30-12 p.m.
41.55	7.22	B, HKE, Bogota, Colombia, Monday 6-7 p.m., Tues., Fri. 8-9 p.m.
41.60	7.20	B, HJ4ABB, Manizales, Colombia, 8-10 p.m.
42.86	7.00	B, HJ1ABE, Cartagena, Co-

Meters	Mega-Cycles	Call
		lambia, Mon. 10-11 p.m., Wed. 8-10 p.m.; Sunday 9 a.m.-11 a.m.
45.00	6.67	B, HC2RL, Guayaquil, Ecuador, Sun. 5.45-7.45 p.m., Tues. 9.15-11.15 p.m.
45.31	6.62	B, PRADO, Riobamba, Ecuador, Thursday 9.00-11.30 p.m.
46.30	6.48	B, HJ5ABD, Cali, Colombia, 7-10 p.m.
46.51	6.45	B, HJ1ABB, Barranquilla, Colombia, 7-10 p.m.
48.00	6.25	B, HJ3ABF, Bogota, Colombia, 7-11 p.m.
48.78	6.15	B, YV3RC, Caracas, Venezuela, 10.30 a.m.-1.30 p.m., 4.30-10.00 p.m.
49.08	6.11	B, YV2RC, Caracas, Venezuela, 10.30 a.m.-1 p.m., 5.15-10 p.m.
49.20	6.10	B, HJ1ABD, Cartagena, Colombia, 11.30 a.m-12.30 p.m., 7-9 p.m.
49.39	6.07	B, YV5BMO, Maracaibo, Venezuela, 5.30-11. p.m.
49.60	6.05	B, HJ3ABI, Bogota, Colombia, 8-10 p.m. irregular.
50.08	5.99	B, YV4BSG, Caracas, Venezuela, 4.30-10.30 p.m.
50.25	5.97	B, HJ2ABC, Cucuta, Colombia, 11 a.m.-12 noon, 6-9 p.m.
50.42	5.95	B, HJ4ABE, Medellin, Colombia, Mon. 7-11 p.m., Tues., Thurs., Sat. 6.15-8 p.m., Wed., Fri. 7.30-10.30 p.m.
51.49	5.88	B, HJ2ABA, Tunja, Colombia, 1-2 p.m., 7.30-10 p.m.
53.00	5.65	B, HJ5ABC, Cali, Colombia, 8-10 p.m.
73.00	4.00	B, HCJB, Quito, Ecuador, 7.30-9.45 p.m., except Monday.

MEXICO AND WEST INDIES

Meters	Mega-Cycles	Call
25.50	11.79	P, XDM, Mexico City, Mexico, 1-6 p.m., irregular.
26.00	11.54	P, XAM, Merida Yucatan, Mexico, 1-6 p.m., irregular.
31.25	9.60	B, XETE, Mexico City, Mexico, 2 p.m.-2 a.m.
47.50	6.32	B, HIZ, Santo Domingo, R.D., Daily 4.40-5.40 p.m., Sat. 11 p.m.-12.40 a.m.
47.80	6.23	B, HI1A, Dominican Rep., Daily 12.10-1.40 p.m., 7.40-9.40 p.m., Sun. 1.40-4.40 p.m., 7.40-9.40 p.m.
49.50	6.06	B, HIX, Santo Domingo, R.D., Tues. & Fri. 8.10-10.10 p.m., Sun. 8.40-10.40 a.m., 2.40-4.40 p.m.
49.8	6.03	B, XEBT, Mexico City, Mexico, 7.00 p.m.-2.00 a.m.
49.96	6.01	B, COC, Havana, Cuba, 4-6 p.m., 8-10 p.m.

OCEANIA

Meters	Mega-Cycles	Call
31.28	9.59	B, VK2ME, Sydney, Australia, Sun. 1-3.00 a.m., 5.00-9.00 a.m., 11.30 a.m. to 1.30 p.m.
31.30	9.58	B, VK3LR, Melbourne, Australia, Daily except Sun., 3.15-7.30 a.m.
31.55	9.51	B, VK3ME, Melbourne, Australia, Wed. 5.00 to 6.30 a.m., Sat. 5 to 7 a.m.

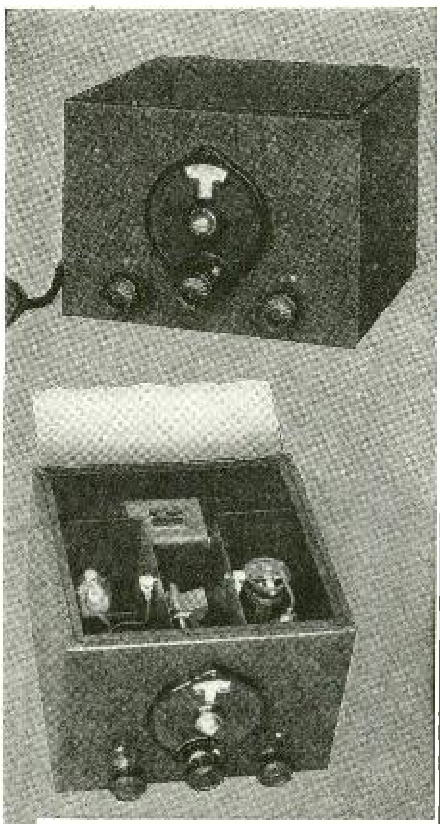
CANADA

Meters	Mega-Cycles	Call
25.60	11.72	B, CJRX, Winnipeg, Can., daily 8.00-12.00 midnight.
48.78	6.15	B, CJRO, Winnipeg, Manitoba, Can., 8-12 midnight.
49.10	6.11	B, VE9HX, Halifax, N. S., 8.30-11.30 a.m., 5-10 p.m.
49.22	6.09	B, VE9GW, Bowmanville, Ont., Mon., Tues., Wed. 1-10 p.m., Thurs. 2-11 p.m., Fri., Sat. 6.00 a.m.-11 p.m., Sun. 10 a.m.-7 p.m.
49.29	6.09	B, VE9BJ, St. John, N. B., 5-10 p.m., irregular.
49.42	6.07	B, VE9CS, Vancouver, B. C., Fri. 12.30-1.45 a.m., Sun. 12 noon-midnight.
49.96	6.01	B, VE9DN, Drummondville, Que., Saturdays after 10.30 p.m.

List of International Call Assignments

The international call letter assignments underwent some extensive changes early this year, when the acts of the Madrid Radio Convention of 1932 went into effect. For the most part the changes affect the smaller countries, but one really important shift gives all the R and U calls to the Union of the Soviet Socialist Republics. ("Russia"). The list as given below incorporates the official changes.

Block of Calls	Country	Amateur Prefix
CAA-CEZ	Chile	CE
CFA-CKZ	Canada	VE
CLA-CMZ	Cuba	CM
CNA-CNZ	Morocco	F
COA-COZ	Cuba	CM
CPA-CPZ	Bolivia	CP
CQA-CRZ	Portuguese colonies:	
	Cape Verde Ids.	CR4
	Portuguese Guinea	CR5
	Angola	CR6
	Mozambique	CR7
	Portuguese India	CR8
	Macao	CR9
	Timor	CR10
CSA-CUZ	Portugal:	
	Portugal proper	CT1
	Azores	CT2
	Madeira	CT3
CVA-CXZ	Uruguay	CX
CYA-CZZ	Canada	VE
D	Germany	D
EAA-EHZ	Spain	EA
EIA-EIZ	Irish Free State	EI
ELA-ELZ	Liberia	EL
EPA-EQZ	Persia	EP
ESA-ESZ	Esthonia	ES
ETA-ETZ	Ethiopia (Abyssinia)	ET
EZA-EZZ	Saar Territory	EZ
F	France	
	France, Algeria, Martinique, Morocco and Tahiti	F3, F8
G	United Kingdom:	
	Great Britain except Ireland	G
	Northern Ireland	GI
HAA-HAZ	Hungary	HA
HBA-HBZ	Switzerland	HB
HCA-HCZ	Ecuador	HC
HHA-HHZ	Haiti	HH
HIA-HIZ	Dominican Republic	HI
HJA-HKZ	Colombia	HJ, HK
HPA-HPZ	Republic of Panama	HP
HRA-HRZ	Honduras	HR
HSA-HSZ	Siam	HS
HVA-HVZ	Vatican City State	
HZA-HZZ	Hedjaz	HZ
I	Italy and colonies	I
J	Japan	J
K	United States of America:	
	Continental United States	W
	Philippine Ids.	KA
	Puerto Rico and Virgin Ids	K4
	Canal Zone	K5
	Territory of Hawaii, Guam and Samoa	K6
	Territory of Alaska	K7
LAA-LNZ	Norway	LA
LOA-LWZ	Argentine Republic	LU
LXA-LXZ	Luxemburg	LX
LYA-LYZ	Lithuania	LY
LZA-LZZ	Bulgaria	LZ
M	Great Britain	G
N	United States of America	W
OAA-OCZ	Peru	OA
OEA-OEZ	Austria	OE
OFA-OHZ	Finland	OH
OKA-OKZ	Czechoslovakia	OK
ONA-OTZ	Belgium and colonies	ON
OUA-OZZ	Denmark	OZ
PAA-PIZ	The Netherlands	PA
PJA-PJZ	Curacao	PJ
PKA-POZ	Dutch East Indies	PK
PPA-PYZ	Brazil	PY
PZA-PZZ	Surinam	PZ
R	Union of the Soviet Socialist Republics	
SAA-SMZ	Sweden	SM
SOA-SRZ	Poland	SP
STA-SUZ	Egypt	ST
SVA-SZZ	Greece	SV
TAA-TCZ	Turkey	TA
TFA-TFZ	Iceland	TF
TGA-TGZ	Guatemala	TG
TIA-TIZ	Costa Rica	TI
TKA-TZZ	France and Colonies and Protectorates	F
U	U.S.S.R.	
VAA-VGZ	Canada	VE
VHA-VMZ	Australia	VK
VOA-VOZ	Newfoundland	VO
VPA-VSZ	British colonies and protectorates	
	Fiji, Ellice Islands, Zanzibar	VP1
	Bahamas	VP7
	British Honduras, Trinidad	VP4
	Jamaica	VP5
	Barbados	VP6
	Bermuda	VP9
	Fanning Island	VQ1
	Northern Rhodesia	VQ2
	Tanganyika	VQ3
	Kenya Colony	VQ4
	Uganda	VQ5
	British Guiana	VR
	Malaya; Straits Settlement:	VS1, 2, 3
	Hongkong	VS6
	Ceylon	VS7
VTA-VWZ	British India	VU
VXA-VYZ	Canada	
W	United States of America:	
	Continental United States (for others, see under K.)	W
XAA-XFZ	Mexico	X
XGA-XUZ	China	XT, XU
XYA-XZZ	British India	VU
YAA-YAZ	Afghanistan	YA
YBA-YHZ	Dutch East Indies	PK
YIA-YIZ	Iraq	YI
YJA-YJZ	New Hebrides	YJ
YLA-YLZ	Latvia	YL
YMA-YMZ	Danzig	YM
YNA-YNZ	Nicaragua	YN
YOA-YRZ	Roumania	CV
YSA-YSZ	Republic of El Salvador	YS
YTA-YUZ	Yugoslavia	UN
YVA-YWZ	Venezuela	YV
ZAA-ZAZ	Albania	ZA
ZBA-ZJZ	British colonies and protectorates	
	Transjordania	ZC1
	Palestine	ZC6
	Nigeria	ZD
	Southern Rhodesia	ZE1
ZKA-ZMZ	New Zealand:	
	Cook Ids.	ZK
	New Zealand proper	ZL
	British Samoa	ZM
ZPA-ZPZ	Paraguay	ZP
ZSA-ZUZ	Union of South Africa	ZS, ZT, ZU



New Rulings of the Federal Radio Commission

(*Continued from page* 23)

W2DEF W2DEF W2DEF DE W1ABC W1ABC W1ABC K

Example 3. Portable or portable-mobile amateur station calls a portable or portable-mobile amateur station:

W3GHI W3GHI W3GHI DE W4JKL BT4 W4JKL BT4 W4JKL BT4 AR

If telephony is used, the call sign of the station shall be followed by an announcement of the amateur call area in which the portable or portable-mobile station is operating.

Rule 386. Each licensee of an amateur station shall keep an accurate log of station operation to be made available upon request by authorized Government representatives, as follows:

a. The date and time of each transmission. (The date need only be entered once for each day's operation. The expression "time of each transmission" means the time of making a call and need not be repeated during the sequence of communication which immediately follows; however, an entry shall be made in the log when "signing off" so as to show the period during which communication was carried on).

b. The name of the person manipulating the transmitting key of a radiotelegraph transmitter or the name of the person operating a transmitter of any other type (type A-3 or A-4 emission) with statement as to type of emission. (The name need only be entered once in the log provided the log contains a statement to the effect that all transmissions were made by the person named except where otherwise stated. The name of any other person who operates the station shall be entered in the proper space for his transmissions).

c. Call letters of the station called. (This entry need not be repeated for calls made to the same station during any sequence of communication provided the time of "signing off" is given).

d. The input power to the oscillator, or to the final amplifier stage where an oscillator-amplifier transmitter is employed. (This need be entered only once provided the input power is not changed).

e. The frequency band used. (This information need be entered only once in the log for all transmissions until there is a change in frequency to another amateur band).

f. The location of a portable or portable-mobile station at the time of each transmission. (This need be entered only once, provided the location of the station is not changed. However, suitable entry shall be made in the log upon changing location, showing the type of vehicle or mobile unit in which the station is operated, and the approximate geographical location of the station at the time of operation).

g. The message traffic handled. (If record communications are handled in regular message form, a copy of each message sent and received shall be entered in the log or retained on file for at least one year).

Rule 387. Advance notice of all locations in which portable amateur stations will be operated shall be given by the licensee to the Inspector in Charge of the district in which the station is to be operated. Such notices shall be made by letter or other means prior to any operation contemplated and shall state the station call, name of licensee, the date of proposed operation and the approximate locations, as by city, town, or county. An amateur station operating under this rule shall not be operated during any period exceeding thirty days without giving further notice to the Inspector in Charge of the radio district in which the station will be operated. This rule does not apply to the operation of portable or portable-mobile amateur stations on frequencies above 56,000 kilocycles authorized to be used by amateur stations. (See Rule 368).

A Beat Oscillator

(*Continued from page* 9)

short-wave station (or a broadcast station when a broadcast-band receiver is used) is tuned in very carefully. Adjust the knob on the top of the shield can of the oscillator until you hear a whistle. Rotate the knob slowly until the whistle is adjusted to zero beat. To locate zero beat, observe the following: the whistle begins high in pitch, grows lower, disappears completely, and, as you continue rotating the knob, reappears low in pitch and gradually rises until it becomes inaudible. The point between the two whistles is called "zero beat." Now, tune in another station and then adjust the tuning to zero beat. Snap the toggle switch on the beat note oscillator to OFF. You will note that the whistle has disappeared and that you are now hearing the station at its peak.

The tuning unit of the beat note oscillator may be one of two types; either it may be adjusted for operation at 175-180 kilocycles for use with most broadcast receivers, or it may be adjusted for operation at 450-500 kilocycles for use with most short-wave and all-wave receivers.

Denton Trophy Awarded

(*Continued from page 32*)

had to be individually treated, with careful attention as to date, etc., it was found that five men, working nightly for a period of two weeks, were required to whip the list of verifications submitted by the contestants into shape. This was a very long, tiresome job, and the members of the judging committee and checking groups are to be commended on their interest in short waves, and on the trophy contest in particular, for their sincere efforts in this connection.

Hundreds of verifications were not credited for various reasons. Many of the contestants sent in more than 150 individual verifications; and, if most of these verifications had been allowed, the final for the winner would have been nearly 145 credits. However, every effort was made to treat all contestants fairly and in the same manner. Anything that was disallowed for one contestant was disallowed for every other contestant.

Contest a Success

Needless to say, the contest was a complete success. However, in the light of the information which has been gathered from letters from short-wave fans all over the world, it is felt that a new set of rules will be devised for the 1935 Trophy Contest, which will enable the rules committee to set up a more satisfactory method of handling the contest. It is to be remembered that, during our Summer here in North America, it is Winter in South America. For that reason, many of the South American contestants have asked that the contest run for a period of exactly one year, thus giving them the advantage of Winter and Summer reception along with their North American friends.

The Denton Trophy Committee extends its sincere thanks to the International Short Wave Club who sponsored the contest, and to the many magazines and newspapers that assisted in so many ways.

F. R. C. Now F. C. C.

With the passing of the 73rd Congress comes also the end of the Federal Radio Commission under whose guidance radio in the United States has steered its course since 1927.

Under the new bill just signed by the President, a board is to be set up which will be known as the Federal Communications Commission. This body is to consist of seven members and will have control of the entire communications system in the country, including telegraph, telephone, cable and radio systems.

By this means it is expected that a better coordination of control of communications will be obtained.

The Theory of the RCA Antenna System

(*Continued from page 21*)

voltage across the primary of the transformer. Hence, since there is a difference of potential, primary current flows and the signals are heard.

It is evident, therefore, that any noise induced in the lead-in is of the in-phase type and, hence, cannot be heard. Of course, if capacitive coupling between the primary and secondary of the coupling transformer is present, in-phase signals will be passed on to the receiver and amplifier. To prevent this action from taking place, the coupling transformer is equipped with an electrostatic shield between primary and secondary. A diagram of the complete system is shown in Fig. 2.

When the switch is in position SW, operation is as described above; when in position STD, the doublet is removed and both lead-in and aerial act together. Hence, in this latter position, both in-phase and out-of-phase signals are passed on. The resistor shown connected from one side of the primary to ground is used to prevent the antenna system from accumulating a high potential which would cause periodic disturbing clicks in the receiver.

Less Noise on STD Tap

In some cases it may be found that short-wave signals originating comparatively close to the antenna may come in with greater strength when the switch is in the STD position than when it is in the SW position. This is due to the fact that many short-wave signals have a very large ground wave which extends a short distance from the transmitter and which is vertically polarized. This means that it will induce a signal mainly in a vertical antenna—the lead-in in our case. This explains why using the lead-in will give louder signals on such stations than the regular SW position.

An anomalous situation arises in connection with automobile ignition noise. Since this noise is generally at some distance from the antenna, it seems reasonable to suppose that both the aerial and the lead-in would pick up the noise, in which case, no improvement in signal-to-noise ratio would be expected by eliminating the line pickup. Nevertheless, some improvement does result. RCA has two possible explanations for this. First, automobile interference is usually of the vertically polarized type and cannot be picked up efficiently by the horizontal doublets. Secondly, probably a good share of the automobile noise is carried to the receiver via the power line. The coupling transformer of the system eliminates, or rather minimizes, noises induced in the receiver through this path. This can best be illustrated by reference to Fig. 3.

"S" represents a signal generator, such as a source of auto ignition noise; (a) represents the capacity coupling from S to the transmission line; (b) represents the capacity coupling from S to the power supply line; (h) represents the capacity coupling from one side of the power supply line to the metal chassis; (f) represents the capacity coupling from S to actual earth ground.

(A) The noise voltage that would be induced by capacity coupling into the transmission line would correspond to an in-phase signal and, therefore, would be coupled or fed through to the secondary of the receiver coupling transformer by the capacity (c) if this capacity were not eliminated by the electrostatic shield (d). If it were not for shield (d), a noise voltage would be developed across ANT and GND of the receiver due to a completed circuit from GND to chassis frame through (h) to the power supply line, which is usually grounded on one side, and thence back to S through (f).

(B) The noise voltage that would be induced by capacity coupling (b) causes current to flow through the power transformer and develop a noise voltage from ground to the chassis through capacity (h). If no receiver coupling transformer was used, this voltage would occur across ANT and GND, the input terminals of the receiver, and hence cause noise. When the RCA System is used, including the receiver coupling transformer, this voltage occurs between the primary and the electrostatic shield, since capacity (c) has been eliminated.

However, this does not produce primary current. Therefore this noise voltage does not induce a voltage in the transformer secondary.

(C) The electrostatic shield (j) provided with most power transformers serves to offset the capacity coupling (g), and thus prevents the introduction of r.f. noise voltages into the voltage supply of the receiver directly.

Do You Know That—

While good reception may be obtained on the short waves with sets using only a single tube, most listeners prefer to use multi-tube receivers in order to obtain greater sensitivity and greater volume?

Radio-frequency amplification will make the set more sensitive to weak signals, while audio amplification will increase the volume?

Two stages of audio amplification are generally sufficient for loudspeaker operation. A single audio stage gives comfortable signals when used with earphones?

Dry batteries last longest when kept in a cool, dry place?

Rectifier tubes should be operated in a vertical position; otherwise the filament will sag?

Using High Voltage Filter Condensers

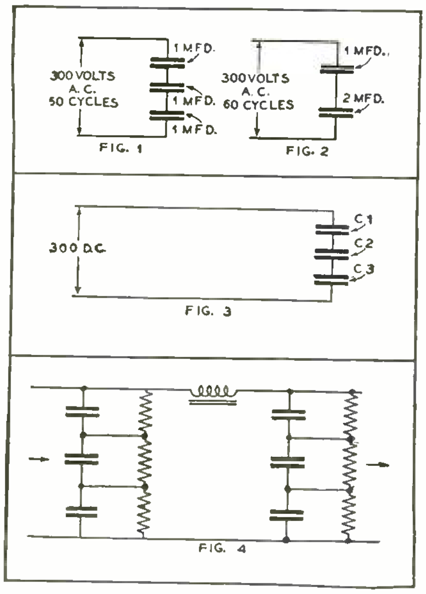
In the design and construction of rectifier filter systems the use of electrolytic condensers for relatively low voltage filter systems in the order of 400 or 500 volts maximum has become almost standard. For these voltages there is little question that electrolytic condensers meet the requirements of such filter circuits as well as any other type of filter condenser. At the same time the electrolytic condenser is cheaper and more compact.

Condensers for filter circuits are of three types. These are the electrolytic condenser, the wax condenser and the oil condenser. The following discussion will, we hope, serve to indicate the essential problems connected with the use of these types of condensers.

In the case of electrolytic condensers where voltages higher than 400 or 500 volts are required, the practice is to connect several condensers in series to obtain a combination capable of withstanding higher voltages. The usual practice is to use for this purpose standard 450 volts working voltage, 525 volts surge peak condensers, and to figure on the basis of allowing one extra condenser so as to reduce the voltage across the condensers. For example, for 1000 volts, three condensers should be used in series; for 1500 volts, four condensers would be used in series, and etc.

Division of Voltage

The problem of using a series combination in this manner naturally raises the old problem that always arises when condensers are connected in series across a source of alternating current. If several condensers of equal capacity are connected across a.c., then the voltage divides evenly among the several condensers. For example, if three 1 mf. condensers are connected across 300 volts a.c. then there will appear across each condenser 100 volts. The important point is that the division of voltage, when a series group of condensers are connected across a.c., is determined purely by the capacity of the individual section, and the only time the voltage division will be unequal is when the capacities are unequal. As an example of this take the case of a 1 mf. condenser and a 2 mf. condenser both connected in series across 300 volts. In such a case there would be 200 volts a.c. across the 1 mf. unit and 100 volts a.c. across the 2 mf. unit. Note that the voltage division is an inverse function of the capacity. The higher the capacity, the lower the voltage.



An Example

Although the reason why the a.c. voltage divides in this manner is probably known to most readers nevertheless it might be worth while to indicate briefly why the a.c. voltage divides as it does in order that the difference between the division of the voltage on a.c. and the division of the voltage on d.c., to be discussed later, will be entirely clear.

Let us, therefore, take a typical example and work it through. For example, suppose, as in Fig. 1, three 1 mf. condensers are connected in series across 300 volts a.c. Assume that the frequency is 60 cycles. It will be found that a 1 mf. condenser has at 60 cycles a reactance of approximately 2600 ohms. If we work out this figure accurately it will be found that it is 2654 ohms, for the purpose of our example, we will take the approximate figure of 2600 ohms obtained from the chart.

Since each 1 mf. condenser has at 60 cycles a reactance of 2600 ohms; then 3 in series will have a reactance three times 2600 or a total of 7800 ohms. The current flowing through the circuit will be equal to the voltage 300 volts divided by the reactance 7800 which gives a current of .0385 ampere.

Voltages Equal

The voltage across any one of the condensers will then be equal to the reactance of that condenser multiplied by the current. The voltage across any one of the condensers will therefore be equal to 2600 times .0385 which gives 100 volts. Since the same current flows through all the condensers, and furthermore since all the condensers have the same capacity, and therefore the same reactance, it is obvious that there will be 100 volts across each of the three condensers. This indicates that the voltage divides equally among the various condensers, provided they have the same capacity.

Now let us take the case of unequal capacities, as shown in Fig. 2. Assume again that the source of voltage is 300 volts a.c. 60 cycles and that we have connected across this voltage one 1mf. condenser and one 2 mf. condenser. The reactance of the 1 mf. condenser as indicated above is 2600 ohms. It will be found that a 2 mf. condenser has one-half the reactance or 1300 ohms. This makes a total reactance of the two in series 3900 ohms. The current through the circuit will therefore be the voltage 300 volts divided by the total reactance 3900 ohms which gives a total of .077 ampere.

The voltage across the condensers will again as in the foregoing example be equal to the reactance of the condenser multiplied by the current. In the case of the 1 mf. condenser this gives us 2600 x .077 or 200 volts. In the case of the 2 mf. condenser we have 1300 multiplied by .077 or 100 volts. Note in this case that the voltage division is unequal and that the larger capacity has the lower voltage across it.

The above example indicates what happens when condensers are connected in series on a.c. When condensers are connected in series to a source of d.c. voltage the results are, however, entirely different.

In the case of direct current circuits the division of voltage bears no simple relation to the capacities of the condensers connected in series. In the case of series sections on d.c. the voltage across any one section depends upon the insulation resistance of the condenser.

A D.C. Example

Let us work through a few examples for series sections on d.c., for in this way we can show most clearly the difference between series sections on d.c., and series sections on a.c. Suppose, we have three sections connected in series on d.c. as shown in Fig. 3 in which the three sections are marked C1, C2, and C3. In the case of d.c. operation we must take into consideration the insulation resistance of the condensers. Assume that the three condensers connected in series for this first example have the following characteristics:

UNIT	CAPACITY	INSULATION RESISTANCE
C-1	1 mf.	1000 megohms
C-2	1 "	1000 "
C-3	1 "	1000 "

When these three series condensers are connected across d.c. the condensers immediately take a charge but after the initial charging current, the current drawn from the d.c. source will be determined by the insulation resistance of the three sections in series. In this case the insulation resistance of the three sections in series is 3000 megohms. The current through the circuit will therefore be, according to the usual Ohms law:

$$I = \frac{E}{R}$$

$$I = \frac{300}{3000 \times 10^6}$$

$$I = 0.1 \times 10^{-6} \text{ amperes}$$

Therefore, the current is 0.1 microampere.

The voltage across any one section is equal to the insulation resistance of the section multiplied by the current. Since in this example the sections have the same insulation resistances the voltage across each section will be equal to the insulation resistance 1000 megohms multiplied by the current 0.1 microampere. This gives

$$E = IR$$

$$= 0.1 \times 10^{-6} \times 1000 \times 10^6$$

$$= 100 \text{ volts}$$

Therefore, in an example of the type given each section will have 100 volts across it, and the voltage will divide equally.

However, in the manufacture of paper condensers the procedure is to check the capacity to be sure that it is within tolerance and to then check the insulation resistance to make certain that it is above a certain minimum value. For example a 1 mf. condenser might have an insulation resistance of 1000 megohms or it might, as an example, have an insulation resistance of 2000 megohms. Both condensers would be considered entirely satisfactory. Suppose, however, we connected three condensers in series which have the following characteristics:

UNIT	CAPACITY	INSULATION RESISTANCE
C-1	1 mf.	1000 megohms
C-2	1 "	1500 "
C-3	1 "	2000 "

In such a combination the total insulation resistance would be 4500 megohms, and if the voltage was 300 volts d.c. the current would be

$$I = \frac{300}{4500 \times 10^6} = 0.0667 \times 10^{-6} \text{ amp.}$$

The voltages across the individual sections will again be equal to the current 0.0667 microampere multiplied by the insulation resistance. This gives the following values for the voltage across the sections.

UNIT	VOLTAGE
C-1	66.7 volts
C-2	100 volts
C-3	133.3 volts

Division Unequal

It will be noted from the above that while, quite naturally, the total voltage adds up to 300 volts the voltage does not uniformly divide be-

(*Continued on page* 44)

Operating Characteristics of the 1C6

THE 1C6 is a pentagrid converter of the two-volt filament type. It is particularly designed for use in two-volt, battery-operated, superheterodyne receivers in which it performs the functions of mixer and oscillator.

This tube which is similar to the 1A6 although not directly interchangeable with it, requires twice the filament current of the latter but offers the feature of an extended operating range at the shorter wavelengths. This feature is of particular value in the design of multi-range receivers, since the oscillator section of the 1C6 has sufficient mutual conductance to function at frequencies as high as 25 megacycles. In order to cover this same range of operation, the 1A6 requires for frequencies above 10 megacycles the use of a triode connected in parallel with the oscillator section. The 1C6 is, therefore, to be preferred for multi-range receivers, since these may be designed to cover frequencies from about 20 megacycles to 150 kilocycles or lower.

The oscillator section of the 1C6 has a mutual conductance of 1000 micromhos (when not oscillating) and an anode-grid current of 4.9 milliamperes, whereas the 1A6 has corresponding values of 425 micromhos and 2.3 milliamperes, respectively. This comparison is made under the voltage conditions of 180 plate volts, 67.5 screen volts, 135 anode volts (no dropping resistor), and zero oscillator-grid volts.

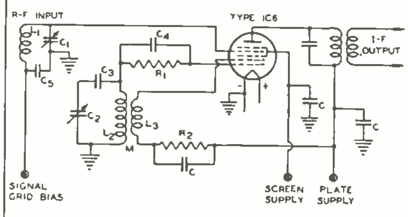
Figure 1 shows conversion transconductance and also total cathode current versus oscillator-grid current (I_{c1}). The maximum conversion transconductance is obtained with an oscillator-grid current of slightly less than 0.2 milliampere. This value should be borne in mind when the oscillator-grid and plate coils, L_2 and L_3 of Figure 3, are wound. Their coupling should be adjusted to make I_{c1} approximately 0.2 milliampere when a grid condenser of 250 mmf. and a grid leak of 50,000 ohms are used.

Remote Cut-off Type

Figure 2 shows the conversion transconductance and also plate resistance versus control-grid voltage E_{c4}. The control grid is of the remote cut-off type. This characteristic may be employed to supplement

RCA-1C6

TYPICAL PENTAGRID CONVERTER CIRCUIT



C = 0.1 μf.
C1 = } GANGED VARIABLE CONDENSERS
C2 = }
C3 = PADDING CONDENSER
C4 = GRID CONDENSER - 250 μμf
C5 = BLOCKING CONDENSER - 0.05 μf
L2 = OSCILLATOR GRID INDUCTANCE
L3 = OSCILLATOR PLATE INDUCTANCE
M = MUTUAL INDUCTANCE OF L2 AND L3
R1 = OSCILLATOR GRID RESISTOR - 50000 OHMS
R2 = VOLTAGE DROPPING RESISTOR - 20000 OHMS

NOTE VOLTAGE APPLIED TO ANODE-GRID (GRID No. 2) SHOULD BE HIGHER THAN THAT ON SCREEN (GRIDS No. 3 & No. 5)

FIG. 3

RCA-1C6

OPERATION CHARACTERISTICS

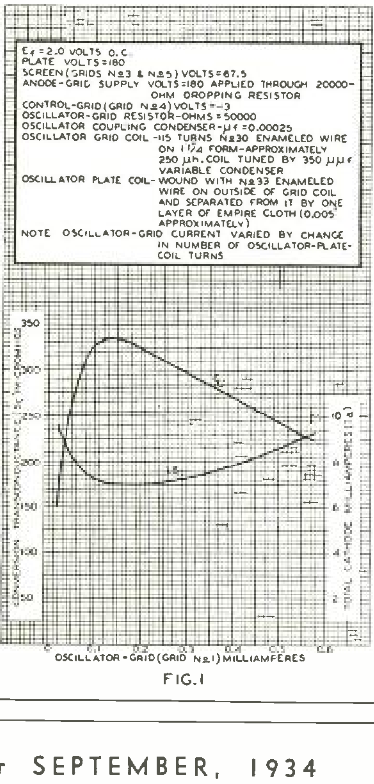


FIG. 1

RCA-1C6

OPERATION CHARACTERISTICS

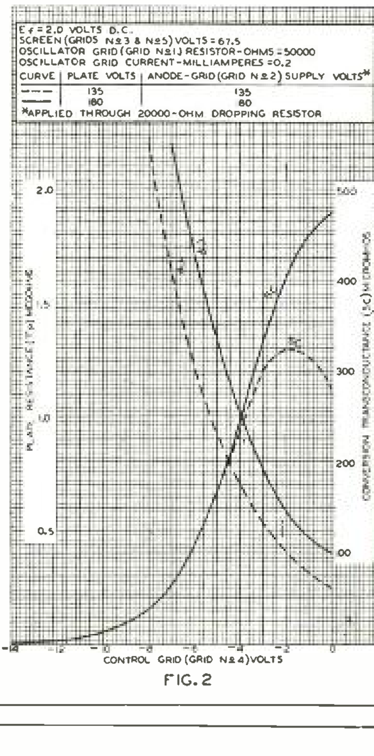


FIG. 2

the control on the amplifier stages. These r.f. and i.f. stages should use the 34, a tube also of the remote cut-off type which can be connected to receive AVC voltage for volume control. For the 34, cut-off occurs at –22.5 volts with 67.5 volts on the screen and for the 1C6, at –14 volts with 67.5 volts on grids 3 and 5.

Figure 3 shows a typical circuit for the 1C6 as a pentagrid converter. Typical operating voltages and currents for converter service follow:

Plate Voltage		180 max.	Volts
Screen (Grids No. 3 and No. 5) Voltage		67.5 max.	Volts
Anode-Grid (Grid No. 2) Voltage		135 max.	Volts
Anode-Grid Supply*		180 max.	Volts
Control-Grid (Grid No. 4) Voltage		–3 min.	Volts
Total Cathode Current		9 max.	Milliamperes
Typical Operation:			
Filament Voltage (D. C.)	2.0	2.0	Volts
Filament Current	0.12	0.12	Amperes
Plate Voltage	135	180	Volts
Screen (Grids No. 3 and No. 5) Voltage	67.5	67.5	Volts
Anode-Grid (Grid No. 2) Supply	135*	180*	Volts
Control-Grid (Grid No. 4) Voltage	–3	–3	Volts
Oscillator-Grid (Grid No. 1) Resistor	50000	50000	Ohms
Plate Resistance	0.55	0.75	Megohm
Conversion Conductance	300	325	Micromhos
Conversion Conductance at –14 Volts bias on Grid No. 4	4	4	Micromhos
Plate Current	1.3	1.5	Milliamperes
Screen Current (approximate)	2	2	Milliamperes
Anode-Grid Current	2.6	3.3	Milliamperes
Oscillator-Grid Current	0.2	0.2	Milliamperes
Total Cathode Current (approximate)	6.5	7	Milliamperes
*Applied through 20000-ohm dropping resistor.			
Direct Interelectrode Capacitances (Approx.);			
Grid No 4 to Plate. (With shield-can)		0.3	mmf.
Grid No. 4 to Grid No. 2. (With shield-can)		0.3	mmf.
Grid No. 4 to Grid No. 1. (With shield-can)		0.15	mmf.
Grid No. 1 to Grid No. 2		1.5	mmf.
Grid No. 4 to all other Electrodes (R-F input)		10	mmf.
Grid No. 2 to all other Electrodes (Osc. output)		6	mmf.
Grid No. 1 to all other Electrodes (Osc. input)		6	mmf.
Plate to all other Electrodes (Mixer output)		10	mmf.

—*RCA Radiotron Co.*

Filter Condensers

(*Continued from page 42*)

tween the various sections due to the fact that the sections have unequal resistances.

Because of the above problem, and the fact that the voltage division may be even more unequal, unless proper care is exercised, it is desirable always to use condensers rated at the proper voltage, rather than for the user to make up a bank out of several individual condensers. If, however, several condensers are used in series then the precaution should be taken to connect across them a group of resistors as shown in Fig. 4. These resistors should have values as low as possible.

These resistors should have values considerably lower than the probable insulation resistances of the condensers. In fact, in the case of paper condensers it will generally be possible in ordinary circuits to use a bank of resistors to give a current drain of 1 mil. This current, while small is still much greater than the leakage current of the condensers, and the resistor will therefore serve to equalize the voltages.

As a typical example, in the case of a 1000 volt circuit the total value of the shunt resistance connected across the circuit will be 1 megohm.

—*Aerovox Research Worker.*

The R. F. Transformer

The total amplification obtained from a single r.f. stage depends to a large extent upon the type of r.f. transformer used in the plate circuit as well as upon the tube. R.F. transformers have a certain ratio between secondary and primary, and it is this ratio, as well as the coupling between the two coils, which determine the gain from the transformer.

The higher the transformer ratio, the greater the gain. There is a limit, however, to the extent to which this ratio may be carried. The size of the secondary is determined by the size of the tuning condenser and the range of frequencies to be covered. The size of the primary is more or less limited by the type of tube used. If it is too large, the tube will oscillate; if it is too small, the gain will be small.

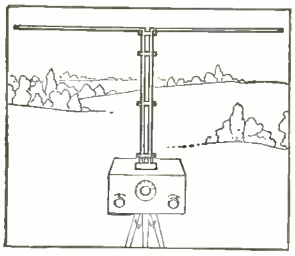
Another consideration is the coupling. Too weak coupling will increase selectivity; too tight coupling will make the set too broad.

The happy compromise between the various factors is not easy to find. While it may be determined to a large extent by mathematics, nevertheless, the trial and error method of the laboratory yields about the best results; the mathematics gives a starting point.

New 5-Meter Antenna

A UNIQUE antenna for 5-meter transmission and reception has just been announced by the E. F. Johnson Company, manufacturers of radio transmitting equipment. The efficiency of the unit is approximately 3 db. above that of a simple, current-fed antenna due to accurate impedance matching secured through a properly designed quarter-wave line section, which also serves as a support.

The Johnson antenna is designed for convenient installation either at a fixed station or under a variety of conditions encountered in portable work. Thus, it is possible to mount the antenna directly on a transceiver or portable transmitter case, or the antenna may be suspended in the air between convenient supports (for increased optical range) with a transposed transmission line back to the main equipment. Impedance remains accurately matched regardless of the method of use. With the aid of simple plug-and-jack fittings, the change from direct plug-in mounting on case to overhead suspension may be made quickly and easily without tools. No internal wiring changes or transmitter readjustments are necessary.



The antenna may be installed horizontally, as illustrated, or vertically by providing simple supports. It can be quickly set up and dismantled and weighs only 1¾ pounds net. Two models are available with either low-loss glazed porcelain or Mycalex.

Phone Polarity

Few people realize that the polarity of the phones or usual magnetic speaker makes a difference in results. As most experimenters know, magnetic speakers and phones have permanent magnets. Connecting the output one way increases the field strength; reversing them weakens it. The proper direction is the one with the red tracer connected to B plus.

A magnetic speaker is very similar in many respects to a detector tube. A weak magnet not only lowers the signal strength, but at the same time introduces a considerable amount of distortion, mostly second harmonic. A poor detector tube or circuit will also result in low signal strength and strong even harmonics.

Certain types of speakers are connected in push-pull fashion, so that they may be connected in a circuit in any direction.

Club Notes

New Jersey

Radio amateurs in the vicinity of Kearney, New Jersey, should be interested in the Eastern Amateur Radio League, a club devoted to short-wave transmission and reception.

Its membership at the present time consists of aboue 36 men residing in Arlington, North Arlington, Kearney and Jersey City. Meetings are held during the summer months at the home of the president, Mr. Vincent Mathews (W2AKX), 42 Union Place, North Arlington, N. J.

The organization is making plans for the opening of its own "shack," at which time a complete transmitting and receiving station will be set up under the club's call letters, W2GZJ.

The topic which most frequently holds the floor at club meetings is that of 5-meter radio; many of its members are operating in this band and report good success.

Communications may be addressed to the secretary of the Eastern Amateur Radio League, Mr. Andrew Kelso (W2GIX), 252 Devon St., Kearney, New Jersey.

Bronx

The Bronx Radio Club, one of the oldest amateur organizations in the East, meets every Friday evening at 740 Prospect Avenue, the Bronx, in the home of Frank Frimerman, (W2FZ.) All amateurs are cordially invited to drop in.

The meetings of this club are noted for their informality. Among the members who attend regularly is S. Loftin White, noted inventor, whose talks on various phases of radio circuit design are worth coming a long way to hear.

New Tube

A very interesting tube which combines the functions of audio amplifier and power supply rectifier has just been announced by the Hygrade Sylvania Corp., known as 12A7.

This tube is designed especially for use in small receivers where conservation of space is an important consideration. It is particularly recommended as a final amplifier in a.c.-d.c. sets.

The amplifier portion of the tube consists of a power pentode with separate connections brought out for the cathode, screen grid and plate. The control grid is brought out to a cap on the tube, and the suppressor grid is connected internally to the cathode.

Separate heaters are used for the two units, each rated at 6.3 volts, and connected in series internally, so that the rated heater voltage of the tube is 12.6 volts.

The rectifier will handle a maximum d.c. load current of 30 milliamperes. The pentode has an output rating of .55 watt.

The B. B. S.W. C.

THE Before Breakfast Short Wave Club, which was first described in the November, 1933, issue of SHORT WAVE RADIO, is a unique organization open to all short-wave listeners. There are no dues, meetings, minutes or other parliamentary nuisances. It is merely a friendly, fraternal and not too serious organization of early birds who believe in the old adage about catching the worm. The only requirement for membership is two verifications from short-wave phone stations one thousand miles or more from the applicant's location, received any time after 5:00 A.M. and before 9:00 A.M. any day of the week.

Verifications sent in to the B. B. S. W. C., are returned promptly to their senders along with a certificate of membership suitable for framing. This certificate measures 8½ in. by 11½ in. and is printed on high grade paper.

We do not make any distinction between short-wave relay broadcasting stations, commercial radiophones, amateur phones, experimental stations, and ship stations. Any station that operates below 200 meters and uses voice transmission is a legitimate catch for the short-wave listener, who is interested only in the feat of reception itself and not in the musical programs, political propaganda and private conversations that fill the air. It is really much more of an accomplishment to bring in an amateur station using perhaps only ten or fifteen watts of power than a powerful broadcasting station using ten or fifteen kw.

Address your verifications and applications for membership to the Before Breakfast S. W. Club, care of SHORT WAVE RADIO, 1123 Broadway, New York, N. Y., and be sure to enclose a large stamped and addressed envelope for their safe return.

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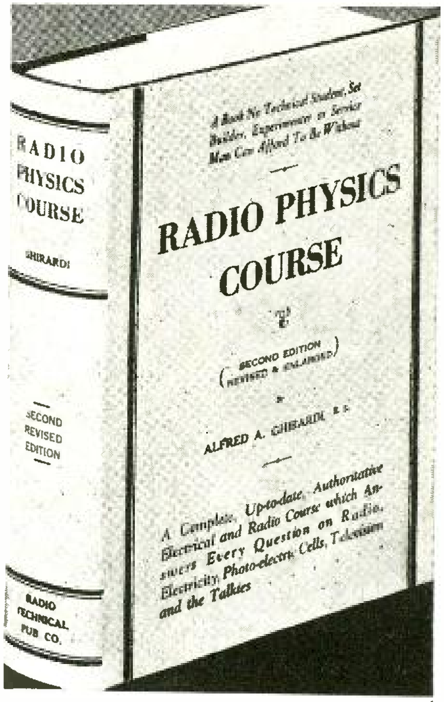

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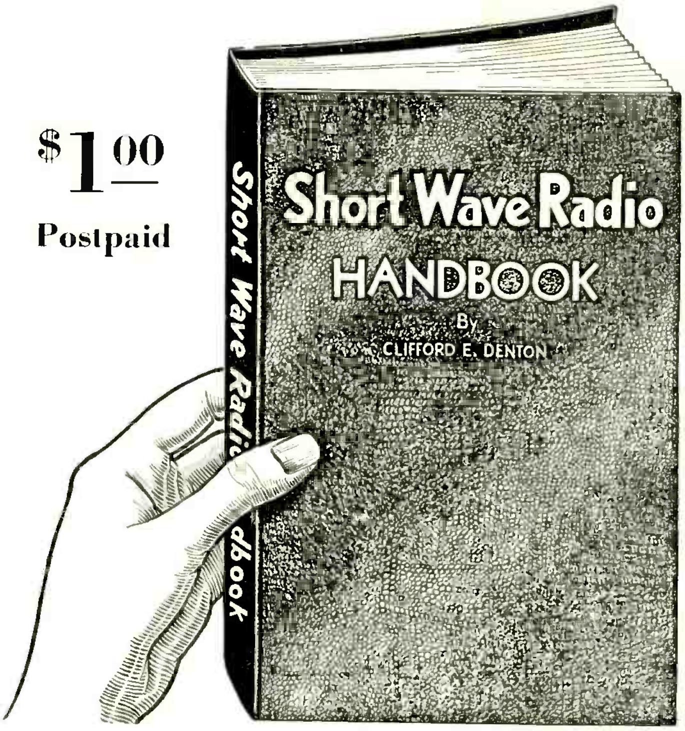

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