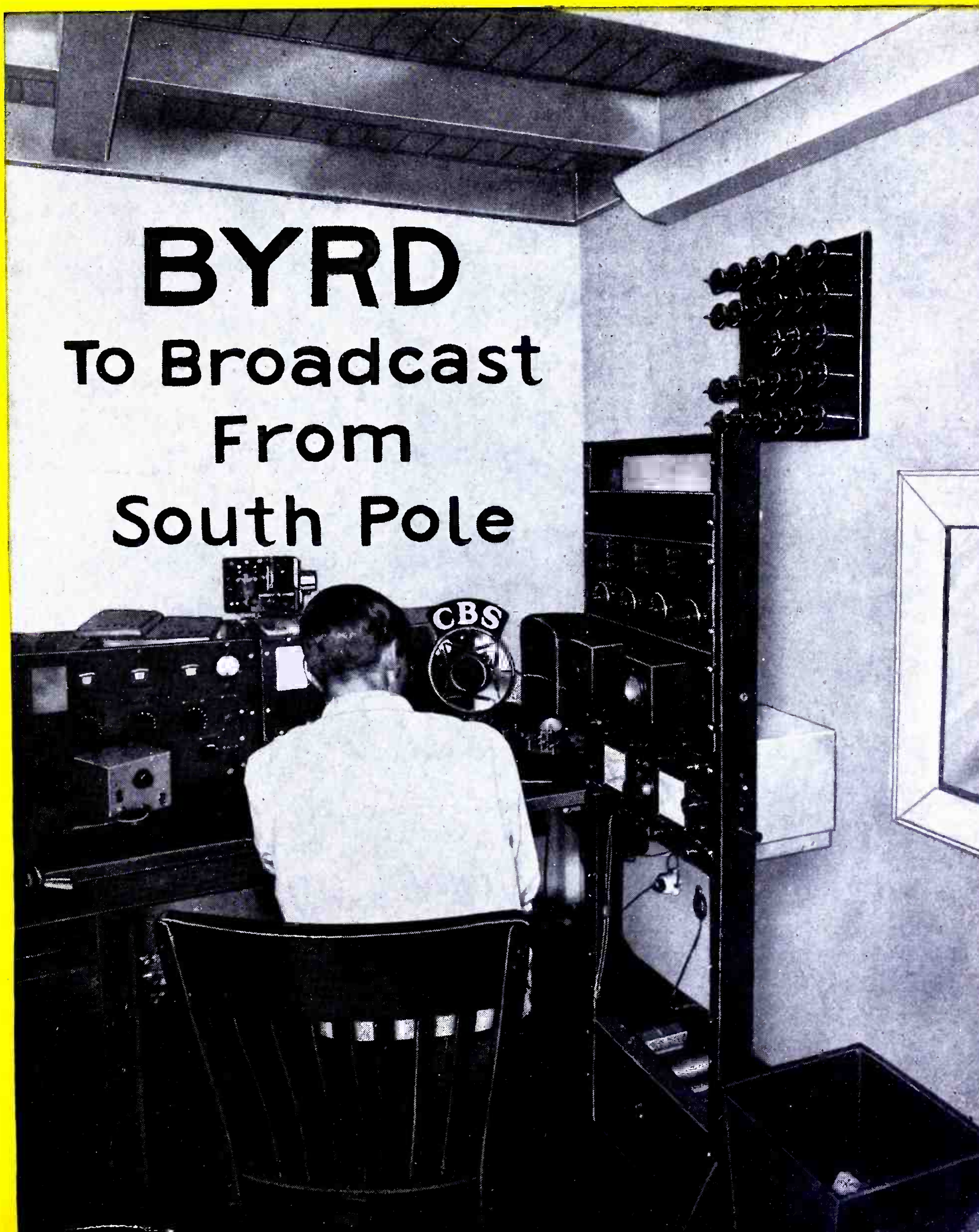
SHORT WAVE RADIO

January
1934

NRA
MEMBER
U.S.
WE DO OUR PART

Edited by
Robert Hertzberg and Louis Martin

IN THIS ISSUE:



25¢
IN CANADA 30¢

For Your Protection

THE readers of a radio magazine who support it by patronizing its advertisers are entitled to all possible protection against misrepresented merchandise, unauthorized substitutions, exaggerated claims, and delayed deliveries. Toward this end, the publishers of SHORT WAVE RADIO are accepting advertising only from firms whose business ethics and general reputations are known to be above reproach, and they are rejecting advertising from firms of doubtful or questionable standing. This means an annual loss of thousands of dollars of advertising revenue, but the protection which this policy affords both readers and advertisers more than compensates us. Furthermore, SHORT WAVE RADIO is a legitimate magazine, not a disguised house organ for a subsidiary business, and has no hidden sales or manufacturing affiliations to influence its editorial activities.

Experienced short-wave fans will recognize the advertisers in SHORT WAVE RADIO as established, well-known firms. New radio fans just getting into the highly interesting short-wave field can patronize them with the utmost confidence.

Another thing: SHORT WAVE RADIO offers no premiums or free goods in an effort to build up spurious circulation. It subscribes to the belief that a magazine should sell itself on the basis of its reading matter alone, and not on irrelevant inducements.

SHORT WAVE RADIO

I will train you at home to fill a GOOD PAY Radio Job!

Here's Proof

$50 to $75 a Week

"The National Radio Institute put me in a position to make more money than I ever made in good times. I am in the Radio service business for myself, where it is possible for me to make from $50 to $75 a week. Service work has increased because people who in normal times would buy a new Radio, now are contented to have the old one 'pepped up'."
BERNARD COSTA,
150 Franklin St.,
Brooklyn, N. Y.

Runs Successful Radio Business

"I am a member of the firm of South Grand Radio & Appliance Co., which runs a very successful business. The greater part of my success I owe to N. R. I. Without your training, I could never have been successful in Radio."
J. A. VAUGHN,
Grand Radio & App. Co.,
3107 S. Grand Blvd.,
St. Louis, Mo.

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"I am operating a 120-acre farm. Three nights a week I teach a Radio class. On the other nights I make service calls. Words cannot express my gratitude to N. R. I. Your training prepared me to earn nice sums of cash in spare time."
HOYT MOORE,
R. R. No. 3, Box 919,
Indianapolis, Ind.

If you are dissatisfied with your present job, if you are struggling along in a rut with little or no prospect of anything better than a skinny pay envelope—clip the coupon NOW. Get my big FREE book on the opportunities in Radio. Read how quickly you can learn at home in your spare time to be a Radio Expert—what good jobs my graduates have been getting—real jobs with real futures.

Free Book Tells How Mail Coupon!

Many Radio Experts Make $40, $60, $75 a Week

In less than 15 years the Radio Industry has grown from a few million to hundreds of millions of dollars in business a year. Over 300,000 jobs have been created by this growth, and thousands more will be created by its continued development. Many men and young men with the right training—the kind of training I give you through the N. R. I. method—have stepped into Radio at two and three times their former salaries.

Get Ready Now for Jobs Like These

Broadcasting stations use engineers, operators, station managers and pay up to $5,000 a year. Manufacturers continually employ testers, inspectors, foremen, engineers, servicemen, buyers, for jobs paying up to $7,500 a year. Radio operators on ships enjoy life, see the world, with board and lodging free and get good pay besides. Dealers and jobbers employ servicemen, salesmen, buyers, managers, and pay up to $100 a week. My book tells you about these and many other interesting Radio jobs.

Many Make $5, $10, $15 a Week Extra in Spare Time Almost at Once

The day you enroll with me, I send you instructions, which you should master quickly, for doing 28 Radio jobs common in most every neighborhood, for spare-time money. Throughout your training I send you information on servicing popular makes of sets. I give you the plans and ideas that have made $200 to $1,000 a year for N. R. I. men in their spare time. My course is famous as the Course that pays for itself."

Television, Short Wave, Loud Speaker Systems Included

There's opportunity for you in Radio. Its future is certain. Television, short wave, loud speaker systems, police Radio, automobile Radio, aircraft Radio—in every branch, developments and improvements are taking place. Here is a real future for thousands and thousands of men who really know Radio—men with N. R. I. training. Get the training that opens the road to good pay and success.

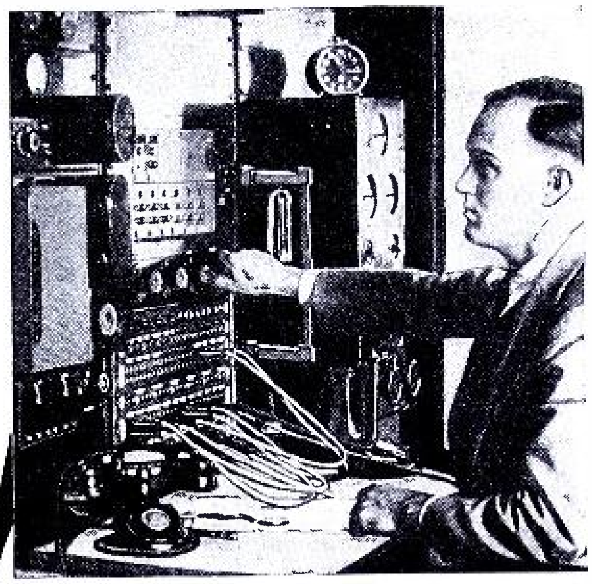
You Get a Money-Back Agreement

I am so sure that N. R. I. can train you satisfactorily that I will agree in writing to refund every penny of your tuition if you are not satisfied with my Lessons and Instruction Service upon completion.

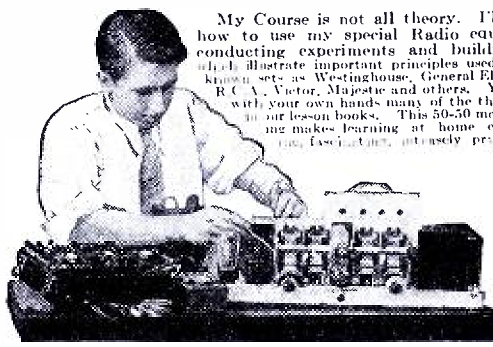
FREE 64-page Book of Facts

Get your copy today. It's free to any ambitious fellow over 15 years old. It tells you about the opportunities in Radio; about my course; what others who have taken it are doing and making. Find out what Radio offers you without the slightest obligation. ACT NOW!

J. E. SMITH, President
National Radio Institute Dept., 4 A S 8
Washington, D. C.

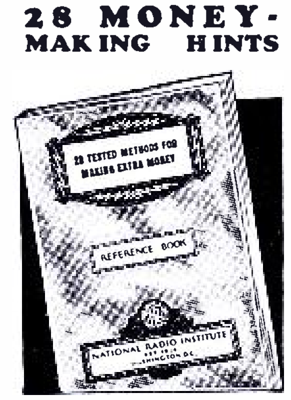


SPECIAL Radio Equipment for Broad Practical Experience *Given Without Extra Charge*



My Course is not all theory. I'll show you how to use my special Radio equipment for conducting experiments and building circuits which illustrate important principles used in such well-known sets as Westinghouse, General Electric, Philco, R C A, Victor, Majestic and others. You work out with your own hands many of the things you read in our lesson books. This 50-50 method of training makes learning at home easy, interesting, fascinating, intensely practical.

28 MONEY-MAKING HINTS FREE



Mail the coupon. I'll send you one copy of my valuable 56-page Reference Book "28 Tested Methods for Making Extra Money." I'll do it to prove that my training is easy to understand and use—that it is practical—that it is full of money-making information right from the start. This book shows you how to do 28 Radio jobs common in every neighborhood — tells you how to get these jobs. Hundreds of my students have made $5, $10, $15 a week in spare time while learning. Prove to yourself that you can do it, too. Mail coupon.

I have doubled and tripled the salaries of many. Find out about this tested way to BIGGER PAY

Get a Job with a Future

FILL OUT AND MAIL THIS COUPON TODAY

J. E. SMITH, President
National Radio Institute, Dept. 4AS8
Washington, D. C.

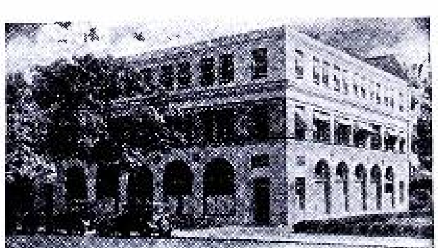
Dear Mr. Smith: I want to take advantage of your Special Free Offer. Send me your two books, "28 Tested Methods for Making Extra Money" and "Rich Rewards in Radio." This request does not obligate me. (Please print plainly)

Name .... *Age* ....

Address ....

City .... *State* .... J

Our Own Home



Pioneer and World's Largest Home-Study Radio training organization devoted entirely to training men and young men for good jobs in the Radio industry. Our growth has paralleled Radio's growth. We occupy three hundred times as much floor space now as we did when organized in 1914.

The Famous Course That Pays For Itself

January, 1934
Vol. 1, No. 3

SHORT WAVE RADIO

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

Robert Hertzberg, *Editor*

Louis Martin, B.S., *Technical Director*

General Advertising and Editorial Offices, 1123 Broadway, New York, N. Y.

IN THIS ISSUE:

IN FUTURE ISSUES:

A NEW TYPE OF SET CONSTRUCTION—Although the necessity for shielding is fully recognized by short-wave experimenters, comparatively few have the facilities or ability to cut large holes in aluminum or perform other machine operations. Realizing this situation, an enterprising manufacturer is bringing out a series of cleverly designed unit panels with a variety of holes already drilled in them. In a forthcoming issue we expect to describe a very fine receiver built around this idea—and with the coils entering from the *front* of the panel. This innovation will undoubtedly be enthusiastically received.

USING THE NEW TUBES—The characteristics and applications of many of the new tubes that deluged the radio market during the past year are still not very well understood by experimenters. We expect to run a number of authoritative articles on this subject, written in simple, understandable language.

SOLDERING THAT STAYS PUT—We thought that everyone knew how to solder, but the surprisingly large number of letters we receive on the subject indicates that many people have not been properly instructed on this very important operation. We have prepared a well illustrated article that tells just how to use the iron and its accessories in radio work.

SUPER-REGENERATION—Super-regenerative circuits are coming back into their own and are enjoying particular popularity for ultra high frequency reception. As the principles of this highly interesting and remarkable circuit are not well known, we have commissioned Mr. J. A. Worcester, well known radio writer, to tell you all about it.

A SIMPLE RADIOPHONE FOR THE BEGINNER—The present generation of new amateurs takes to the microphone rather than to the key. For the benefit of advanced short-wave broadcast listeners who want to get into the "ham" game, John B. Brennan, Jr., has prepared a whole series of articles describing the construction and operation of an inexpensive but highly effective short-wave phone transmitter.

CHARLES H. FARRELL, Advertising Manager

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Why the SCOTT ALL·WAVE *Deluxe* *Excels all Other* RADIOS

E H Scott

Pioneer designer and custom-builder of superheterodyne all-wave radio receivers of superior quality.

This receiver gives clear, loud-speaker reception from stations 10,000 miles or more distant. It covers the entire wave band between 15 and 4,000 meters.

But this is no longer a distinction. Many receivers are able to tune in, with more or less regularity, short wave stations from foreign lands. Now it is not *what* an all-wave receiver can do . . . but *how* it can do it!

All automobiles have motors, wheels, frames, fenders, etc., regardless of price. Practically all radios have the same general line-up of component parts. The factors that make for superiority in motor cars or radios are scientific precision, highest quality parts, rigid inspections and tests and careful hand workmanship by highly skilled technicians. When quantity-production demands speed and more speed there must be a sacrifice of these qualities. You can get them only in a custom-built receiver.

The SCOTT ALL-WAVE Deluxe is quality custom-built in one of the most completely and modernly-equipped radio engineering laboratories in the land. Constant and gruelling tests, both in the laboratory by scientific instruments and by reception tests carried on in various parts of the world, maintain its quality.

The ultimate result is a vastly superior instrument. It demonstrates its ability not only by startling reception of far-away foreign stations on both the broadcast and short wave bands, but by consistently finer reproduction of programs from domestic broadcasting stations. Tone fidelity in the SCOTT ALL-WAVE Deluxe convinces the ear of actuality . . . laboratory tests prove its variance from actuality undetectable by the human ear.

No claim for SCOTT superiority is made without positive supporting evidence. It will be a pleasure to furnish you with these PROOFS, its moderate price and all other information regarding this radio that has won the title of "The World's Finest Receiver." Simply mail the coupon below.

E. H. SCOTT RADIO LABORATORIES, INC.
4450 Ravenswood Ave. *Department S W 14* **Chicago, Ill.**

Performance!

After all, the supreme test performance is made in the hands of owners. Here are a few of hundreds of letters on file in our laboratories:

Venezuela and Germany in Minnesota

The following foreign stations being received at present: FYA, Pontoise; GSA, Daventry, England; EAQ, Madrid, Spain; YV1BC, Caracas, Venezuela; VK2ME, Sydney, Australia; DJB, Germany and CMCI, Cuba.

L. C. Melville,
Minneapolis, Minn.

A Real DXer Reports!

My Scott DeLuxe Allwave Receiver has certainly pulled in the stations. I have only had the set a little while and have pulled in 225 stations on the broadcast band from all over the North American Continent. I have received 86 stations on the short waves of which 62 have been foreign stations. On February 12 and 13 I received 27 foreign stations (short waves) of which nearly all were regular broadcasts with good loud speaker volume. In all I have received 20 different countries to date. The tonal qualities are the best. The sensitivity and selectivity cannot be beaten.

J. F. Luttmann,
Milltown, N. J.

Gets Sweden on West Coast

My set brings in stations other sets don't even show are in the air.
I have a log of over 750 in all states and around 15 foreign countries. On my log I have Motala, Sweden, which I think is extremely good from the West Coast.

Charles Maylone,
Placerville, Calif.

England and Spain Every Night

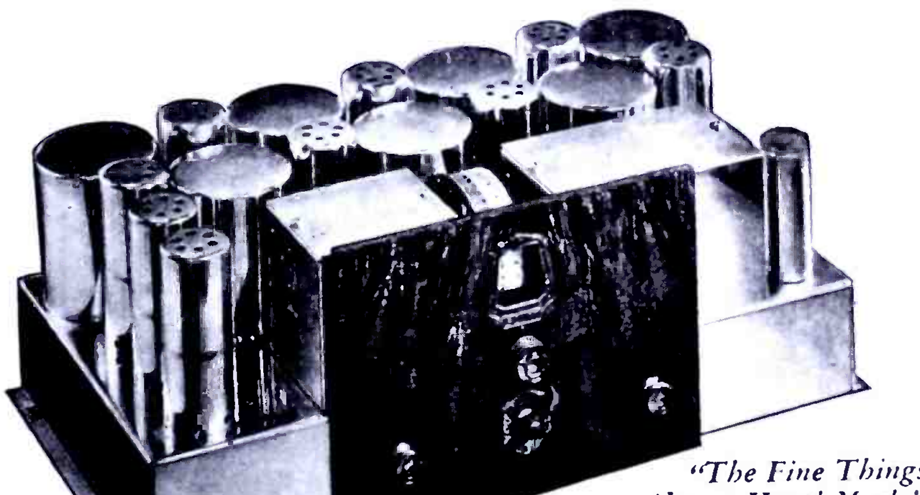
Have received both England and Spain every night for two weeks. I get them with plenty of volume.

Solomon Ford,
Toledo, Ohio.

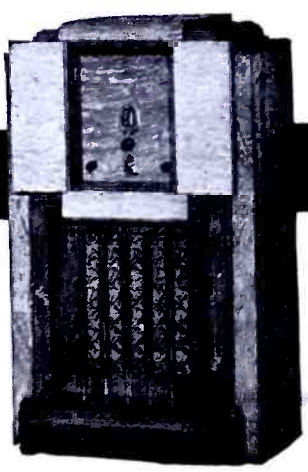
Results in Bad Location

I made it my point to try for VK3ME Australia and picked them up at 7:45 and held them to 9:00 A.M. Sunday morning April 2, 1933. I certainly am more than convinced that your receiver is the only one that I have seen that will do as you said. Also tuned in the following stations with good results, considering the cloudy and unsettled weather conditions, and my locality in which I am surrounded by all kinds of electrical machinery. The stations I have received are VK3ME, Australia; Rabat, Morocco; Pontoise, France; Germany, England, and I2RO, Italy.

Mr. Fred L. Roenbeck,
Chester, Pa.



"The Fine Things are Always Hand Made"



A super-fine receiver deserves housing in a cabinet of comparable merit. Here is one of the many distinctive and exclusive designs in consoles created for the SCOTT ALL-WAVE Deluxe. This is the Westerly Grande Model, in rare and exotic woods patterned in a theme moderne.

MAIL THIS COUPON *NOW!*

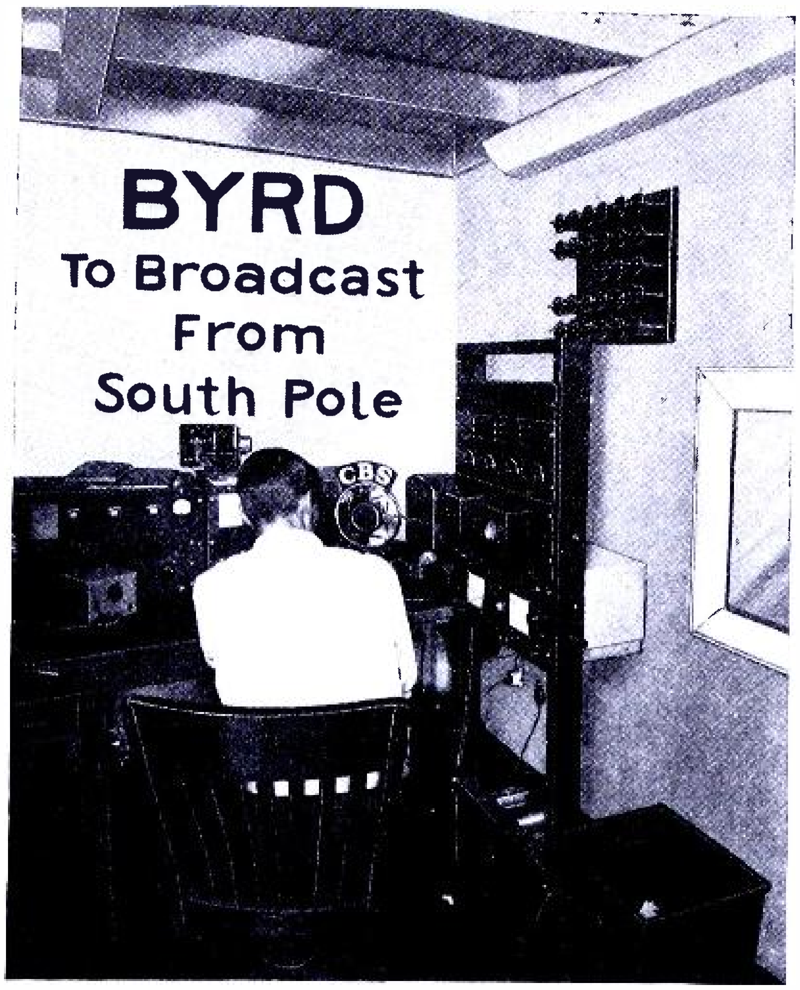
E. H. SCOTT LABORATORIES, INC.
4450 Ravenswood Ave., Dep't SW 14, Chicago, Ill.

Send me, without obligation, PROOFS of the superiority of SCOTT ALL-WAVE Deluxe performance and tone together with price and complete details regarding its laboratory-construction, etc.

Name ....

Address ....

City .... State ....



The radio room of the S.S. Jacob Ruppert, showing Operator Dyer at the control panel of KJTY, the short-wave transmitter that is being used for the Byrd broadcasts. The receiver on the lower section of the rack is a regulation National AGS.

By Robert Hertzberg

THE second Byrd Antarctic Expedition promises to provide short-wave fans everywhere with extremely interesting reception. Although, of course, the previous Arctic and Antarctic Expeditions of Byrd carried considerable radio equipment and maintained very successful contact with civilization, all this communication was accomplished by radio-telegraph, voice transmission not being employed at all. The present Expedition is noteworthy from the radio standpoint because of the very considerable use that will be made of *radio-telephone* transmitters. Whereas in previous years only amateurs or other listeners with a knowledge of the code could follow the progress of the explorers, now all short-wave fans will be able to listen in *directly* on the special transmissions from the South Polar wastes, reception conditions permitting. Special equipment has been provided by the Columbia Broadcast System for what is probably the most unusual broadcasting stunt ever attempted.

The *Jacob Ruppert*, Admiral Byrd's main supply vessel, in which he, himself, is sailing, carries very elaborate radio equipment. Many amateurs have already reported hearing the one kilowatt radio-telephone transmitter, which has the call letters KJTY. According to the October 1st, 1933, issue of the Radio Service Bulletin, issued by the Federal Radio Commission, KJTY is licensed for telephone transmission on a whole mess of frequencies. These are as follows:

6650	kilocycles	(45.11 m.)
6660	"	(45.05 m.)
6670	"	(44.98 m.)
8820	"	(34.01 m.)
8840	"	(33.94 m.)
13185	"	(22.75 m.)
13200	"	(22.68 m.)
13245	"	(22.65 m.)
13260	"	(22.62 m.)
17600	"	(17.045 m.)
17620	"	(17.026 m.)
21575	"	(13.905 m.)
21600	"	(13.889 m.)
21625	"	(13.873 m.)

Regular Weekly Broadcasts

A series of regular broadcasts from the icy wastes of Antarctica will be heard over the Columbia Broadcasting System's nation-wide network. The programs, in addition to their value as a means of keeping the civilized world in touch with the progress of this vast scientific enterprise, will gain added interest from the fact that they will be the first series ever to be broadcast from a point so far from any humanly inhabited portion of the world.

CBS Sends Announcer

A CBS engineer and a combination production man and announcer are accompanying the expedition on its two-year sojourn in the bleak South Pole territory. Although separated from network headquarters by more than 10,000 miles, both men will carry on the same duties which are the lot of engineers and production men on less remote broadcasts. They will supervise each week's program, checking voice levels, writing continuity and arranging technical details.

An elaborate technical set-up has been worked out for the Antarctic broadcasts. Great care was taken in the planning of facilities, since the broadcasts are looked forward to as being more than mere technical stunts. Valuable information of a scientific nature is expected to be sent over the air-waves from Admiral Byrd's base as new discoveries are made concerning the nature of the ice-bound Antarctic.

The broadcasting arrangements call for the use of three transmitters. One is to be a Collins 1,000-watt crystal controlled 100 per cent modulated radio-telephone transmitter installed on the supply ship of the Expedition during the trip to Little America. This will later be set up at the Expedition's permanent base, where it will operate through a directional antenna to one of the directional receiving antennas at Buenos Aires, Argentina. The signals will be relayed from there by short waves to the Columbia key station in New York, and then rebroadcast. Of course, there is no

Dr. Thomas S. McCaleb of Harvard University, radio adviser to Rear Admiral Byrd on his second Antarctic Expedition.

doubt that short-wave listeners in the United States will be able to hear many programs *direct*.

The second sending apparatus is a 200-watt crystal controlled radio-telephone transmitter located at Admiral Byrd's sub-base at the foot of the polar barrier, about three hundred miles closer to the South Pole than the main base.

A portable 100-watt short-wave radio-telephone transmitter will be installed in the bi-motor plane in which Byrd will fly across the South Pole and from which an attempt will be made to broadcast the flight while it is in progress.

Edwin K. Cohan, technical director of the Columbia Broadcasting System, worked out the arrangements with Dr. T. S. McCaleb, of Harvard University, Byrd's counsellor on radio; A. Y. Tuel, vice president of the International Telephone and Telegraph Corporation; Harry Young, of Western Electric; William Thompson, of the American Telephone and Telegraph Corporation; and S. H. Simpson of the Radio Corporation of America.

Rear Admiral Richard E. Byrd, photographed in Norfolk, Va., on the occasion of his last broadcast on American soil. His talk was carried over the Columbia Broadcasting System network.

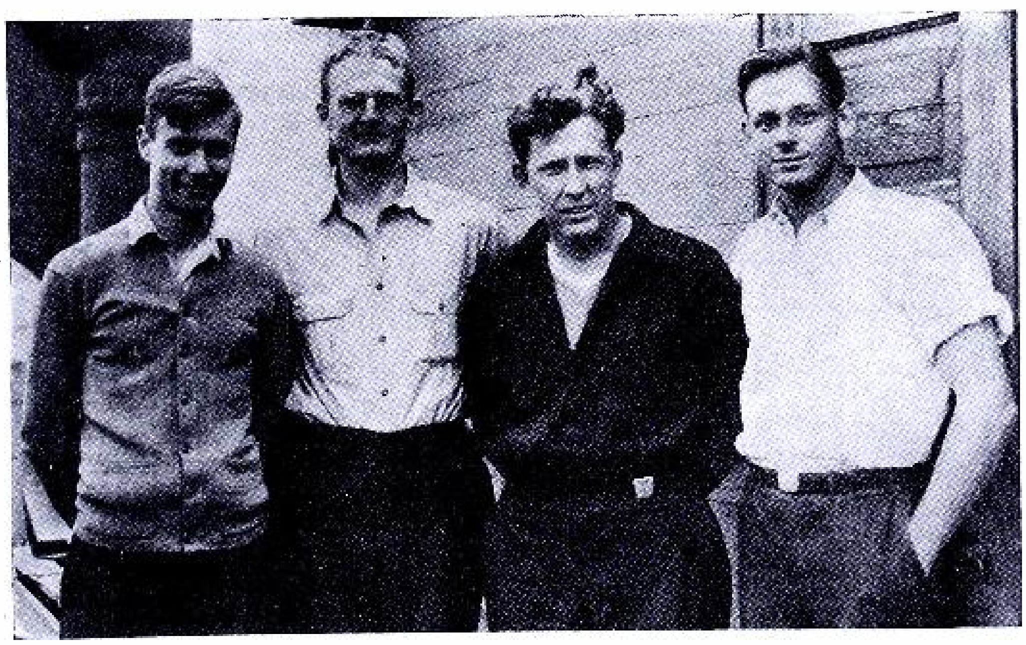
5000 Pounds of Equipment

Five thousand pounds of broadcasting equipment were loaded on board the *S.S. Jacob Ruppert*, flagship of the Second Byrd Antarctic Expedition. Five miles of wire, 9000 feet of it for antennas alone; 300 tubes for transmitting and receiving apparatus; three major transmitting units; ninety-foot wooden poles for antenna structure; dozens of microphones of various types, and power generators are among the items making up the broadcasting cargo.

The heaviest single item of the broadcasting equipment is a 1000-pound gas-driven generator. On the way down to Little America this device will not be employed, but once the ice-party is settled on the Ross Barrier, it will be the only reliable source of electrical energy. This generator will have to be transferred from the *Ruppert* to the *S.S. Bear*, the ice-breaker, at sea at a point just outside of the ice-pack.

Charles J. V. Murphy, newspaperman, author, and radio announcer, has been chosen as production manager and announcer of the weekly programs to be broadcast from the base of the Byrd Antarctic Expedition in Little America over the Columbia Broadcasting System's nationwide network.

As station manager of the most remote unit of any network, Murphy's duties will consist of preparing scripts, introducing speakers or any of the Expedition's potential amateur talent, arranging special programs and coaching all in microphone technique.



The radio men aboard the S.S. Jacob Ruppert. Left to right: John N. Dyer, CBS engineer; Stanley Pierce, operator; Clay Bailey, chief operator, and Guy Hutcheson, operator.

Murphy is a native of Boston and a close friend of Rear Admiral Byrd. He is 29 years old and attended Harvard.

John Newton Dyer, of the Columbia Broadcasting System's field engineering department, has been chosen to accompany the Byrd Expedition as technical supervisor of the program series to be broadcast from Little America over the CBS network. In addition to his broadcasting duties, the engineer will also be in complete charge of all Admiral Byrd's communication facilities.

Dyer is 23 and a resident of Haverhill, Massachusetts. He is six feet tall and passed the physical examination, to which all who are going on the expedition are subjected, with a rating of 98.2 per cent.

Among the qualities for which Dyer was selected is his wide knowledge of short-wave transmission, especially in connection with directional work. He studied radio engineering, among other courses, at Massachusetts Institute of Technology, and graduated with a B.S. degree in 1931. He did post-graduate work there for two years. He is well known in New England amateur radio circles as W1BJD.

Special W2XAF Programs

From the short-wave transmitting station of the General Electric Company at Schenectady, N. Y., W2XAF, special radio programs will be sent to Rear Admiral Richard E. Byrd's base on the Bay of Whales. This is one of the stations that continually "talked" to Byrd and his men during their previous Antarctic expedition, from 1928 to 1930, and it is the station which they picked up more frequently than any other. The station sends on a wavelength of 31.48 meters. It is still equipped with the directional antenna successfully employed in the broadcasts to the earlier Byrd expedition. This antenna was designed by Dr. E. F. W. Alexanderson, radio consulting engineer of the General Electric Company. Its effect is to increase the signal volume in one direction about twenty times. The normal power of this station is 20 kilowatts. During the previous expedition Admiral Byrd heard every program which W2XAF sent out.

Saturday nights from 11 to 12 o'clock (E.S.T.) will again be the time when the radio programs will be transmitted in the direction of the South Pole for the Byrd expedition to pick up. These programs may start even before the expedition reaches Little America. It is planned to inaugurate the series as soon as Byrd's second ship, the *Jacob Ruppert*, clears from the Panama Canal.

The hour from 11 to 12 o'clock will consist of radio entertainment. After 12 o'clock the station will read letters addressed to members of the expedition from relatives and friends. This "radio mail" will be the only mail service which the expedition will possess. It is also planned to invite, on occasion, relatives and friends to talk before the microphone. The entertainment programs will originate not only at Schenectady but also in various centers of the east, such as Boston, New York, Washington, Richmond, Va. (Byrd's home city), Albany, Rochester, and other points.

Standard Equipment Taken

One of the odd things about the radio equipment is that all the fixed receivers and transmitters will be entirely a.c. operated, the aforementioned gas-driven generator supplying all the necessary "juice."

Some widely published and misleading advertising notwithstanding, all the short-wave communication receivers taken on the expedition are standard National units. Included in the lot are two each of the AGS, FB7 and SW-58 models, and a number of SW-3's for use in the expedition's planes. The plane transmitters are all Western Electric. For the sled parties, Harvey transceivers, tiny combination transmitter-receivers working on the ultra-high frequencies, will be used. A Hammarlund broadcast receiver is also being taken.

Marconi Believes Broadcasts from Antarctic Feasible

The proposed series of broadcasts from the Little America base of the Byrd Antarctic Expedition are entirely feasible, Senatore Guglielmo Marconi informed Edwin K. Cohan, technical director of the Columbia Broadcasting System, in an interview at the Hotel Ritz-Carlton, New York, during September. At the same time, Senatore Marconi accepted membership on an honorary advisory committee on radio for the expedition.

Marconi, after discussing the frequencies to be used in the broadcasts and the radio equipment to be taken to the Antarctic, told Cohan:

"I think the project is entirely feasible and the manner of carrying it out is very sound."

Learning that the frequencies to be used range from the eight to the twenty-three megacycle band, Marconi pointed out that it is possible for signals transmitted in the twenty-three megacycle end of the spectrum to be heard around the world, and that, therefore, it may be possible some time during the expedition's stay in the Antarctic to transmit voice direct to New York, instead of relaying it through a short-wave station at Buenos Aires, as will be done with their weekly broadcasts.

Marconi signified his interest in the outcome of the broadcasts by saying he will establish a listening post either aboard his yacht *Elettra*, or somewhere in Italy to keep in touch with transmission from Little America. Cohan offered to collate all technical data accumulated during the period of the broadcasts, and Marconi, in turn, said he would be glad to supply Cohan with his findings in connection with the work.

Dressed for the Job

Charles J. V. Murphy, CBS announcer and continuity writer, who will stage the weekly Byrd broadcasts from Little America.

A High-Gain Resistance Coupled A. F. Amplifier

THE 37, 56, 57 and 77 type tubes may be operated as resistance-coupled amplifiers with high plate-supply voltages, of the order of 500 volts, to provide high audio input voltage for the operation of large power output tubes.

In the design of power amplifiers, the tubes, the coupling devices, and the operating voltages to obtain the highest output levels with the least amount of distortion must be carefully selected.

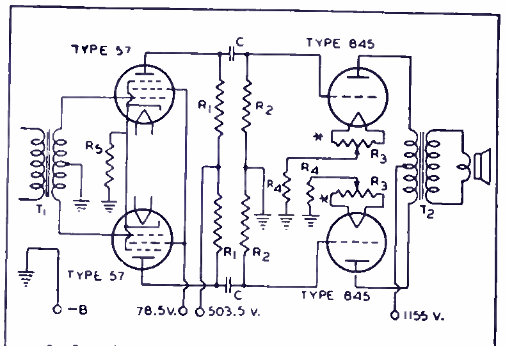
For representative tubes operated with a plate supply of 500 volts, a plate load of 250,000 ohms, and a grid leak of 500,000 ohms for the following tube, the voltages developed across the a.c. load of 167,000 ohms are:

TABLE I

Tube Type	Grid-Bias Volts	Screen Volts	Peak-Output Volts	Distortion Per Cent
37	—22.5	..	172	3.5
56	—16.0	..	180	5.9
57	— 3.5	92	180	5.0
57	— 3.5	90	200	7.0
77	— 4.5	100	200	9.5

From the standpoint of distortion, the 37 is the most satisfactory. The 37, however, requires 6.5 times as great an input voltage as the 57 to yield the same output. From the standpoint of gain, therefore, the 57 is to be preferred to the 37.

An excellent output tube for providing very large audio output of high quality is the 845. This tube, operated as a self-biased audio amplifier with a peak-input voltage of 150 volts, is capable of an a.f. output of 21 watts. Any of the tubes shown in the table (the 37, 56, 57, and 77) can be used to provide the necessary grid excitation for the 845.



C = 0.1 μf
R1 = 250000 OHMS
R2 = 500000 OHMS
R3 = 20-40 OHMS
R4 = 2380 OHMS. SELF-BIASING RESISTOR FOR EACH 845
R5 = 1400 OHMS. SELF-BIASING RESISTOR FOR 57'S
T1 = INPUT TRANSFORMER
T2 = OUTPUT TRANSFORMER

* SEPARATE WINDING ON POWER TRANSFORMER FOR EACH 845 FILAMENT
NOTE: R4 PROVIDES 155 VOLTS BIAS FOR EACH 845
R5 PROVIDES 3.5 VOLTS BIAS FOR 57'S

From the plate characteristics of the 57 and 77, one might expect that low distortion at high output voltages would be obtained from these tubes when the plate supply is 500 volts, plate load is 250,000 ohms, and grid resistor is 500,000 ohms for following tube. However, distortion increases rapidly with output at high plate-supply voltages and, although large outputs can be obtained, they may not be sufficiently free from distortion. This relationship is indicated in Table I. Distortion, incidentally, is somewhat critically dependent upon screen voltage.

Operation of any of these tubes in push-pull will provide greater output at lower percentages of distortion. The accompanying tabulation shows self-biased push-pull operation for pairs of the same tubes as in Table I with the same conditions, i.e., plate supply voltage of 500 volts with plate and a.c. loads of 250,000 and 167,000 ohms respectively per tube. Screen voltage is given for minimum distortion.

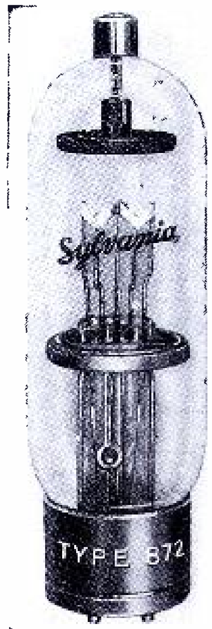
Considering both output voltage and distortion, the 57 provides the most satisfactory performance.

(*Continued on page 40*)

Graphite Anode Transmitting Tubes

SUMMARY: *The use of graphite as material for plates of high power tubes has long been a dream of tube engineers. Graphite, when pure, allows greater heat dissipation, more uniform characteristics, and freedom from secondary emission effects which ordinarily hamper tube operation.*

In the discussion below, Mr. Replogle gives some interesting data regarding the construction and operation of graphite anode tubes used for transmitting, although the same principles apply to receiving tubes as well.



A "graphite" 872.

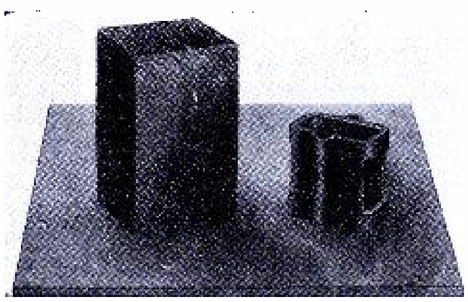
By D. E. Replogle *

BECAUSE short-wave radio, particularly ultra-short-wave radio, stands for utmost precision, the graphite anode transmitting tube must prove of more than ordinary interest to radio amateurs. Here is a tube development which, in the opinion of many familiar with the history of transmitting tube engineering, is comparable with the introduction of the thoriated tungsten filament several years ago. In matters of greater heat dissipation or ability to withstand heavy overloads, the prevention of primary and secondary grid emission, the elimination of troublesome leakage within the tube, the positive clean-up of gases during production, and a continued getter action during an exceptionally long life, and, what is of cardinal importance, the rigid maintenance of tube characteristics at all times because of a non-warping anode—these and other features attach particular significance to the graphite anode transmitting tube in short-wave work.

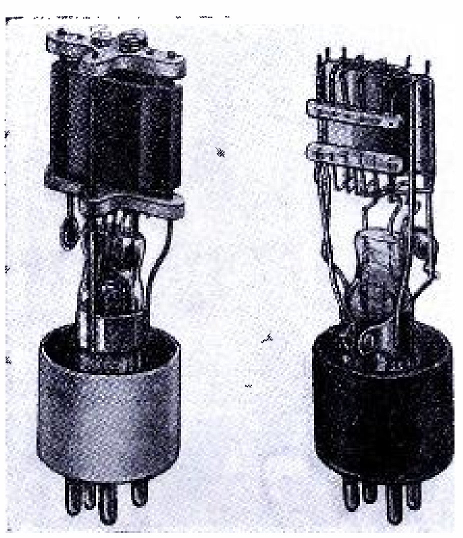
What Is a Graphite Anode?

It may be well to explain what a graphite anode is, and then proceed to an analysis of its actual worth in short-wave transmission. By a graphite anode is meant a one-piece anode or plate of pure carbon. There are several theoretical reasons why carbon—this term being used here to indicate the unrefined form, as distinguished from the pure form termed graphite—should be considered for the anode or plate of transmitting tubes. First and foremost is the fact that carbon quite closely approaches the perfect black body which is the ideal heat radiator. Tube makers have long sought to take advantage of carbon. Carbonized plates, or metal plates coated with graphite, have been employed in large and small tubes alike with some success, but could hardly be considered as carbon plates because of the retention of a metal base or support for the thin coating.

Also, there have been carbon plates or anodes of solid carbon, usually made up of several sections, or segments. These carbon plates have generally failed to realize the theoretical advantages of the carbon anode. To begin with, the use of several sections, or segments, has introduced high contact resistance within the plate itself. Again, the usual commercial carbon contains a binder, hydro-carbons and other impurities, as well as sheds its amorphous carbon, or a loose surface layer. The practice has been to mount the carbon anode and seal it in the tube, followed by bombardment and exhaust. Under bombardment, commercial carbon gives off its impurities, as well as sheds its amorphous carbon or loose surface layer. One result is a deposit of carbon dust on the inside of the glass bulb, actually cutting down heat radiation and consequently defeating the very purpose of the carbon anode. Another result is the spattering of loose carbon and impurities on the glass press, the spacers and other insulating parts of the tube, causing troublesome leakage at the high potentials impressed on transmitting tubes. Still another result is incomplete gas cleanup, perhaps not so obvious during production, but certainly noticeable after the tube has been in use for some time. The impurities in the carbon are bound to be distilled or boiled out during the heat of actual operation.



Left, a block of amorphous carbon before machining; right, the plate after machining.



Left, the stem mount of a new 210; right, the stem mount of an old type 210 tube.

History of the Graphite Anode

When we first contemplated the use of carbon anodes in our tubes as a justification for an entirely new line of tubes at this rather late date, we were not unmindful of the many technical difficulties in the way of successful realization. It was decided from the start that the anode or plate would have to be in one piece, and that the commercial carbon stock would have to be purified, or reduced to graphite, prior to mounting in the tube.

The task of evolving a pure carbon or graphite anode was assigned to our assistant chief engineer, Victor O. Allen, who has long specialized in filaments, oxide coatings, getters, and other phases of tube chemistry. The research began shortly before March, 1933. Already conversant with the chemical factors involved, it was not long before Mr. Allen announced a unique process for refining commercial carbon. Experimental tubes were built and tested. His claim of a pure carbon, or graphite, was borne out by performance and accelerated life tests. Soon tubes were in production, employing graphite anodes in place of the former nickel or molybdenum plates. One type after another was redesigned for the graphite anode.

The graphite anode begins with a solid block of commercial carbon. This is machined to the ultimate size and shape with a precision of one one-thousandth of an inch tolerance. The finished anode, with its excavated center, thin walls, reinforcement, mounting fins, and long holes, is then chemically treated to remove the binder, hydro-carbons, and amorphous carbon. The resulting graphite anode is then mounted in the tube assembly by means of screws and nuts and rods, in a rigid manner, yet with noticeably less metal support than it required when using metal plates which must be

(*Continued on page* 40)

* Chief Engineer, Electronics Dept., Hygrade Sylvania Corporation.

The "Hg-7"-A Super

By L. van der Mel

SUMMARY: *Here is a complete description of a modern superheterodyne with a really novel coil-changing arrangement. This arrangement permits plug-in efficiency without changing individual coils.*

It uses seven tubes, has a.v.c., a pre-selector stage, single dial control, and a host of other new details which should make this set the last word in short-wave receiver design.

THE usual procedure for a person interested in radio is to start constructing simple receivers and then gradually promote himself to the more complex types. During the course of this promotion, he gains a certain critical viewpoint regarding what a radio set should or should not do, and no receiver which, in his opinion, does not satisfy his personal requirements is a good one. Only too often have authors expounded their theories as to why *their* sets are the last word in radio; but it seems to the writer that not a few of these authors entirely underestimate the intelligence of the average set-builder. During the author's fifteen years of experience in radio, he has seen many a set-builder unknowingly make a receiver work, which, even during the loftiest peaks of the designer's imagination, could produce nothing but a wide variety of tube noise. In fact, I dare say that our experimental psychologists would do well to use some of our present schematic diagrams as intelligence tests. The results, I am sure, would be surprising.

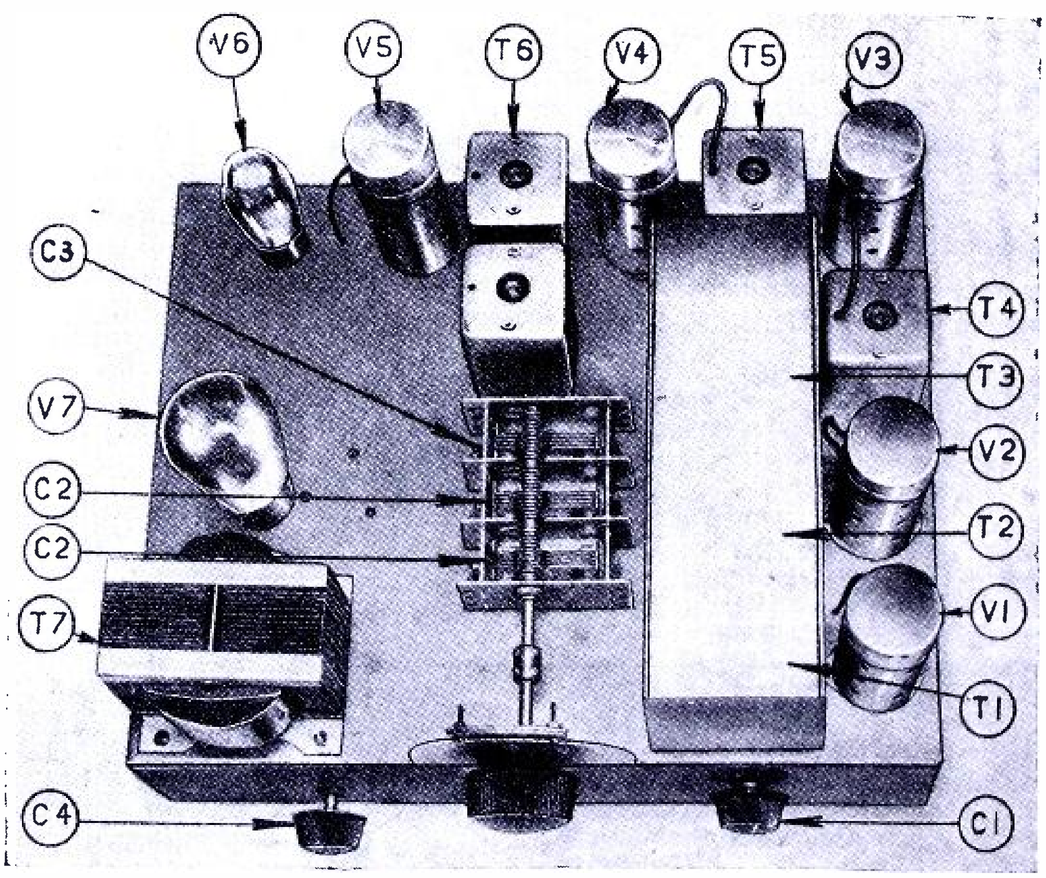
The receiver to be described was designed for the man with some knowledge of radio, preferably with superheterodyne experience. I don't maintain that anyone with a screwdriver, a pair of pliers, and a lot of nerve can assemble this receiver in twenty minutes and hear China ten minutes later; I do maintain, though, that with the proper attention to details and with the proper apparatus, this receiver will satisfy the most critical listener.

The receiver is modern in every respect. It contains all of the improvements that the author has found necessary for good reception; it does not contain any unnecessary complications that would not improve performance, but that would only be good sales talk. I am trying to explain that this set contains no mysterious gadgets, but is a straightforward, well designed superheterodyne using six tubes and a rectifier, gives excellent quality and has more than enough sensitivity for the comfortable reception of most foreign programs. By "comfortable" I mean enough volume for a listener to really sit back and enjoy the foreign programs with volume to spare. With this preliminary qualitative description over, let us turn to a more quantitative consideration of the receiver.

Electrical Characteristics

Study the schematic circuit and the photographs until you have a general idea as to the placement of parts and the symbols used to designate the main units. You will notice, first off, that the antenna is inductively coupled to a preselector r.f. stage using a type 78 tube. This tube, while it is of the variable mu type, was selected for two reasons: first, because of its variable mu characteristics it is not very critical as to grid bias, so that slight variations in the value of its bias will not cause this tube to detect and defeat its very purpose—to increase selectivity; second, it has a high amplification factor, higher, in fact, than any other similar amplifier tube.

The output of the first r.f. tube, V1, feeds into a 6A7 combination oscillator and first detector. This tube was selected, not only because it has a higher translation gain (ratio of i.f. voltage output to r.f. voltage input) than any other detector tube, but because it obviates the necessity of using a separate oscillator. I don't believe that any saving in cost is effected by the use of the 6A7 over the cost of a sep-



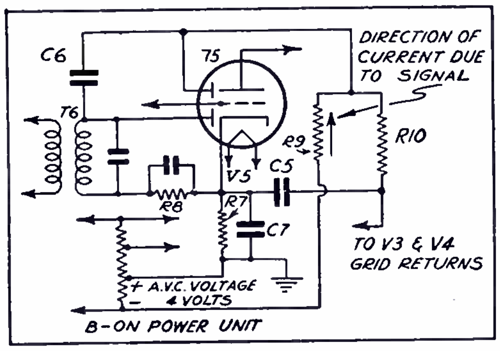
TOP VIEW OF THE "Hg-7" WITH ALL PARTS LABELED
The transformer in front of T6 is for c.w. reception.

arate oscillator and first detector, but the increase in efficiency certainly justifies the use of this tube.

The output of the 6A7, which is i.f., feeds into V3, the first i.f. stage, which, in turn, feeds into a second i.f. stage and, finally, into the second detector. This second detector uses a type 75 duo-diode triode. This tube performs three separate and distinct functions: first, it rectifies the incoming signal using one of the diode plates; second, it provides delayed automatic volume control by virtue of its second diode plate; and third, it amplifies the a.f. output and resistance-couples it to a type 41 output tube.

The power unit is very conventional and needs no further comment. The voltages at the important points along the bleeder resistor are specified in the diagram. These voltages, however, are only approximate, and may vary 5 volts at the highest point, about 3 volts at the intermediate point, and about a one-half volt at the lowest point. These voltages are measured with respect to the B— end of the power unit, which is *not* at chassis potential.

The sensitivity of this receiver was measured by the writer using a standard signal generator and was found to have a sensitivity of 3 microvolts absolute, or ¾ microvolt per meter, at 30 meters, and a sensitivity of 1 microvolt absolute, or ¼ microvolt per meter, at 60 meters. Those familiar with sensitivities will find that these figures are more than satisfactory.

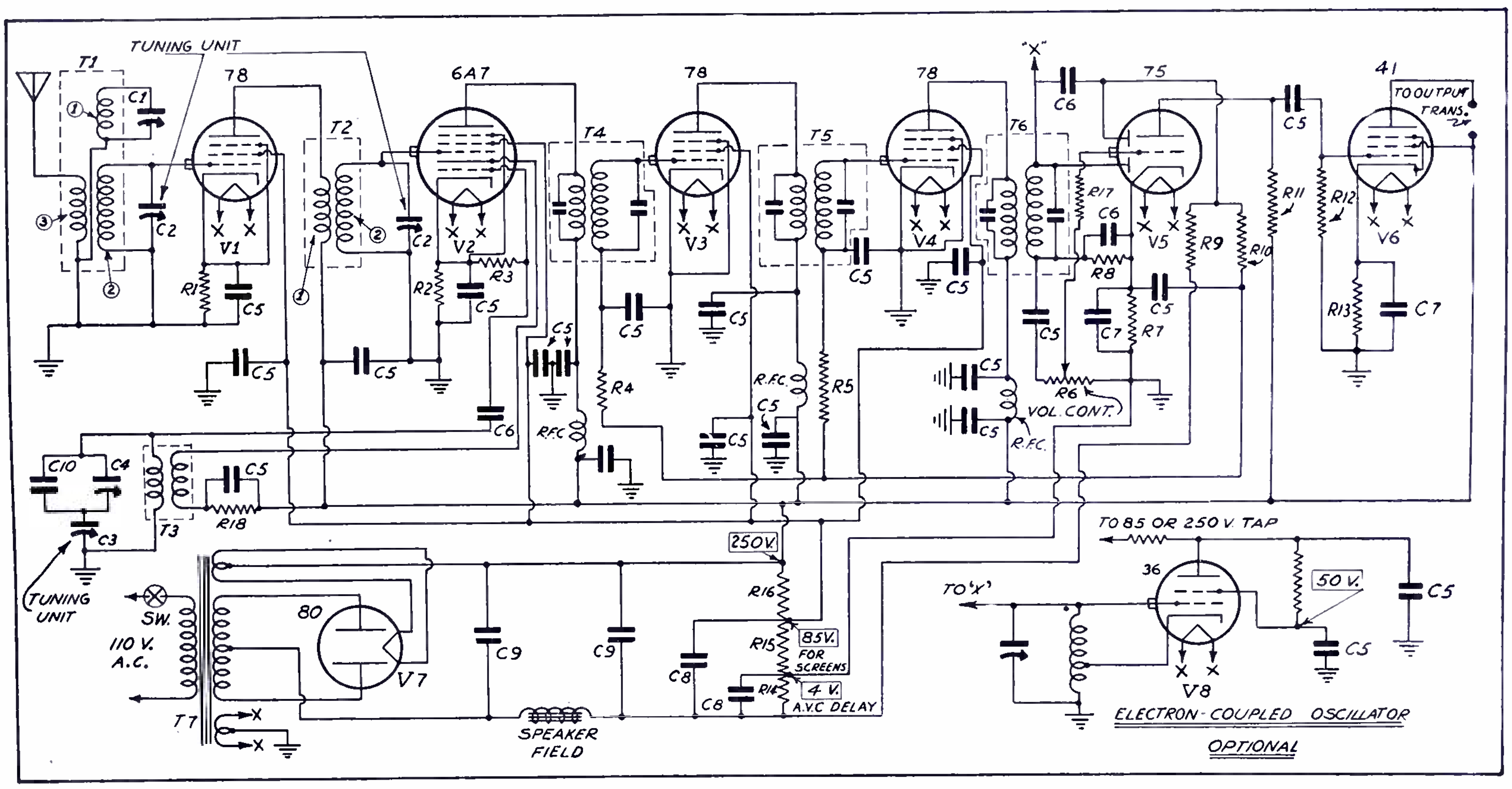


DETAILS OF THE A.V.C. CIRCUIT

Detailed schematic of the a.v.c. circuit, showing how delayed a.v.c. is obtained.

The Delayed A.V.C. System

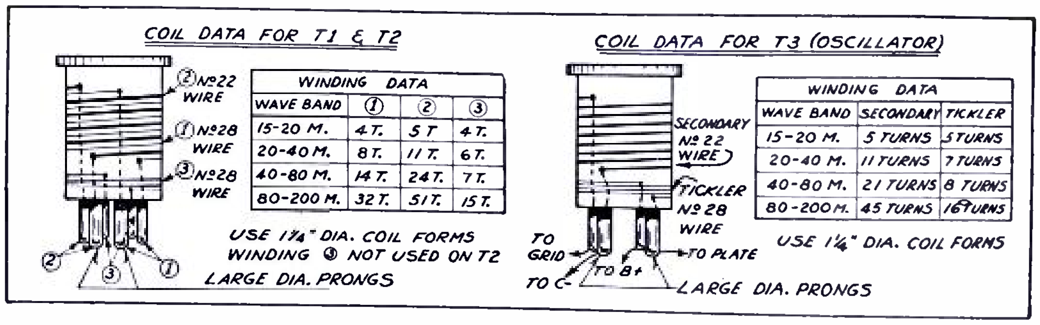
In one of the preceding paragraphs I mentioned that the chassis is not connected directly to the B— end of the power unit. The reason for this becomes apparent when the A.V.C. system is considered. Refer to the detailed schematic of this system. It will be seen that the left diode plate is used for rectification and produces a voltage across resistor R8, which is audio. This voltage is applied through a coupling condenser to the grid of its triode section, and volume is controlled by means of potentiometer R6. The right-hand diode plate connects to two resistors, R9 and R10. One end of R9 connects to the low point of the bleeder resistor, while the corresponding end of R10 supplies C bias to tubes V3 and V4. Note, also, that a small fixed condenser having a capacity of .00025 mf. and designated C6 is connected directly across the two diode plates. It should also be noticed that the cathodes of V3 and V4 connect directly to ground.



COMPLETE SCHEMATIC CIRCUIT OF THE "Hg-7" AND LIST OF PARTS FOR IT

C1—35 mf. variable condenser, Hammarlund Midline.
C2, C3—three gang 140 mmf. tuning condenser, General Instrument type 1450, counterclockwise rotation.
C4—100 mmf. Hammarlund variable condenser, S.L.C.
C5—.01 mf. fixed condensers, Aerovox, twenty-one required (twenty-three required with local oscillator for A.V.C.).
C6—.00025 mf. fixed condensers, Aerovox, three required.
C7—25 mf. tubular electrolytic condensers, 25-volt rating, two required.
C8—4 mf. metal-cased condensers, Flechtheim, 200-volt rating, two required.
C9—8 mf. electrolytic condensers, Aerovox, 600-volt rating, two required, insulated type.
C10—.003 mf. fixed condenser, Aerovox.
R1—350-ohm, ½-watt resistor, Lynch.
R2—300-ohm ½-watt resistor, Lynch.
R3—50,000-ohm resistor. 1 watt, Lynch.
R4, R5, R10, R11, R17—.1-megohm resistors.
R6—.5-megohm potentiometer and line switch, Frost.
R7—2500-ohm resistor, 1 watt.
R8, R9, R12—.5-megohm resistors.
R13—600-ohm resistor, 1 watt.
R14—50-ohm, 5-watt resistor, Acratest.
R15, R16—10,000-ohm 5-watt resistors, Acratest.
T1, T2, T3—coils as specified in the article, Mercury.
T4, T5, T6—465 kc. i.f. transformers, Meissner, Litz wound.
T7—power transformer: high-voltage secondary, 850 volts with center tap to supply 100 ma. d.c.; one 5-volt, 3 ampere filament winding for 80 rectifier; one 6.3-volt, 3 ampere filament winding for remainder of tubes, Mercury.
9—six-prong sockets for antenna coil, first-detector coil, for tubes V1, V3, V4, V5, and V6, and two for the coil shields without contacts on them.
4—four-prong sockets for the oscillator coil, speaker plug, for V-7, and for oscillator coil in shield can.
1—seven-prong socket for the 6A7 tube.
1—spot welded steel chassis as specified in mechanical drawing, also four coil shields, Mercury.
3—2 millihenry r.f. chokes.
1—power cord and a.c. plug.
1—dial and cabinet (a National vernier dial was used on the model shown).
7—Sylvania tubes: 1—80; 1—41; 1—75; 1—6A7; and 3—78.
5—tube shields.

Now, with no signal applied, the voltage of the A.V.C. diode is —5 volts with respect to ground, 4 volts due to the bleeder resistor and 1 volt due to resistor R7, which supplies grid bias for the triode section. This plate, therefore, cannot draw current, since it is negative with respect to the cathode. The potential on the grids of the two i.f. tubes equals 4 volts, since the grid return leads travel through R10, R9, and the 4-volt section of the bleeder to ground. There is no voltage loss in R9 and R10 simply because there is no current flowing through them with no signal. Now, when the carrier voltage of a station reaching the detector is strong enough so that the voltage across C6 (connected between the two diode plates) is greater than 5 volts, the right-hand diode plate starts to draw current because, by virtue of the signal, it begins to become positive. The only place from which this current can be obtained is the bleeder circuit, so that current starts to flow through R9 in the direction indicated by the arrow. This results in one end of resistor R9 becoming negative because of the signal. This negative voltage is carried through R10 to the grid circuits of the i.f. tubes. Hence, the bias on these i.f. tubes increases and decreases in direct proportion to the signal strength, since the diode rectifier is a linear rectifier. This increase in bias lowers the sensitivity of the receiver, and it is in this manner that A.V.C. is obtained. The 5 volts constitutes the delay section of the A.V.C. In plain English, the A.V.C. system is delayed until the carrier voltage causes the A.V.C. plate to become positive before A.V.C. action starts.



COIL DATA FOR T1, T2, AND T3 FOR THE "Hg-7"

This system has proved very effective in operation, and we found no necessity to amplify this A.V.C. voltage. A further increase in A.V.C. action would only tend to reduce the sensitivity of the receiver to a point where noise would have sufficient magnitude to lower the sensitivity and blanket the signal entirely.

The Oscillator Padding Circuit

One of the major problems in designing a short-wave superheterodyne is obtaining and maintaining the proper i.f. It is not sufficient to merely remove turns from the oscillator coils in order to secure the i.f. of 465 kc.; this i.f. must be maintained over the entire short-wave band. For this reason, the padding circuit composed of C4 and C10 is used; the main oscillator tuning unit is C3. C4 is a variable 100 mmf. condenser, which is tunable from the front panel. When the coils are properly adjusted, the i.f. may easily be maintained constant, and any slight misadjustments compensated by varying C4.

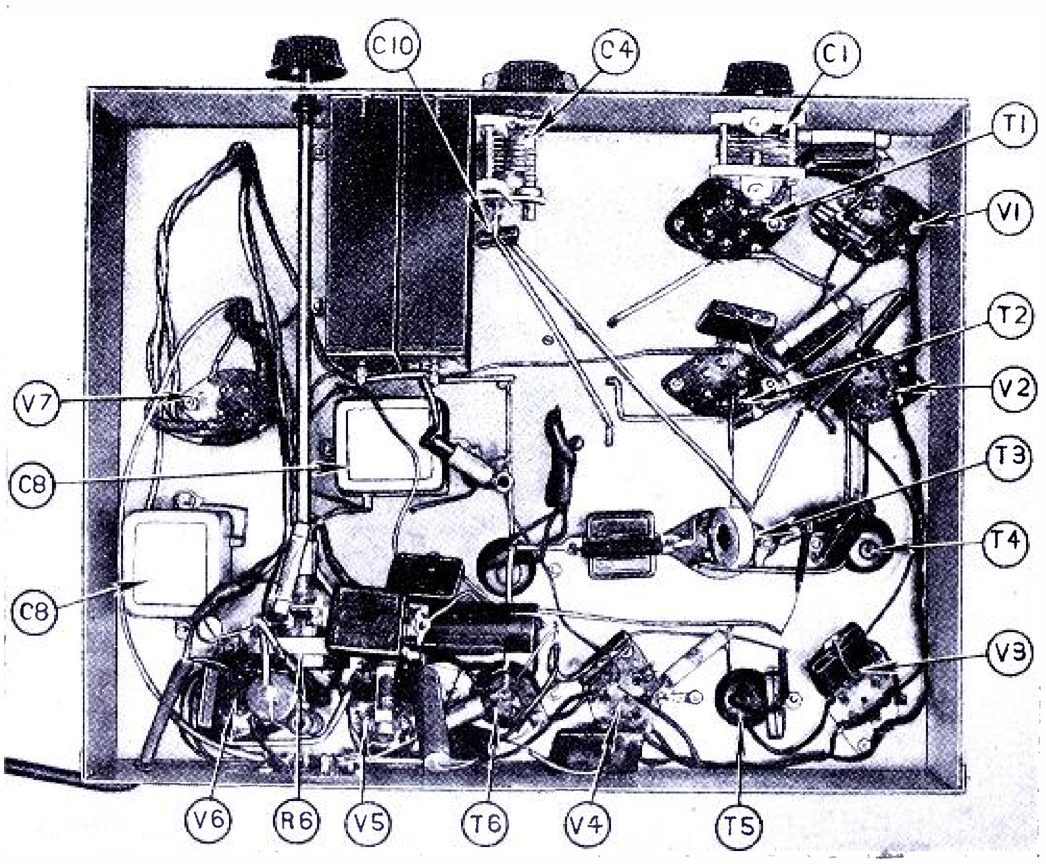
The coils used in this receiver may easily be wound at home in accordance with the data given in a separate sketch. The antenna transformer, T1, uses 3 coils: a primary, a secondary, and a third winding across which is connected a 35 mmf. condenser, C1. This coil is wound on a six-prong form and has its coils numbered 1, 2 and 3, respectively. Coil 2 is the secondary. Coil 1 is an interwound primary having the condenser C1 shunted across it. Coil 3 is wound near the base of the form and connects to the antenna and ground.

Transformer T2, although it has but two coils, is also wound on a six-prong form. The reason for this becomes apparent when one attempts to buy coils for use in this set. For some unaccountable reason, four-prong coils are not made with high impedance primaries suitable for use with type 78 tubes. To obtain such primaries, it is necessary to buy six-prong coils, and since the third winding on these coils is unused in this part of the circuit, we have the anomalous condition of a two-winding transformer on a six-prong form.

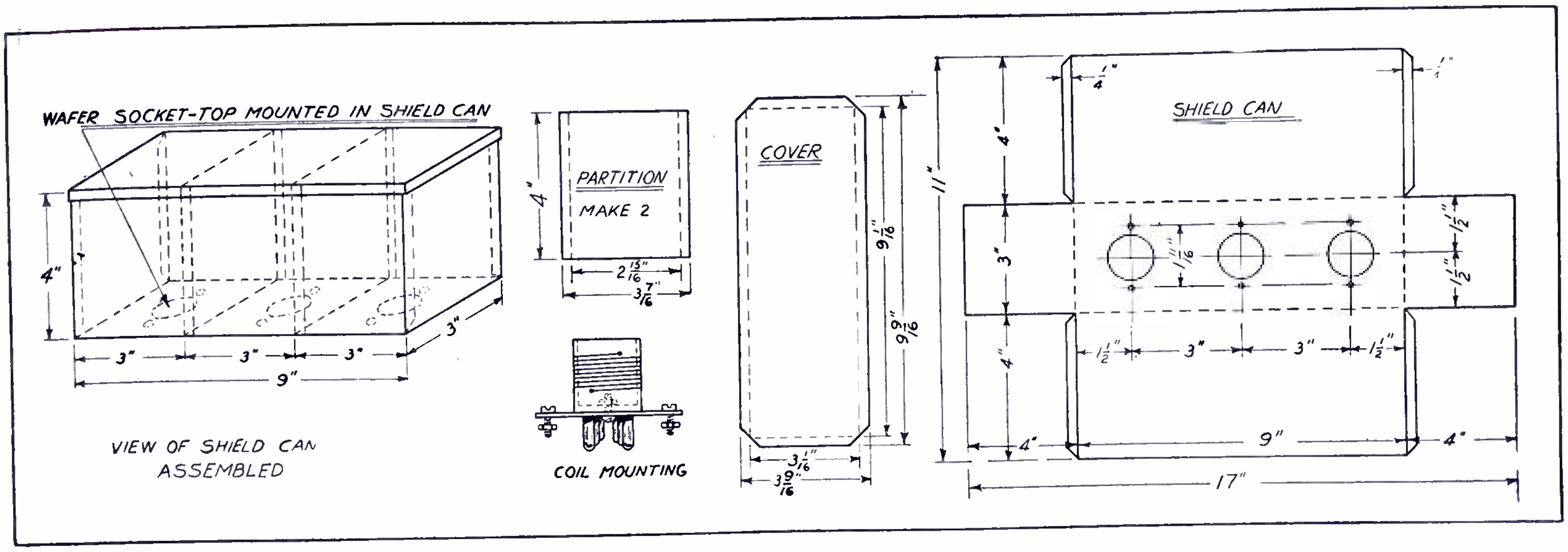
The coils comprising C3 are of the four-prong type simply because the primary is used as the tickler, and the ticklers on these four-prong coils are very satisfactory.

There is nothing unusual about the power unit. It is standard in every respect and is economical because no choke is used—the speaker field, which should have a d.c. resistance of 1000 ohms, acts as the choke. Two 8-mf. electrolytic condensers provide sufficient filter action. A glance at the underview of the receiver will show that there are two large paper condensers used in the filter system; a top view of the receiver shows an electrolytic condenser used in the filter circuit. These condensers happen to be present in the model photographed although they have been eliminated in later models, and two 8 mf. electrolytics as shown in the schematic circuit are used instead. It might be well to mention here that the detailed drawing of the chassis layout makes provision for these electrolytic filter condensers.

Although the receiver was not designed for the reception of c.w. signals, a local oscillator may be incorporated for such purpose if so desired. It is best to use an electron-coupled oscillator, the circuit of which is shown in the schematic diagram.



UNDER-VIEW OF THE RECEIVER WITH MAJOR PARTS LABELED
The two large condensers may be replaced by electrolytics.



DETAILS OF MOUNTING THE COILS IN THE SHIELD CAN—FOUR CANS ARE NEEDED

In view of the fact that this receiver was intended mainly for broadcast reception, this local oscillator was omitted in later models, but sufficient room had been left in the chassis for its incorporation at any time. Thus, one of the i.f. transformers, which is not labeled and which is shown in the top view of the receiver, is the electron-coupled oscillator.

Constructing the Receiver

There is very little to say regarding the mounting and wiring of the receiver itself. Those readers who have built sets before realize the essential details of wiring, and it would be a waste of space to repeat these fundamentals. There are, however, a few points which should be enlarged upon if this superheterodyne is to function properly. The first requirement is that all plate leads be kept as short as possible. Although you probably have heard this statement many times in the past and are possibly fed up with hearing it now, I would like to relate how one of the problems in the design of this superhet was overcome.

In one of the earlier models, uncontrollable oscillation in the i.f. amplifier prevented us from obtaining maximum sensitivity. Every time we lined up the i.f. transformers, the oscillation, of course, would drown out everything. We tried choking and bypassing every single lead in the r.f. and i.f. portions of the receiver, but to no avail. After considerable experimentation, it was found that the plate and B+ leads of both i.f. stages had to be shortened. When this was done, oscillation stopped and stability was obtained. A glance at the schematic circuit will also show the very complete filtering in the plate-return circuits.

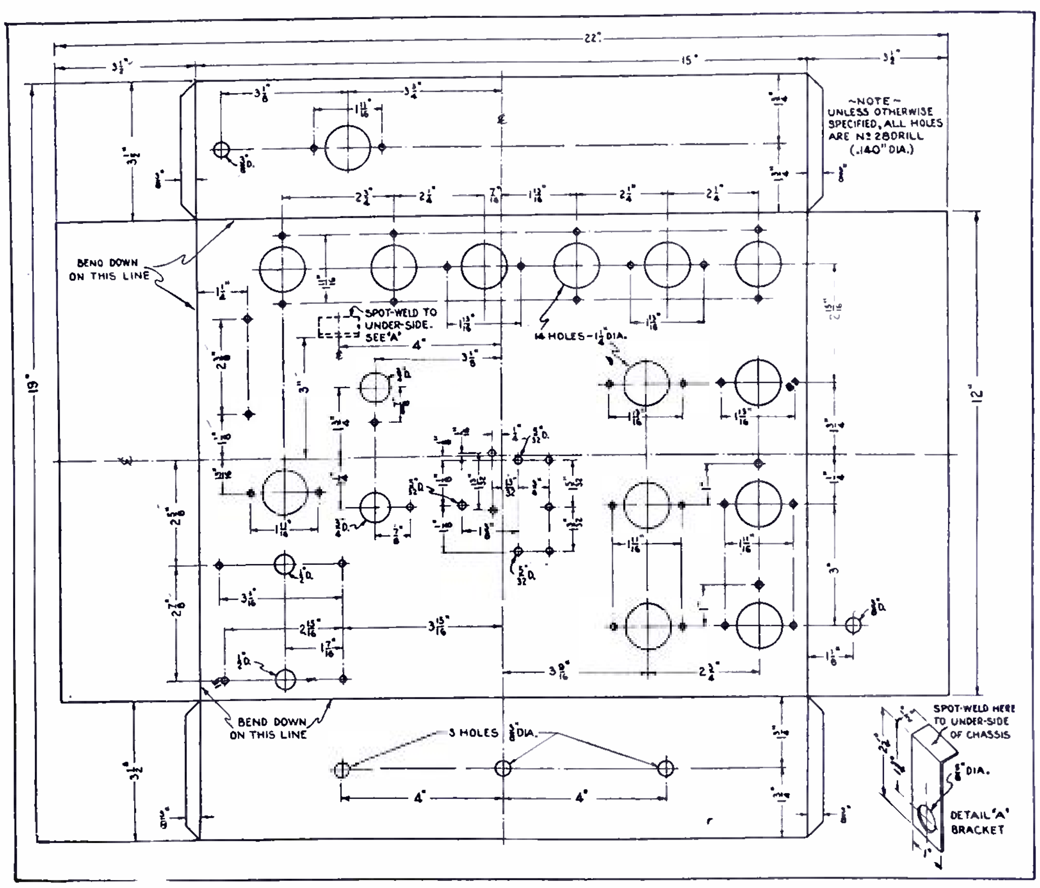
Mount the apparatus as shown in the photographs and wire accordingly. Please take your time at this stage of the game if you want to have a receiver that you can be proud of.

Coil Shields

The problem of what coil arrangement to use had been given considerable thought. Switching arrangements, while they are excellent, did not suit us, simply because suitable switches could not be purchased in the open market. The only other efficient arrangement left was plug-in coils, but here again the necessity for changing three coils every time the wave band had to be changed did not seem highly desirable. This problem was solved by Mr. Clifford E. Denton, who suggested that the coils for a given wave band be placed in one box, so that all that need be done to shift wave bands is to change one box. Furthermore, the coils would automatically be shielded and be kept out of the way of the operator.

The arrangement as finally decided upon is shown in a sketch. A metal box, preferably of copper, aluminum, or copper-plated steel, 9" long, 3" wide and 4" high, is divided into three compartments as shown. The usual socket mounting holes are drilled in the center of each compartment and a wafer type socket *with the contacts removed* is mounted in each compartment. The coil is then plugged in and a hole is drilled through this wafer socket through the coil form. A nut and bolt thus fastens the coil form to the socket. This construction is shown in a separate sketch. Thus, when finished, each compartment has a coil in it, the coil being fastened to the upper part of the wafer socket by means of the nut and bolt, and the wafer socket, in turn, is mounted

(*Continued on page 47*)

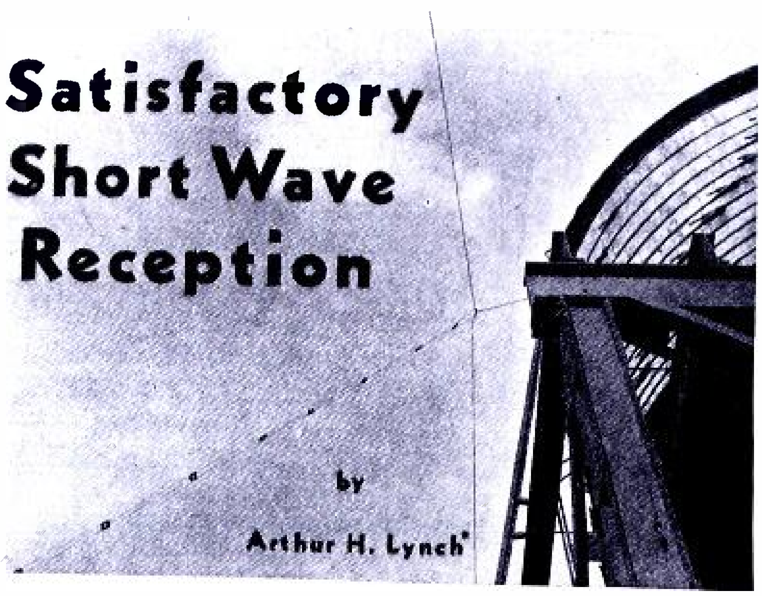


MECHANICAL DRAWING OF THE CHASSIS OF THE SET

This drawing is for the actual parts specified in the list of parts.

Satisfactory Short Wave Reception

by Arthur H. Lynch



A Lynch antenna system installed on the roof of the American Sales Co. building in New York.

HOW best to get rid of background noise becomes a more and more important question as we go up in frequency and down in wavelength. In the old days when, with tall, pillar inductances or concentrated honeycomb coils, we listened to "over-the-pond" stations, it was possible to locate the receiver in a veritable hot bed of electrical devices of one type and another and it was rarely that the interference they kicked up caused us any real concern. Why, for a number of months we stood a regular twenty-four hour watch, with three eight-hour shifts, in the tower of the *N. Y. Times* Building, at Broadway and 42nd Street, New York City, where we copied regular schedules from most of the then important foreign stations. There was plenty of ordinary static, to be sure, but there was very little of the man-made variety. Or, to put it more correctly, there was plenty of both, but the man-made variety did not bother us above four thousand meters, where most long-distance communication was being carried on at that time.

The first time that the serious trouble which background noise or man-made static causes became generally recognized was during the first International Radio Broadcast Tests in 1923. At that time, with every broadcasting station on the North American Continent shut down for an hour each night for a whole week, and with every receiver cranked up to the limit of its sensitivity in the attempt to hear the foreigners, radio fans became cognizant of the effect of local interference. And the waves used at that time were the ordinary broadcast waves, most of them being between 400 and 500 meters. The problem has become aggravated as the trend in waves has been down-hill—the frequency up.

Beam Arrays and Transmission Lines

The publicity which followed some of the recent tests on short waves and ultra short waves has brought a number of rather intricate and very expensive, as well as very effective, receiving systems to the attention of the serious investigator; and a natural demand for additional information on the part of the hams learning of the improvement has followed. The publicity, valuable as it is, has been just a little misleading. It would seem that the present tests and improvements have been worked out with some new sets of fundamentals; that the engineer has waved his magic wand, and out of his trick hat has popped a new rabbit in the form of a receiving antenna which cuts out interference, but which costs thousands of dollars to erect.

In his classic presentation of this important subject in the latter part of 1930 before the Institution of Electrical Engineers, London, T. Walmsley, reviews the art in this way:

"Although as early as 1899 Brown had taken out a patent for a type of aerial which utilized the principle of interference, it was not until 1927 that the first commercially successful 'beam' high-speed telegraph service was inaugurated at Bodmin, Cornwall. . . .

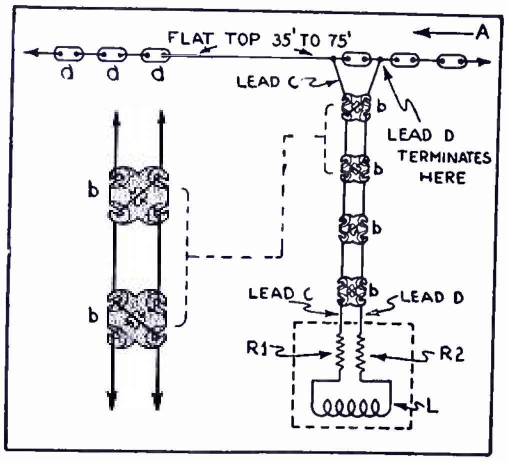
"Since the establishment of the fact that short-wave beam telegraphy is a highly successful commercial proposition, many different types of beam arrays have been developed. *The principle in all is the same; by means of wires correctly spaced, and currents correctly phased, an increase in field strength in the desired direction and a decrease in the other direction is produced.*" (Italics are present author's.)

Some idea of the complexity and the expense involved in the erection of the arrays which are being used for commercial point-to-point purposes may be had from the following considerations.

While a number of these arrays have been designed for transmission purposes, the same principles are involved when it comes to receiving. Remember the ads you have seen from time to time in the newspapers telling you that you can now hear all the foreign broadcasting stations at any and all times with this or that new gadget, which can be hitched to your present receiver, which costs little or nothing, and which only requires a wire under the rug? Keeping such statements in mind, a certain amount of humor may be had from pondering a few more paragraphs from Mr. Walmsley's interesting treatise, under a heading which he is pleased to call "Economical Size of Array." Here they are; read 'em and weep:

"In the case of an array consisting of exciting and reflecting panels for a wavelength of 16 meters, a convenient span is eight wavelengths, which, allowing for attachments and clearance between supporting structures and end radiators, would necessitate two towers separated by 500 feet.

"An array having two rows of vertical radiators, one above the other, would require towers 2¼ wavelengths, or 120 feet in height. This figure, taken from an actual design by the author, allows one quarter of a wavelength clearance from the ground, three quarters of a wavelength for dip of the supporting cables, and one quarter of a wavelength for insulators and attachments. Again, the towers would be required to resist a total top pull of four tons, *viz.*, two tons for the exciter panels and two tons for the reflectors. An array having four vertical rows of half-wave radiators would require twice the dip allowed for the two row array to ensure a four ton top pull. The height of the towers required would thus be about four wavelengths, *i.e.*, 210 feet. . . . Assuming an approximate cost of



Method of connecting a transposed lead-in to an "L" type antenna.

fabricated steel of $200.00 per ton inclusive of foundations and erection, or a total of $3,800 and $8,000 respectively for the two towers for each array, and estimating the cost of the arrays complete with insulators as $1,750 and $3,250 respectively, the grand totals are $5,550 and $11,250 respectively. The field-strength gain of the four vertical half-wave aerial over the two vertical half-wave aerial has been shown to be 2.8 decibels, and this gain might be well worth the extra expenditure involved."

My purpose in bringing these facts and figures to your attention is two-fold. Firstly, it will indicate that serious attempts to improve short-wave communication are not new, and they are engaging the attention of an increasing number of the greatest minds in the communications field. They indicate that great care and great expense are being incurred with a view toward making slight improvements in the efficiency of the radiating and pick-up systems, and that the expense is considered worth while. Secondly, it is obvious from the few examples which space permits calling to your attention here that this is a fertile field for the serious investigator, and that, in more modest forms, *some of the advantages of these elaborate systems may be employed by the radio enthusiast to whom radio communication of one form or another is an avocation rather than a vocation.*

Transmission Lines for Ham Radio

In the locating of a transmitting aerial, and even more generally in the locating of a receiving aerial, it is desirable to have the equipment itself some distance from the aerial proper; receiving conditions in metropolitan centers impose this restriction in nearly every case. As a matter of fact, this is more of an asset than a liability, since it enables us to place the receiving antenna system a considerable distance from the receiver itself and well out of the field of man-made interference.

In order to get from the antenna proper to the transmitting or receiving apparatus, it is generally desirable to use some feeder system which has no effect upon the antenna system itself and which does not form any portion of the radiating or pick-up system, as such. The leads used for this purpose are called "transmission lines." They are usually designed to have several very important properties and their design determines the degree to which these various properties may be obtained.

The principal difference between the schemes used for short-wave reception and the systems used for the broadcast waves lies in the selection of the transmission line and the method of coupling it to the antenna and the receiver. The systems which

This Series of Articles

The article is the third of a series of articles by Mr. Lynch on "Satisfactory Short-Wave Reception".

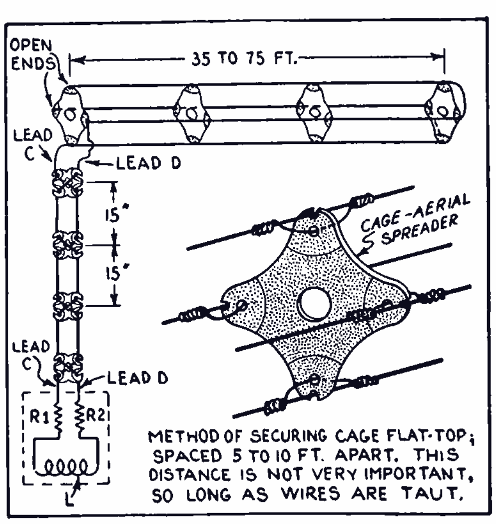
The first of the series outlined, in general, the problems involved in short-wave reception; the second part gave specific directions on the installation of transposed lead-ins; and this, the final article, illustrates the problem from the economic angle—an important one for the average radio listener.

Any questions pertaining to this subject should be addressed to Mr. Lynch, care of SHORT WAVE RADIO.

work well for the broadcast wavelengths introduce rather severe losses when we attempt to use them on short waves. The shorter the waves the greater the losses. The reason is very simple to understand.

In most of the really effective noise-free systems for broadcast reception we have one lead or a pair of twisted leads running from the antenna to the receiver through a metallic sheathing; the sheathing is grounded. The distance between the lead and the sheathing is not very great, and therefore we have a condenser effect. The puny signal voltage picked up on our antenna for use in a suitable building-up process in our receiver is thus bypassed right through the condenser formed by our lead and is shot into the ground without getting to our receiver at all, or in a very greatly weakened condition.

In order to cut down this loss as far as possible, elaborate systems have been put in operation in several of the important commercial stations as well as at those stations where short-wave broadcast signals are picked up for retransmission. In cases of this character, an improvement of a few tenths of a percent is generally worth while, because the



The transposed lead-in connected to a cage aerial. See text.

result is made to benefit a great many listeners; but the benefits derived from such a system are beyond the engineering and the financial limits of the average short-wave operator. Suitable systems for home use on short waves are available, and they are giving a very favorable account of themselves in actual use. Before this year is out, the average performance of the short-wave receiver—and therefore the effectiveness of the short-wave transmitter — will have improved materially.

Analysis of Losses

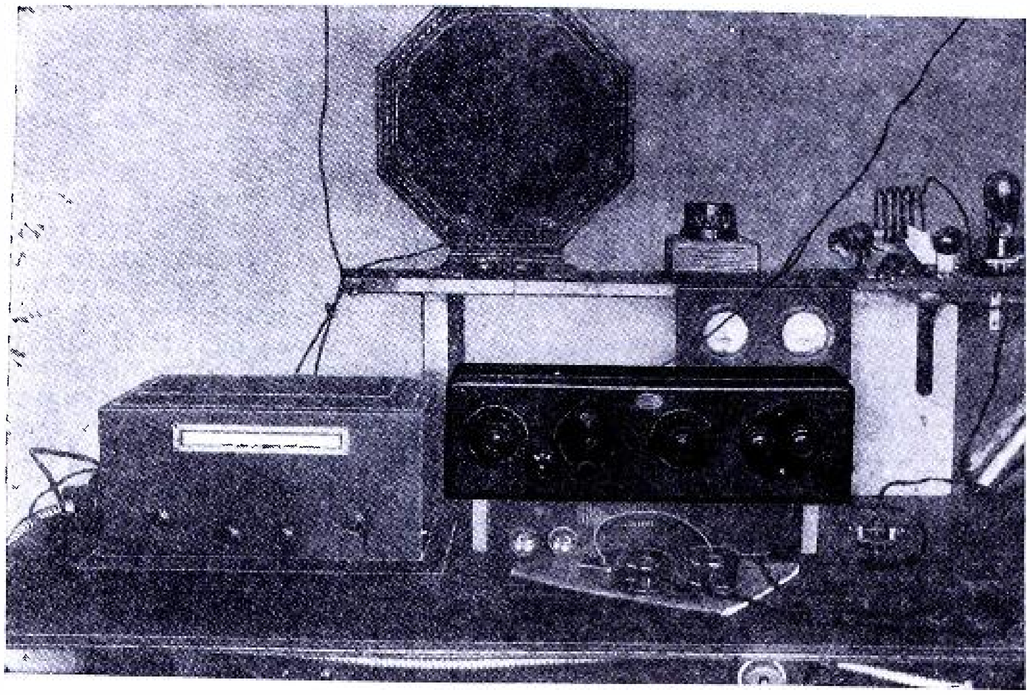
The losses in transmission lines may be classified under three headings: (1) ohmic loss, (2) dielectric hysteresis and eddy-current losses, and (3) radiation losses.

Ohmic losses are appreciable at high frequencies. This resistance loss may be reduced by using several insulated wires of small diameter instead of one large wire for each of the two members of the transmission line. For example, a No. 5 wire has only twice the *high-frequency* resistance of No. 00 wire of equal length. Thus, assuming that the proximity of other wires does not change the resistance values of individual wires, four No. 5 wires would have half the resistance of one No. 00 wire of equal length. To test the truth of this contention a 16.1-meter array was fed by a group of transmission lines running along the same poles. Three insulated open lines, two of which were used normally for two other arrays, were bonded at the transmitter and the array ends. From the current values of both ends of the lines the efficiency of transmission was calculated. The result showed that the reduction in loss, namely 16 per cent, was approximately the same as the estimated reduction due to less ohmic resistance.

No method is known of estimating dielectric hysteresis losses with any degree of accuracy. *To reduce insulator losses the best type of ceramic or other insulation should be used.* Subject to mechanical requirements, the insulator should be as *long as possible* and the *cross-section as small as possible* to minimize leakage and reduce local capacity at the points of attachment to transmission poles. The latter precaution is necessary to lessen small reflections due to changes in the constants of the line.

Obviously, we cannot avail ourselves of the elaborate short wave systems which are used commercially, so as to receive with the same satisfaction with which we now receive our local broadcast stations. However, a few intelligent applications of the same fundamental principles in a less elaborate degree, and a few intelligent compromises, make it possible, at very slight expense, to get very much better results on the

(*Continued on page 38*)



THE REVAMPED A.K. 20 ALONGSIDE A NATIONAL SW-58

Revamping the A. K. 20 for Short-Wave Use

A GREAT many of the people who are getting into the short-wave game are ex-broadcast experimenters and set-builders from the 1920-1928 broadcast era, people who bought a lot of radio apparatus at a time when sockets cost $1.50 apiece, variable condensers $7.00, and tubes, $12.00. They have a fairly good foundation of practical radio experience, but simply are not "up" on present day short-wave practice.

Many of these people do not want to buy modern receivers immediately, but prefer to renew their contact with the radio game by first experimenting with simple and inexpensive outfits built up out of old parts they have on hand or rebuilt from old broadcast receivers.

A very good way for these people to get started is to pick up some ancient broadcast receiver and to revamp it. There must be thousands and thousands of obsolete t.r.f. receivers kicking around in radio dealers' back rooms. These can be purchased for next to nothing, in most cases the dealers being delighted to get rid of the junk. The type of set that is most suitable for short-wave conversion is the old 5-tube, 3-dial battery model. There were probably more sets of this type made and sold than of all other types put together to date. Who does not remember the old Fada, Freed-Eiseman, Garod and Eagle neutrodynes, and a host of other similar t.r.f. sets? Even today, some of the radio surplus houses list these sets for sale at prices that would not even have paid for the shipping cases at the time they were first produced.

Just to show what could be done along these lines, the writer visited a number of radio dealers in his own community, which is in Long Island, and without any trouble at all picked up an old Atwater Kent model 20 receiver for the munificent sum of $1.25. He does not doubt that he could have cut this down to the sum of an even dollar if he had cared to bargain! He deliberately avoided visiting New York's famous Radio Row, along Cortlandt Street, because there is only one such place in the United States, and any experience he had there could not be duplicated very well in other cities.

THE "WHY" OF THIS ARTICLE

The editors of this magazine have received so many inquiries of late regarding the use of old broadcast receivers for short-wave work that they decided to go out, buy a cheap broadcast set of the vintage of 1925, rebuild it for s.w. use, and let you have the dope.

The investment was so small, and the results so satisfactory, that the complete story is presented herewith in detail.

Why the A.K. 20?

This Atwater Kent model 20 was a fortunate selection because it is certainly a typical t.r.f. set of the pre-a.c. period. It contains three variable condensers, to the back of each of which is fitted an r.f. tuning coil, two individual sockets for the r.f. tubes, a triple socket block for the detector and a.f. tubes, and two encased audio transformers. Each condenser has its individual dial on the front panel, which also holds an on-off switch and two filament rheostats. This same description can be applied very accurately to any number of sets of other makes. The sockets are all of the four-prong type, the set probably having been designed to use 201A's in the r.f., detector and a.f. positions, and a 112A or 171A in the output position. Front and back views of the set before it was "given the works" are shown herewith.

Although the cabinet is of wood, the front panel is either iron or steel. The sockets and audio transformers are mounted to an iron shelf welded to the back of the panel.

First of all, the set was torn completely to pieces, a job that required only a soldering iron, a screw driver, and a pair of pliers. The old fixed condensers and resistors were discarded, as they were not marked in any way. The r.f. coils were thrown into the junk box, as their forms might prove useful some time. The variable condensers were thoroughly cleaned up, as they are very beautiful instruments, with conical bearings, accurately adjustable tension plates, and moulded bakelite end-pieces.

Designing the New A.K.

In view of the straight-in-line arrangement of the parts, with the r.f. tube sockets between the condensers, it was decided to make the new short-wave set consist of one untuned r.f. stage using a type 34 tube, a regenerative detector using another 34, and a single audio output stage using a 33 pentode. These tubes work very satisfactorily with ordinary No. 6 dry cells for filament supply and three small 45-volt B batteries for plate supply. A.c. operation was decided against because it was felt that the cost of a power pack would be too high for a mere "junk" set; besides, if a.c. operation were adopted, it would have been just as cheap to buy or build a set of new and modern design. Batteries are cheap and will last long enough to familiarize the builder with the many tricks of short-wave operation that he should know before he buys himself a modern tuned t.r.f. or superhet set. The surprising "wallop" that the set developed when it was finished more than justified the choice of these tubes.

The socket that formerly held the first r.f. tube in the original broadcast circuit now holds the untuned r.f. amplifier tube, V1. Since the 34 has a four-prong base, no changes in the socket were necessary. In the AK model this particular socket is also equipped with two spring post binding posts, which are very convenient for the aerial and ground connections.

The second tube socket, also of the four-prong type, now accommodates a two-winding short-wave plug-in coil. The first socket on the triple block takes the 34 detector tube. A new five-prong bakelite-base tube socket was fastened on the other half of this socket block to accommodate the type 33 pentode, which has a five-prong base. It was not even necessary to drill new holes for the socket screws, as two of the old tube prong holes happened to be the right distance apart.

The Tuning Condensers

The variable condenser nearest the detector socket was discarded altogether, and a 100,000-ohm potentiometer, R6, mounted in its place instead. This potentiometer is the regeneration control. Since two condensers were available, it was decided to take advantage of them by using one as a tank turing condenser, C1, and the other as a vernier or band-spread condenser, C2. There was no way of determining the capacity of the condensers, but as most condensers of the period were about .00035 or .0005 mf., one of the condensers was cut down by the removal of a total of 9 of its 16 plates. This seemed to give adequate tuning range and overlap with a set of standard Na-Ald four-prong plug-in coils. This condenser is the one on the extreme right in the back view of the revamped set. The other condenser, C2, was cut down to two plates.

It so happens that the condensers in this old AK set lent themselves very readily to reduction in capacity, as both the rotor and stator units are held in place by nuts tightened over threaded members. With condensers of other makes, it may be necessary to pull out plates by means of a pair of pliers. In any event, please remember that it is not necessary to remove *both* stator and rotor plates. The capacity of a 16-plate condenser can be cut approximately in half simply by removing half the plates in either the rotor or the stator alone. Test the revamped condensers carefully with a battery in series with a pair of phones to make sure that the plates do not short circuit at any point. The revision of the condensers represents the major part of the mechanical work in the set.

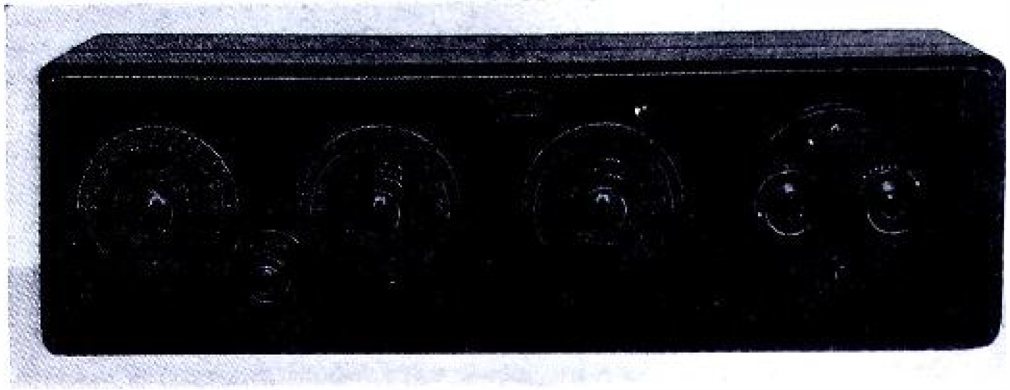
The complete schematic diagram of the revamped receiver is shown. There is nothing particularly new or tricky about this; it is a simple and utterly reliable circuit. The untuned r.f. tube, V1, is coupled to the antenna by means of a fixed resistor R1, which has a value of 20,000 ohms. The plate of this tube runs directly to the top of the grid winding of the plug-in coil, L1, and also to the tuning condensers, C1 and C2, and the grid condenser, C6. Notice that plate voltage for the r.f. tube, V1, is fed through the grid coil; condenser C5 is provided to prevent the battery from short circuiting itself to ground and has no appreciable effect on the tuning circuit because of its high capacity. While it is more desirable to have a separate primary coil, this arrangement works quite satisfactorily and simplifies the wiring of the set and the winding of the coils.

Regeneration is obtained by means of a series tickler, the regeneration control being the previously mentioned screen potentiometer, R6. The detector plate coupling inductor, L2, is simply the secondary *alone* of the larger of the two old audio transformers from the original set. This worked out quite well and was found to be much superior to an ordinary resistor.

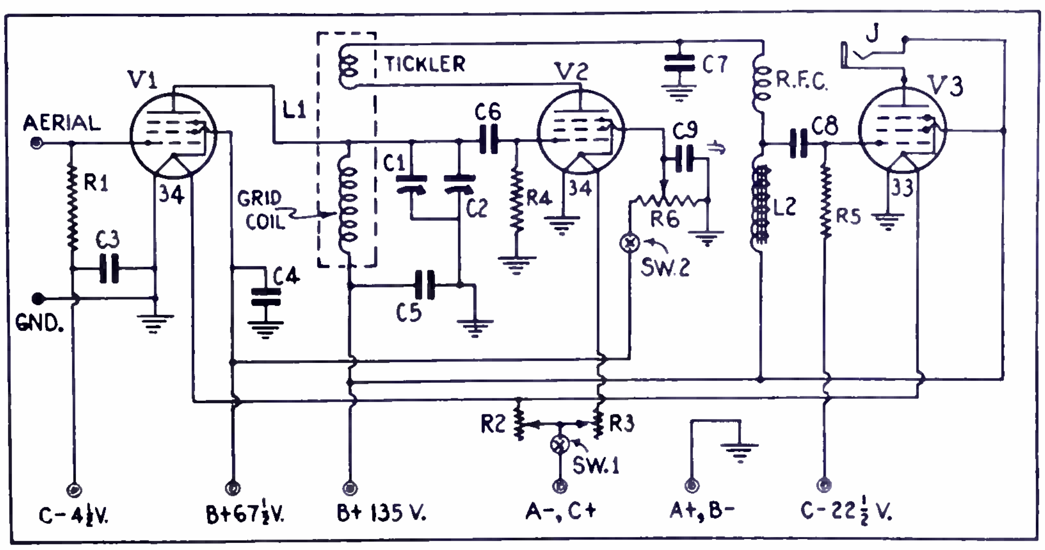
The detector is coupled by condenser C8 directly to a type 33 pentode, in the plate circuit of which is connected a single circuit earphone jack, J. The mounting of this jack required the only new hole made in the whole set. As the metal panel represents B–, it was necessary to insulate the jack by means of a couple of bakelite washers and a narrow strip of friction tape wound around the mounting stud to prevent it from touching the metal.

A shield can base was mounted over the detector socket, as shielding of the detector tube is quite important. The mounting details of various other parts are evident from the illustrations.

Since two rheostats were variable, one of them, marked R2, was used to control V1 and V3 together, and the other, R3, the detector tube V2



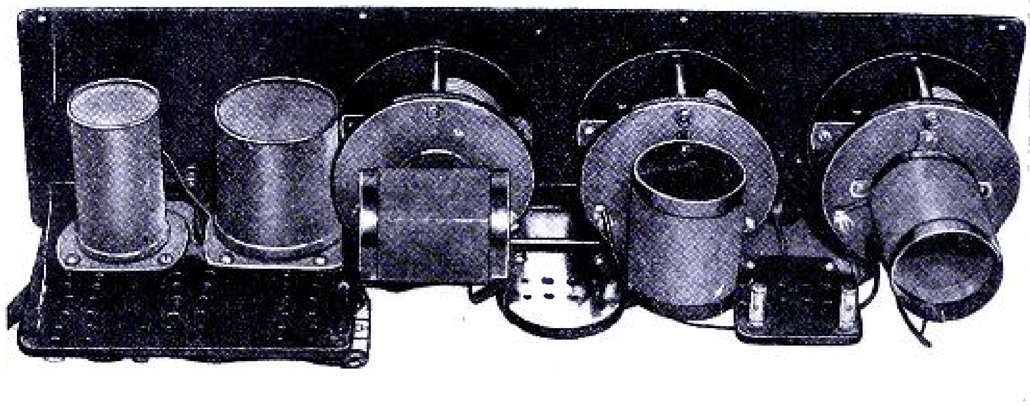
PANEL VIEW OF THE ORIGINAL A.K. 20 AS PURCHASED



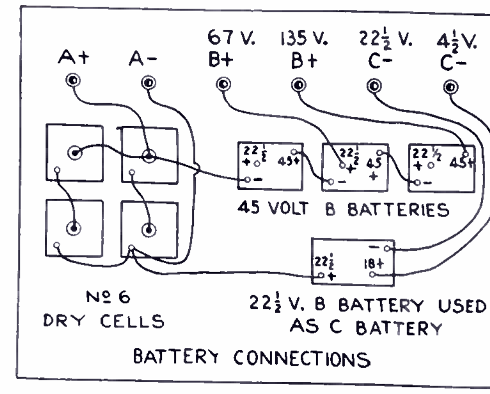
SCHEMATIC CIRCUIT OF THE RECEIVER AFTER ALTERATIONS

The following new parts were purchased:

C3, C4, C5, C8—.01 mf. mica fixed condenser (Trutest).
C6—.0001 mf. mica fixed condenser (Trutest).
C7—.00025 mf. mica fixed condenser (Trutest).
C9—2 mf., 500-volt dry electrolytic bypass condenser (Trutest).
R1—20,000 ohm fixed resistor (Trutest).
R4—Grid leak, between 4 and 10 megohms, exact value to be determined by experiment.
R5—250,000-ohm grid leak (Trutest).
R6—100,000-ohm potentiometer (Clarostat).
RFC—2½ mh. r.f. choke (National).
J—Single open circuit phone jack.
1—five-prong bakelite base tube socket for V3.
1—National type "B" midget velvet vernier dial.
1—aluminum tube shield to fit over V2.
2—grid grips for V1 and V2 (National).
1—set of four-prong plug-in coils, 13 to 200 meters (Na-Ald) or home-wound according to directions.
V1, V2—type 34 screen-grid tubes.
V3—type 33 pentode.
4—No. 6 dry cells for filament supply type.
3—Small size 45-volt B batteries (General type 30AA).
1—small size tapped 22½-volt B battery for use as C battery.
1—pair 2000-ohm ear phones.



REAR VIEW OF THE ORIGINAL SET EXACTLY AS PURCHASED



BATTERY CONNECTIONS
Hook-up of the batteries for the A.K.

alone. The values of these rheostats are unknown, but they seem to be just right when three volts of dry cells are used for filament supply. The correct filament voltage of two volts was obtained with the rheostats turned about half way up. The original six-wire battery cable supplied with the set was again used.

Screen Switch Useful

The AK model 20 happened to be fitted with a three-point switch which was used originally as a selectivity control of the primary of the first r.f. transformer. As long as this was available, it was connected in the position marked SW2. With this switch open, the potentiometer R6 does not draw current from the "B" batteries, which would be the case if no such switch were used. With battery type tubes, it is a good idea in all cases to use a switch of this kind. Incidentally, this switch proved to be very useful when the receiver was used in an amateur station. During periods of transmission this switch was simply opened to prevent the signals from thumping in the ears of the operator.

The revamped receiver worked perfectly the first time it was turned on. It was only necessary to experiment with a few different grid leaks, R4, to obtain smooth regeneration.

Rough tuning is done with condenser C1 and fine tuning with C2. A National type B midget vernier dial was attached to C2 to facilitate fine adjustment. Incidentally, this arrangement produced a most excellent band-spreading receiver for amateur purposes.

The set was never intended for anything more than ear phone operation, but many signals are received with such strength they work a small magnetic speaker quite comfortably. This is with an antenna only about 40 feet long and about 10 feet off the ground. The four plug-in coils, for which complete winding data are given, tune from about 13 to 200 meters and are providing no end of interesting reception. The absence of background noise and the smoothness of the regenerative action make tuning a real pleasure.

As four No. 6 dry cells were available, these were connected in series—parallel, as shown. They maintain a surprisingly steady voltage at the terminals of the tube sockets. In fact, it is unnecessary to change the rheostats at all, once the correct adjustments have been determined by means of a small d.c. voltmeter. The total filament drain is only .38 ampere, which is a very comfortable load on these batteries. The same four dry cells, after more than three weeks of pretty steady use, showed no appreciable drop in voltage. The measured plate current drain is only about 15 ma., which means that the B batteries will outlast the set.

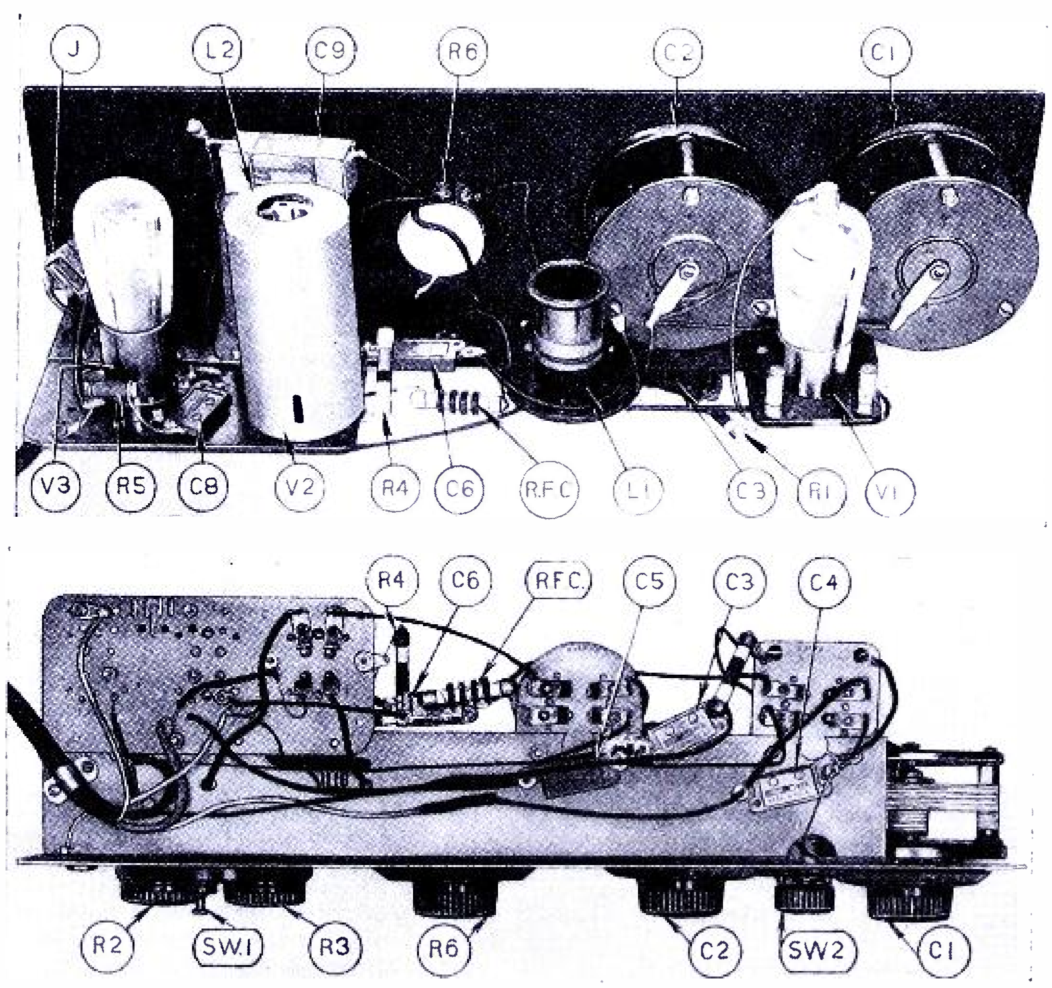
For filament supply it is also possible to use a single cell of a storage battery, which gives a little more than two volts. In this case the rheostats should be turned all the way up. It is desirable to check the filament voltage by means of a small d.c. voltmeter; maintain the value as closely as possible to two volts.

Complete coil winding data are given in the lower right hand corner of page 17, directly opposite. The 20-40, 40-80 and 80-200 meter coils are all that are really necessary.

What We Received

Although no particular attempt was made to log foreign stations, programs from EAQ, Madrid; Radio Coloniale, Paris; and the various Daventry and Berlin transmitters have been received quite regularly. Daventry and Berlin can even be heard on the loudspeaker quite comfortably through a sensitive magnetic speaker. And code stations! No attempt is even made to even count them, as they drop in by the hundred.

While not all new short-wave enthusiasts will be able to obtain Atwater Kent model 20's, the general directions given in this article can be applied just as readily to other sets.



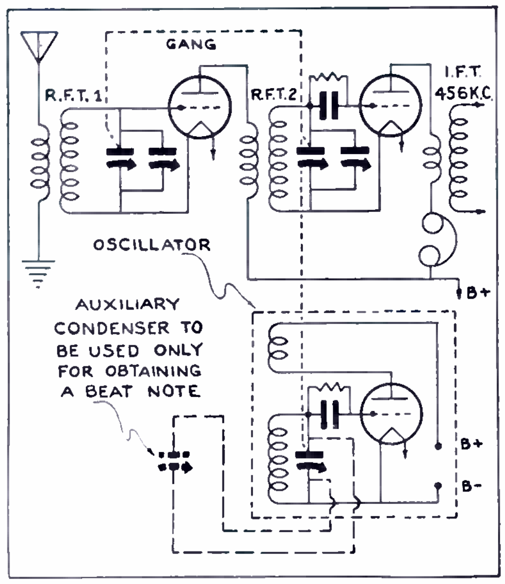
TOP AND BOTTOM VIEWS OF THE REVISED A.K. 20
Compare the designations with those given in the schematic circuit.

Problems in S.W. Super Design

EVERY so often we hear some one say, "Why not more s.w. supers?" And just as often the answer is, "Aw, they're too hard to adjust." The strange part of the situation is that supers *are* hard to adjust—if you go about it haphazardly. Suppose we build a super—on paper—make it squeal and howl; in fact, let this hypothetical super do everything but deliver signals. O.K.? Let's go.

This super will consist of a tuned r.f. stage; a first detector, also tuned, an oscillator, two stages of i.f., a second detector and one or two stages of audio. We have just finished wiring it—on paper—but the thing won't perk. Where do we start and when do we finish?

The first thing to do is to break the plate circuit of the first detector and insert a pair of phones, connect an aerial and ground and tune *carefully*. Still no sigs. Set the trimmer on the tuned r.f. stage about half-way in, and gradually adjust the first-detector trimmer; after each adjustment, turn the tuning dial over the complete range. This procedure is tiresome; but if you are patient and if the apparatus is good, you will eventually hear something—provided, of course, that a fairly strong station is on the air. We may safely assume that eventually some station will be heard. Once a station is tuned in, hold him, and keep adjusting the r.f. and first detector trimmer until maximum signal strength is obtained.



The r.f. and first detector stages that we just adjusted comprise a standard, garden-variety two-stage receiver with which most experimenters are familiar. If the r.f. stage should oscillate, then the usual precautions should be taken: shield the tube, coil, and perhaps some of the wiring; reduce primary turns on the second r.f. coil; insert grid suppressors. One or all of these measures may have to be taken to insure stability. In any event, there should be no oscillation when the phones are connected in the plate circuit of the first detector. Of course, as an added precaution, be sure to remove all the other tubes in the set from their sockets.

The Oscillator Circuit

With the signal still coming in, insert the oscillator tube in its socket and adjust its trimmer until the familiar beat squeal is heard. Now, here an important point arises. In the usual run of supers intended for s.w. reception, the i.f. is about 456 kc. To obtain this i.f., the oscillator inductance may be made smaller

(*Continued on page* 41)

The Eagle Short-Wave Receiver

A SIMPLE but very effective short-wave receiver that is finding great favor with both short-wave broadcast listeners and amateurs is Jerry Gross' "Eagle." This is a three-tube job using a 32 untuned r.f. amplifier, a 32 regenerative detector, a 33 pentode output tube. For power supply, dry cells are used exclusively. Two ordinary No. 6 dry cells (or better still, four, connected in series parallel) light the filaments. For plate supply 135 volts of "B" battery is needed; for grid bias, 22½ volts.

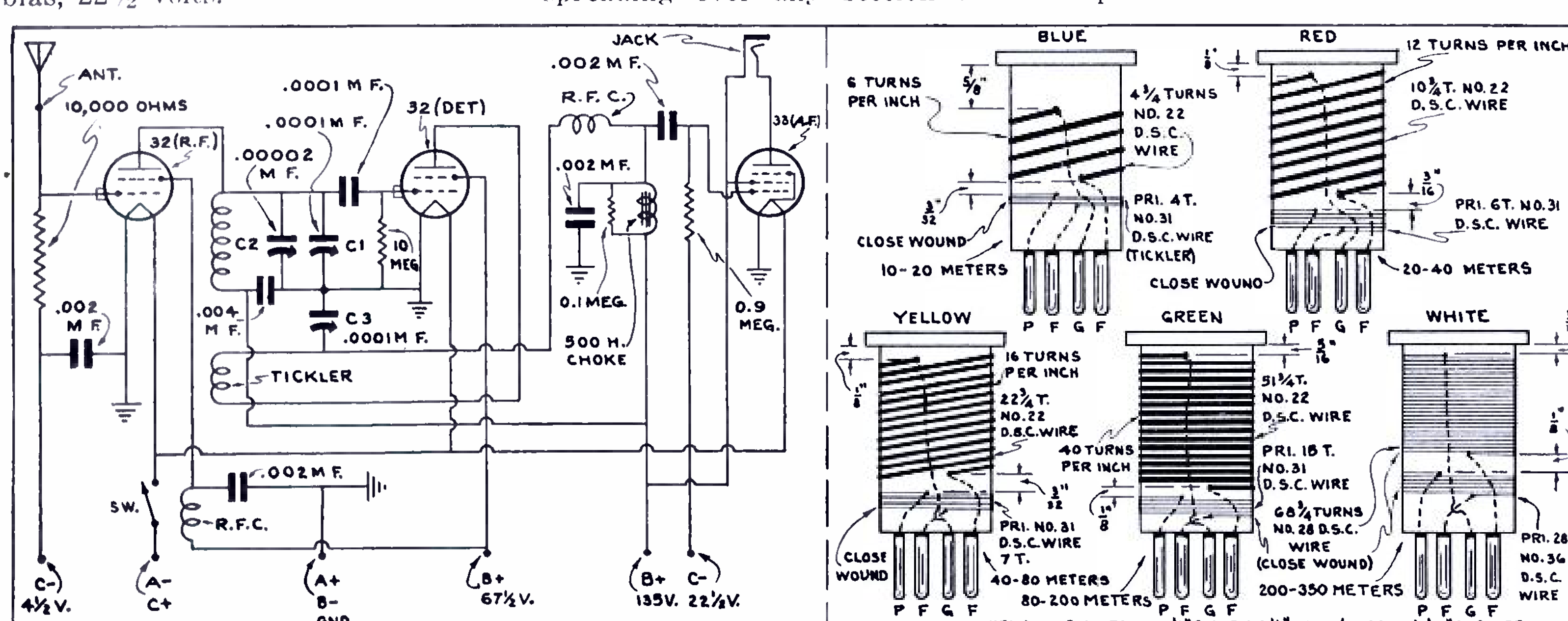
Since the antenna stage is untuned, only one plug-in coil is necessary for each wavelength range. Five standard Alden coils give the set a range of 10 to 350 meters. The complete coil details are given in the accompanying diagram.

Continuous band-spreading is provided by means of a 3-plate midget condenser C2, connected directly across the regular tuning condenser C1, which has a maximum capacity of .0001 mf. Rough tuning is done by means of C1, and then band-spreading over any section of the coil range obtained by means of C2.

Regeneration is controlled by means of another .0001 mf. variable condenser, C3.

Plate voltage for the r.f. tube is fed through the grid winding of the detector plug-in coil. The .004 mf. condenser connected between C2 and the bottom end of the coil closes the r.f. circuit.

With a normal antenna about 50 feet in length, this set provides excellent signals. Many stations can be heard quite well on a magnetic speaker.



SCHEMATIC CIRCUIT AND COIL DATA OF THE EAGLE SHORT-WAVE RECEIVER

Correct Design Applied to a 2-Tube Short Wave Receiver

THE RELATIVE SIZE OF THE SET AND COILS IS ILLUSTRATED HERE

By J. A. Worcester, Jr.

ALTHOUGH it may appear to the casual reader that all two-tube short-wave receivers are practically identical as far as circuit diagrams are concerned, the fact remains that some work better than others, while some can scarcely be said to work at all. The explanation lies in the fact that in short-wave receiver design the circuit diagram means very little as far as determining whether a receiver will be a success or a failure. It is the attention to seemingly trivial details, such as smooth regeneration control, hum-free output, noiseless tuning, etc., that makes for successful operation. The method of obtaining the above characteristics in the receiver to be described will be discussed in the following paragraphs.

In order to obtain smooth regeneration control, it is necessary, first of all, to employ a low resistance tuning circuit. In this receiver, this is accomplished by employing a high-grade variable condenser in conjunction with a set of manufactured plug-in coils employing strip-wound, silver-plated secondaries. The strip construction is designed to reduce eddy current losses, while silver plating increases the surface conductivity.

Regeneration

It has been pointed out on numerous occasions that as long as regeneration is used, the effective circuit resistance can be reduced to practically zero, and, hence, there is no object in reducing the actual circuit resistance to as low a value as possible. As a matter of fact, however, the value to which the effective circuit resistance can be reduced by regeneration is proportional to the initial circuit resistance. The reason for this is not difficult to comprehend. As the feedback is increased the signal strength builds up to a certain critical value; any further increase in feedback will cause the circuit to break into oscillation. This can be explained by the fact that the feedback at any setting of the regeneration control is not constant, but varies slightly due to irregular electron emission, etc. When the feedback is increased to a point beyond the critical value, these uncontrollable variations in the feedback are sufficient to make the circuit resistance negative at some point, thus causing the production of sustained oscillations. Now, if the resistance of the tuned circuit is increased, say by the use of less efficient coils, it will be necessary to increase the feedback over the value previously required before the critical adjustment is obtained. Due to the increased feedback, which magnifies the effect of the uncontrollable feedback variations, the value to which the effective circuit resistance can be reduced before continuous oscillations are produced is diminished.

SUMMARY: *The essential points in good receiver design are as follows: (1) a low resistance tuning circuit, in order to secure uniform and smooth control of regeneration; (2) a high amplification-factor tube of the screen-grid type, which permits regeneration to be controlled by varying the screen-grid voltage; (3) impedance coupling in the detector plate circuit to permit of high gain because of high plate voltage; and (4) a heater-type output tube to reduce the hum level to a minimum.*

The above discussion, of course, only applies to the reception of modulated carriers. Any receiver that will work at all is capable of receiving continuous wave signals from any part of the globe. There are two reasons why this should be so. In the first place, the circuit resistance when using the beat method of reception is always negative, since the detector is in an oscillating condition. Secondly, the audio-frequency output from such a detector is directly proportional to the radio-frequency input, instead of being proportional to the square of the input as is the case with an ordinary detector. Consequently, the effectiveness of a receiver must be determined by its performance on modulated signals.

57 Used as Detector

For a detector, a type 57 tube is used and regeneration is controlled by varying the voltage applied to the screen grid. This combination was chosen for its sensitivity and freedom from reaction between the tuning and regeneration controls. Incidentally, the 57 tube is appreciably superior as a detector to the type 58, as can be readily proved by comparative tests on a weak signal.

It was found that with the above detector tube, the number of tickler turns on the plug-in coils was several times too great for obtaining satisfactory regeneration control. As a matter of fact, the circuit in most instances went into oscillation so violently that irregular oscillations were produced almost immediately; these manifest themselves by anything from a continuous squeal to an almost inaudible hiss, depending on the values of the grid condenser and leak employed.

This state of affairs cannot be regarded as faulty coil design, however, since in order to make the coils applicable to all types of tubes, it is

List of Parts

C1, C3—Hammarlund adjustable padding condensers, 10-70 mmf., type MICS-70.
C2—Cardwell 140 mmf. Midway variable condenser, type "C" plates, type 405C.
C4—Aerovox .0001 mf. molded mica condenser.
C5—Cornell .5 mf. tubular bypass condenser, type BB-2050.
C6—Solar .0005 mf. molded mica condenser, pigtail leads.
C7—Solar 25 mf., 25-volt dry electrolytic condenser.
L1, L2—One set Bruno short-wave plug-in coils, 15-228 meters.
L3—Hammarlund isolantite 8 mh. r.f. choke, type CH-8.
R1—Lynch 3 megohm grid leak.
R2—Acratest 50,000-ohm potentiometer.
R3—Acratest 250,000-ohm potentiometer
R4—Electrad 400-ohm wire wound pigtail resistor.
T1—National impedance coupling unit, type S-101.
1—National type B vernier dial.
1—Eby 4-prong isolantite socket.
2—Alden 6-prong wafer sockets.
1—Alden 5-prong type 435 socket.
1—Alden type 95 Connectorald plug.
1—Eby twin binding post assembly.
1—Eby twin speaker jack.
3—feet Belden 5-conductor cable.
1—roll Belden hookup wire.
2—Aluminum panels 6½" x 9" x 1/16" and 8¾" x 8½" x 1/16".
1—Type 57 tube.
1—Type 2A5 tube.
1—Hammarlund aluminum tube shield, type TS-50.

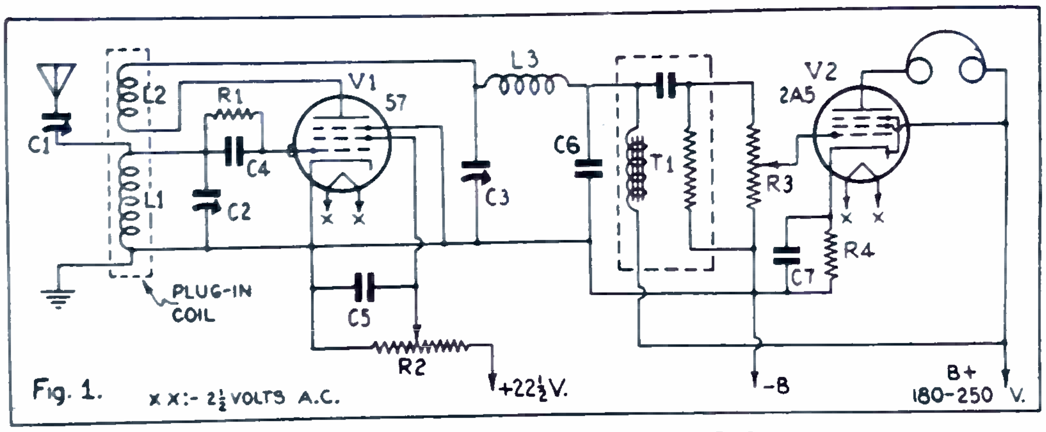


Fig. 1.

SCHEMATIC CIRCUIT OF THE CORRECTLY DESIGNED SET

necessary to put on sufficient tickler turns to provide satisfactory operation from the least efficient. As is well known, the older type triodes require several times more turns than the present tetrodes and pentodes.

Of course, an obvious solution to this difficulty would be to remove turns until satisfactory operation is obtained. However, it was not desired to mutilate the coils unless necessary; hence, the more convenient and satisfactory solution shown in the wiring diagram was adopted. A small padding condenser, C3, is used as a variable bypass in the detector plate circuit, and is so adjusted that the circuit just oscillates over the whole dial when the potentiometer control is about three-quarters advanced. For satisfactory operation the voltage across the potentiometer should not exceed 22½ volts.

Impedance Coupling Unit

Another feature designed to improve the smoothness of regeneration control is the use of an impedance coupling unit, T1, instead of the usual resistance coupling in the detector plate circuit. This results in smoother regeneration by allowing a respectable voltage to be impressed on the detector plate, and, also, provides a substantial increase in volume over that obtainable with resistance coupling.

The Output Tube

In order to obtain a low hum level, a heater-cathode type output tube is employed, which practically eliminates hum from the audio stage. This tube is the 2A5 pentode, and is quite similar to the filament type 47 in operating characteristics. With this tube combination, it is entirely feasible to operate a small magnetic loudspeaker on most stations. If headphone reception only is desired, it is advisable to employ a plate voltage of 180 volts or less in order to reduce the plate current to a satisfactory value. The volume can be readily adjusted for satisfactory headphone reception by means of the 250,000 ohm potentiometer, R3.

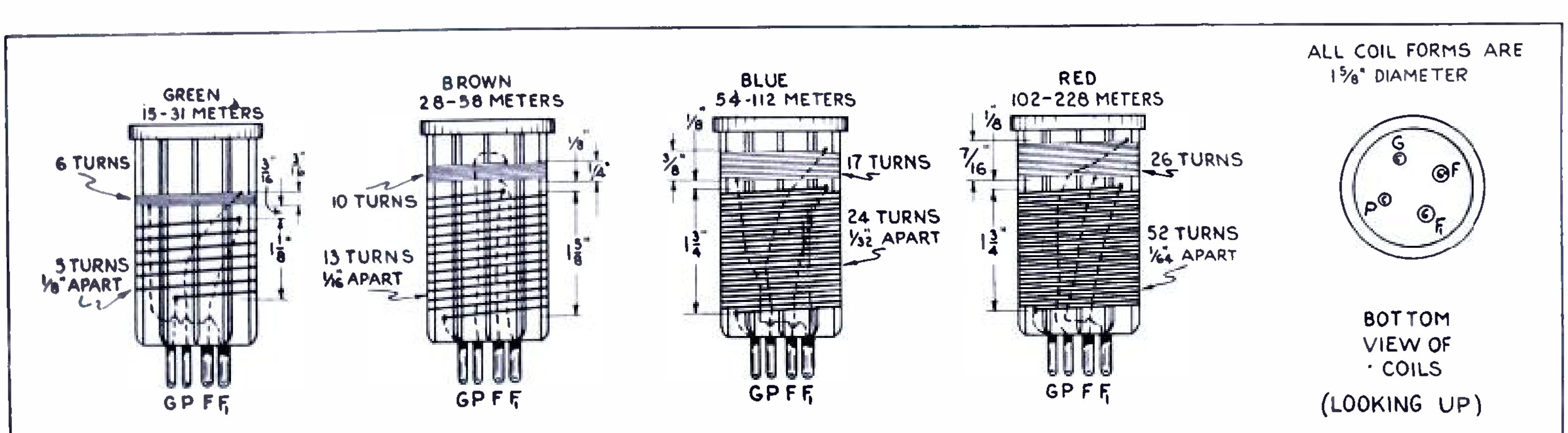
To reduce the hum originating in the detector tube to a satisfactory level, it was found necessary to enclose the detector tube in an aluminum shield. It was also found advisable to locate the grid leak and condenser so that the tube shield isolated them as much as possible from the field of the impedance unit. The proper location of these units can be noted from the photographs.

In addition to these precautions, it is also necessary to have a well filtered power supply containing at least two chokes and plenty of capacity. For best results, this supply should be located three feet or more from the set if at all possible.

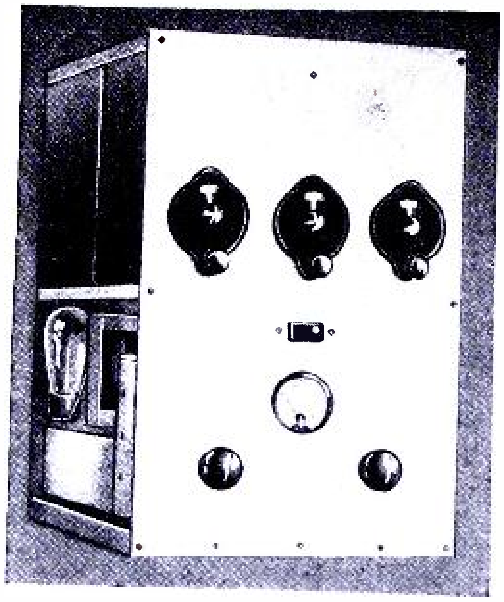
Noiseless operation requires, first of all, a well built variable condenser designed especially for short-wave reception. Condensers with coiled brass pigtails should be avoided. They invariably introduce all sorts of grating noises when used for reception below 50 meters. If pigtails are used, be sure that they are of the non-inductive variety designed especially for short-wave use.

Factors Affecting Noise

Other factors tending to produce smooth and noiseless tuning are a well designed, high ratio vernier dial and a composition type potentiometer for regeneration control. If a potentiometer having a grounded slider is used, it will be necessary to insulate the shaft from the panel. This can be done by cutting a hole in the panel sufficiently large to enable the threaded bushing of the potentiometer to clear the panel. By employing fibre washers between the nuts and panel and between the potentiometer casing and panel, it is possible to completely insulate the potentiometer. An alternative method would be to first mount the potentiometer on a bakelite strip which, in turn, is mounted to the panel. If this is done, it is, of course, necessary to drill a large enough hole to provide



COMPLETE COIL CONNECTIONS AND WINDING DATA FOR ALL BANDS



Replacing Obsolete 5-Meter Modulated Oscillators

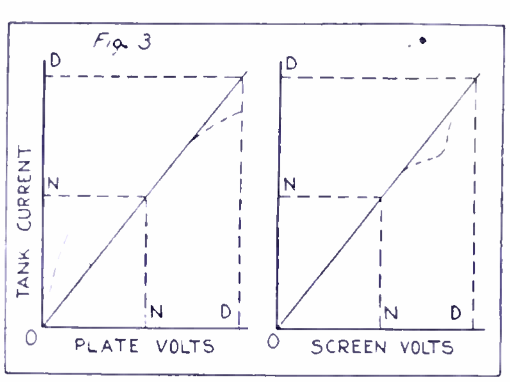
SUMMARY: *Part II of a series of three articles by Mr. Kruse on the why and wherefore of replacing obsolete 5-meter modulated oscillators. The first part gave a general outline of the problem; this, the second, gives a rigid technical discussion of "why"; and the third, the last part, will describe an actual transmitter using the principles discussed.*

The illustration to the left is a front view of a modern 5-meter transmitter built along the lines suggested by the author. It uses an oscillator, screen-grid buffer, and a modulated output amplifier.

IN Part I of this paper the almost incredible frequency instability of the primitive modulated-oscillator type of five-meter voice transmitter, with which the amateur world has been struggling these past two years, was pointed out. It was suggested that such low-grade performance was hardly in line with the results demanded in other bands, and that there exists no reason why it should be tolerated or permitted—at five meters, or why such equipment should be described.

Some experimental 1929 equipment was shown in order to emphasize the fact that for at least four years we have had both the apparatus and the information with which to make a decent 5-meter radiophone. It is, incidentally, interesting to note that since I somewhat forcibly called attention to these shortcomings some months ago, there have begun to appear really proper 5-meter rigs—showing that inertia alone was causing the delay. Of course, others, too, have been objecting to modulated-oscillator operation; many months ago Messrs. James Millen and Dana Bacon built and described a magnetron transmitter of good frequency stability, and used it to demonstrate that with a stable signal, reception was better with something other than a "zero-selectivity" receiver such as are now current. Five-meter rigs under crystal control have been built by many experimenters, usually for c.w. work.

* Consulting Engineer.



Showing why neither plate modulation (left) or screen modulation (right) can alone give good fidelity from a tetrode used as a modulatee, that is, a modulated r.f. amplifier.

By Robert S. Kruse, E. E. *

Taking for granted that our transmitter will be of the oscillator-buffer-modulatee type, just as on any other waveband, let us see what else is necessary. As a first requirement toward something modern, let us forget all desires to put the transmitter into a spectacle case until we bring the circuit up to date. During this business of getting up to date, we shall be better off in a frame-and-panel rig, without any model-builder's problems to complicate our electrical work. As a concession to portability—if necessary—we shall make the frame of aluminum and aluminum alloys, and keep its size down to what is really necessary for a rig whose output is but a few watts. The photograph shows this plainly enough.

Now, what tubes? For the oscillator, the 10 is beautiful; but its 7.5-volt filament is an infernal nuisance. The 45 does not last too long as a 5-meter oscillator, nor do some makes of 2A3. A number of other tubes are inferior 5-meter oscillators, so that the problem gradually simmers down to a choice of the 71A, 46, or 12A, of which I prefer the last; my only regret is that the somewhat sturdier 12, with the ½-amp. filament, is no longer made.

For the buffer, we shall, of course, use a screen-grid tube, and for this small set it may as well be a receiving tube. The 24, 51, 35, 57, and 58 all serve very decently, as do their 6-volt relatives. The life is not always long, but until we get that intermediate-size transmitting tetrode, we can well feed a few, cheap 24 tubes to the set in order to escape the nuisance of neutralization.

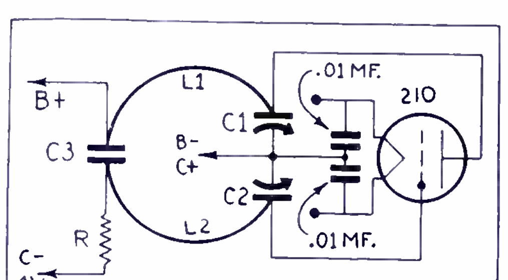


Fig. 4: The oscillator circuit repeated for those who came in after the picture started. It is the familiar Hoffman-Colpitts circuit with a very small inductance and high capacity. C1 and C2 are the sections of a 2-part Cardwell receiving condenser, with about .0005 mf. per section; C3 is about .01 mica; L1 and L2 are parts of the same single 2-inch turn of heavy wire; or 3-inch turn of heavy strap. R is 5,000 to 15,000 ohms.

For the modulatee—that is, the tube-to-be-modulated—we may use several kinds of the more capable output tubes, including the 10, 46, and 59, but not the 50, 2A3, 45, or 53—either because they do not work well or because they are too hard to drive adequately.

For no reason whatever, it seems to have been assumed that a 5-meter transmitter must depend on plate modulation. While it is perfectly o.k. to modulate in this manner, we shall show several other schemes that are not new, but useful in these small sets.

Before getting into details, we suggest consideration of the following useful combinations:

12A oscillator, 24 buffer, 59 modulatee (or push-pull pair) with plate modulation from an amplifier using two stages of 56 and a p.p. output stage with 2A3 tubes. The catch in this arrangement is that the output transformer has to be specially made.

The same, with plate modulation effected by a stage of 58 and one of 47, or better, a 2A5. The coupling transformer is one intended to work out of 45's in p.p. into the grids of class B tubes. The center taps on both sides are ignored, and the primary as a whole put into the 2A5 plate circuit while the secondary is put into the B+ lead of the 59. This doesn't give 100 per cent modulation, it merely gives about 30 per-cent more than you can secure by modulating an oscillator—and it isn't "all over the dial." The 59 is adjusted to draw 25 to 30 ma. All tubes are working with 250 volts on the plate in this and in the preceding arrangement.

The same as in the foregoing two paragraphs, but with grid modulation of the 59, which is now operated at 400 volts with a plate current of 20 ma., giving a carrier of about

4½ watts, the bias being —125 volts with enough r.f. grid input to produce the plate current just mentioned. One hundred percent modulation can now be produced if audio swings with peak values of 40 volts are fed to the grid, and *no* audio power is necessary. A 58 and a 56 stage suffice—believe it or not! Incidentally—you can modulate a p.p. output stage just as easily, getting 9 watts of carrier, which is ample for the present-day short-distance 5-meter work.

If more "hop" is desired than in the above combinations, use type 10 tubes in the output stage—how we need that new screen-grid tube! Run it with 700 volts on the plate with a bias of —135 volts, and feed in enough r.f. to produce a plate current of 15 ma., which will produce a carrier of some 6.3 watts. Or, use two tubes in p.p. and make it 13 watts. The same modulator rig suffices, a 58 and a 56. In all these grid-modulated rigs adjust the speech level to *just* draw grid current on loud sound peaks—I mean grid current in the modulatee.

If *that* isn't power enough, take a crack at a pair of 800 tubes in p.p. with a bias of 200 volts, plate voltage of 2000, and r.f. input such as to show a per-tube plate current of 20 ma., total 40 ma., carrier around 40 or 50 watts. This requires a buffer with more authority,—again we certainly need that successor-to-the-865—so we will reluctantly let neutralization creep in and use a second buffer consisting of a single 800 working at 1000 volts, with a grid leak of about 3000 ohms to supply its bias. The oscillator and first buffer might stay as they were, but we are now into 7.5-volt filaments anyway, and the whole thing has become costly, so one might as well jump off the dock and use a 10 oscillator and an 865 buffer.

Tetrode Output Stages

Having thrown rocks at the idea of neutralizing, it seems inconsistent to describe triode output stages—and so it is. If you can afford it, by all means use 865 tubes (for a while) or Western Electric 282s.

When modulating them, we remember that—as this chap Kruse has said in nearly every radio magazine—mere plate modulation will not give us a linear modulation like the slanting straight line in the first (left) chart of Figure 3; but will produce the dynatron bump (dotted) of uncontrolled oscillation on the downswing, and the screen-droop (also dotted) on the upswing. Dynatron action is reputed not to take place at 5 meters. Maybe not, but hitch a tetrode up to a cathode-ray tube and try to use it at 5 meters with plate modulation. The dynatron bump appears—though I will not testify as to its frequency. The fidelity is awful.

On the other hand, if we use screen-modulation alone, we have the effect shown in the right-hand chart of Figure 3. Up to about 70 percent modulation things are good enough, then the curve goes haywire, as they say at the University of Borneo. Of course, 70 percent is still more than twice as much modulation as we can get on the present crop of modulated oscillator dingbats—but let's get into step with the other bands!

To do this, we modulate both the screen and the plate or else we screen-modulate in two stages.

(Chorus from gallery—"Aw, you said that before." All right—why not do it? I'll say no more and let you read it up for yourself—and tell you where to find the dope if you don't know.)

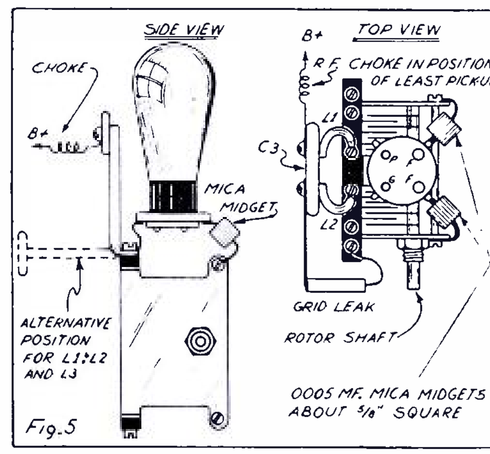
Now, our triode stages are of two distinct sorts—the plate-modulated ones, which require some neutralization, and our grid-modulated ones which don't require it. This sounds silly, but the explanation is that the grid-modulated ones require very little r.f. input, hence are very loosely coupled to the buffer-tanks. This leaves the grids without much in the way of a reactance across which feedback voltages can build up: hence the stability is really quite good, especially if adequate antenna coupling is used. Neutralization, if used at all, is uncritical.

Now, then, we can start doing something definite.

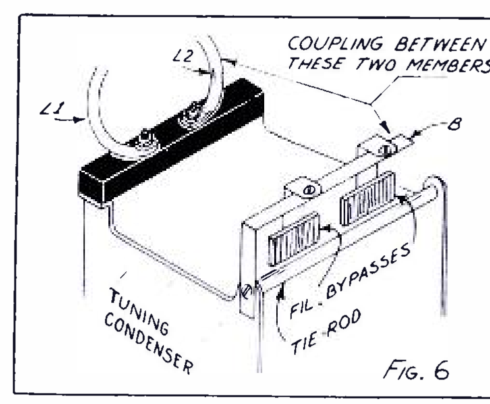
Since there are to be three tubes in the r.f. system, we shall place a transverse wall half way back, putting the oscillator and buffer ahead of it—just behind the front panel—and leaving the entire back compartment for the output stage, or modulatee. Since this output stage will sooner or later be tried in push-pull, we may as well begin by keeping both sides of the tuning condenser "off-ground." It is, accordingly, mounted on a small bakelite subpanel, and turned by a ¼ inch bakelite shaft extending forward through the division wall and the front panel to one of National's "velvet" dials—the central one on the panel. This location not only misses both early stages nicely, but allows symmetrical p.p. stages to occupy the back compartment.

In the forward compartment we have the oscillator, which uses the circuit shown once more in Figure 4, and the buffer, which is nothing more than a straightforward 24, r.f. amplifier stage. Push-pull isn't ordinarily needed here, hence the tuning condenser is "off-ground" by only a small amount, which is to say we insulate it for d.c., but ground it via a bypass condenser, generally a .01 mf. mica condenser. This permits us to use series feed and dodge one r.f. choke. At five meters this means something, and with care a voltage gain of four or better can be obtained. This isn't very good compared to the 90 we easily achieve in the i.f. stages of a broadcast receiver, or the 35 that we find in the r.f. stages of the same receiver, or

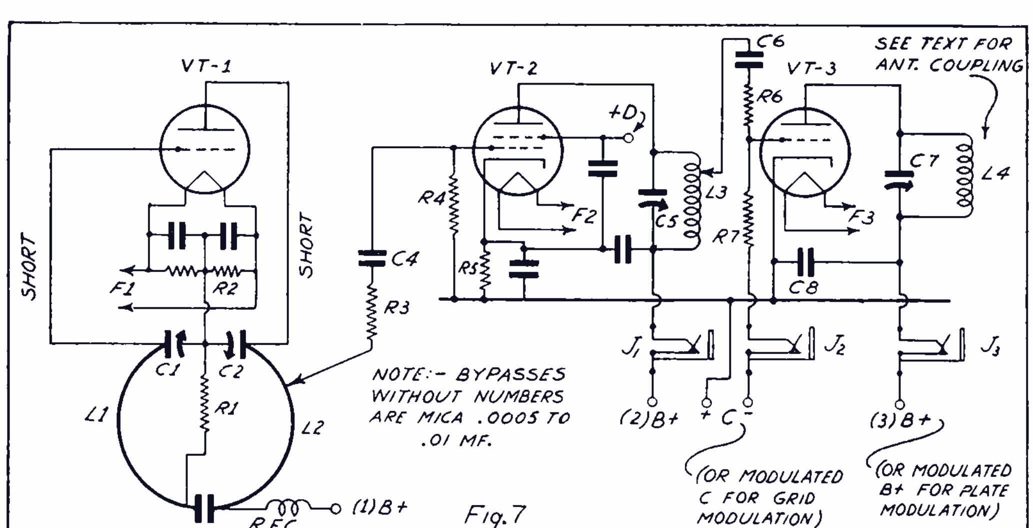
(*Continued on page 44*)



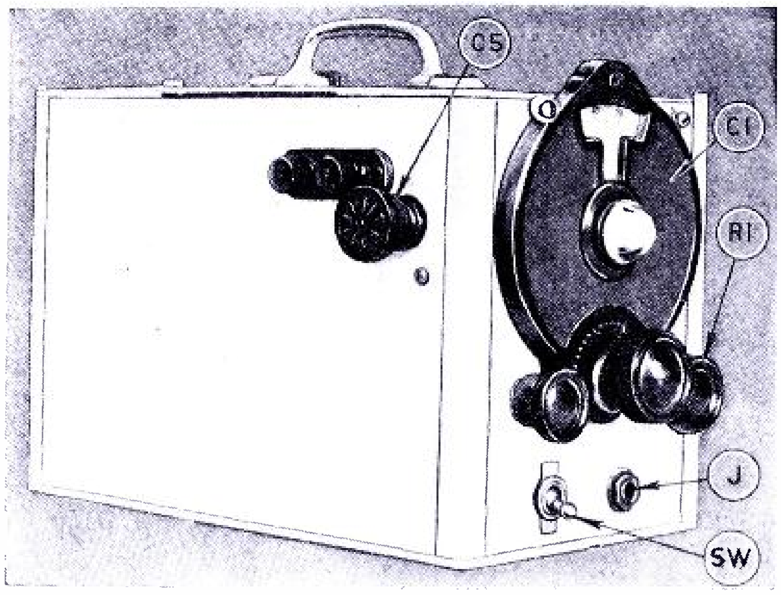
An oscillator construction. Compare with Fig. 2 in Part I of this paper.



A bad oscillator, see text.



Type-diagram, with constants temporarily omitted to concentrate attention on the entirely normal nature of the circuit. We have known this for many years; why use obsolete modulated oscillators?



THE COMPLETE PORTABLE RECEIVER

A Portable Set That Is Portable

SUMMARY: *Here is a real portable receiver that does not require six men to carry it around. Here is a real portable short-wave receiver that may be used in the home as well as in the field with equal efficiency.*

There is no doubt about the fact that portable short-wave receivers have appeared before; but we believe that the results obtained with the one described here, considering its extreme portability, are such as to bring it into first place. We take pleasure in presenting this description.

By Frank Lester*

MOST portable radio receivers are about as portable as baby grand pianos with handles attached to them. Although it is a very simple matter to make up a compact tuner-amplifier, the weight of the required batteries or other power equipment invariably is enough to discourage even the strongest and most rabid radio bug. All the enjoyment that the portable receiver is supposed to give disappears quickly after the perspiring owner has massaged his aching shoulder muscles for the twentieth time!

Of course, if you have an automobile, you really do not need a set belonging in the portable class, as you can use the car's storage battery for filament supply, and even carry a small dynamotor or vibrator type B power unit for plate supply.

Realizing this situation, the writer undertook the construction of a *portable* receiver so that he could have something to listen with when he visited the World's Fair in Chicago this summer. Never having been farther west than the Atlantic seaboard, he wanted to get an idea of short-wave receiving conditions in the Middle West. As he was traveling by train, compactness, lightness, and true portability were essential requirements. That he succeeded pretty well is indicated by the fact that his two-lunger survived 2000 miles of train, taxi, and elevated travel, and that he is more enthusiastic about short-wave radio now than ever before.

*In charge of Short Wave Dept., Wholesale Radio Service Co., Inc.

THE RECEIVER IN ACTION
Taken in Central Park, New York, a notoriously bad location.

Batteries Self-Contained

It was decided in advance that all A and B batteries must be built into the same container as the receiver itself. There were to be no outside accessories, except, of course, a pair of very light earphones and an aerial of thin, flexible wire. The phones were readily stowed away in a traveling bag, while the aerial wire, when not in use, was simply stuffed into the set cabinet itself.

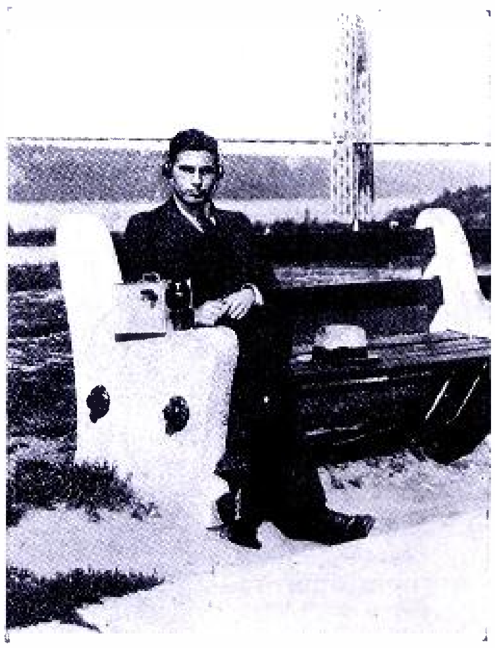
The receiver proper is a straightforward, trustworthy two-tube outfit, comprising a regenerative detector and one stage of transformer-coupled audio amplification. The tubes used were 30's. For filament supply, a large size 4½ volt C battery was used. This is the size measuring 4″ wide, 1¼″ thick, and 3″ high. For plate supply, a single 45-volt B battery is employed. This measures 4¼″ wide, 2½″ thick, and 6″ high. The case for the set is a standard aluminum shield can 9″ long, 5″ wide, and 6½″ high. This can has four corner posts, and the sides, bottom, and top are quickly removable.

On one of the ends of can are mounted the tuning condenser C1, the regeneration controls C2 and R1, the filament switch SW, and the earphone jack J. As the can is grounded and forms the B— A+ side of the circuit, the jack is insulated from the aluminum by means of two fibre washers. The hole for the jack stud is drilled out extra large to provide comfortable clearance.

The vernier dial shown in the illustrations sticks above the top of the can about half an inch. This was used only because a smaller dial was not available at the time the set was taken to Chicago. A three-inch dial was used originally, but this was broken by one of the writer's friends during a preliminary trial.

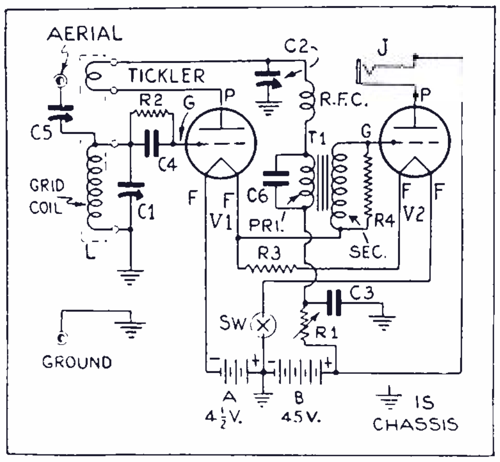
On the bottom of the shield can are mounted two tube sockets; an audio transformer, T1; a bypass condenser, C3; and a small r.f. choke. These are compactly arranged to cover exactly half of the base area. Another tube socket, to accommodate a plug-in coil, is mounted between the two tube sockets 3″ above the base. It is supported by two ¼″ brass rods, which are drilled and tapped at each end for 6/32 screws.

On the left side of the cabinet are mounted a two-plate variable midget condenser, C5, which is the antenna-



IN THE WIDE OPEN SPACES!
On Riverside Drive, with the George Washington Bridge in the background.

C1—50 mf. variable tuning condenser (National No. ES-50).
C2—50 mmf. midget variable condenser (Cardwell Balancet was used for size).
C3—1 mf. bypass condenser (Trutest).
C4—.0001 mf. mica grid condenser (Solar).
C5—two-plate midget variable condenser, made by cutting down five- or seven-plate midget (Trutest).
C6—.001 mf. mica condenser (Solar).
R1—50,000 ohm potentiometer regeneration control (CRL).
R2—5 megohm grid leak (Trutest).
R3—8 ohms fixed resistor (Trutest).
R4—1 megohm grid leak (Trutest).
T1—3½ to 1 ratio uncased audio transformer (Trutest).
SW—Single pole snap switch (Trutest).
J—Single open circuit earphone jack (Trutest).
3—four-prong bakelite base tube sockets, one for plug-in coil L, the other two for tubes V1 and V2 (Na-Ald).
V1, V2—Type 30 tubes.
1—double binding post strip marked ANT. and GND. (Eby).
1—Vernier dial, National midget type B.
1—aluminum shield can 9" x 5" x 6¼".
L—short-wave plug-in coils, any standard four-prong, two-winding coils are satisfactory, such as Octo or Trutest, etc., or home-wound according to directions given.
1—pair of light earphone with plug attached.
1—4½-volt C battery used for filament supply (Burgess No. 2370).
1—45-volt B battery (Burgess No. 5308).
Incidental hardware such as bakelite strip for mounting of C5, brass rods for mounting of coil socket, insulated push-back wire, etc.

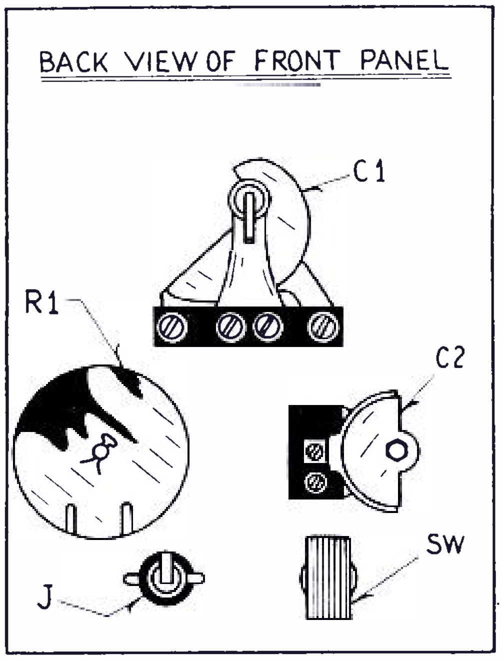


SCHEMATIC CIRCUIT OF THE PORTABLE

coupling condenser, and a double binding post strip. C5 is actually mounted on a piece of bakelite measuring 1¼" x 2". A large hole is drilled in the aluminum to clear the mounting stud. The bakelite piece is then fastened by one of the same screws that holds the binding post strip and by one extra 6/32 screw. This bakelite mounting is necessary, of course, to insulate the condenser from the grounded can. The two-plate condenser was made by cutting down an ordinary five-plate midget.

The Circuit

The hookup is very simple and the wiring should not take more than 30 or 40 minutes. Note carefully that the tube filaments are wired in series and are connected directly across the A battery, with an 8 ohm fixed resistor, R3, also in series. The filament battery has given remarkably good service. The same unit was used continually for 3½ weeks during the very hottest part of the summer, and lasted another 2½ weeks when the portable receiver was lated used as a station monitor. The drain on the B battery is, of course, very light, and a life of 9 to 12 months is expected.



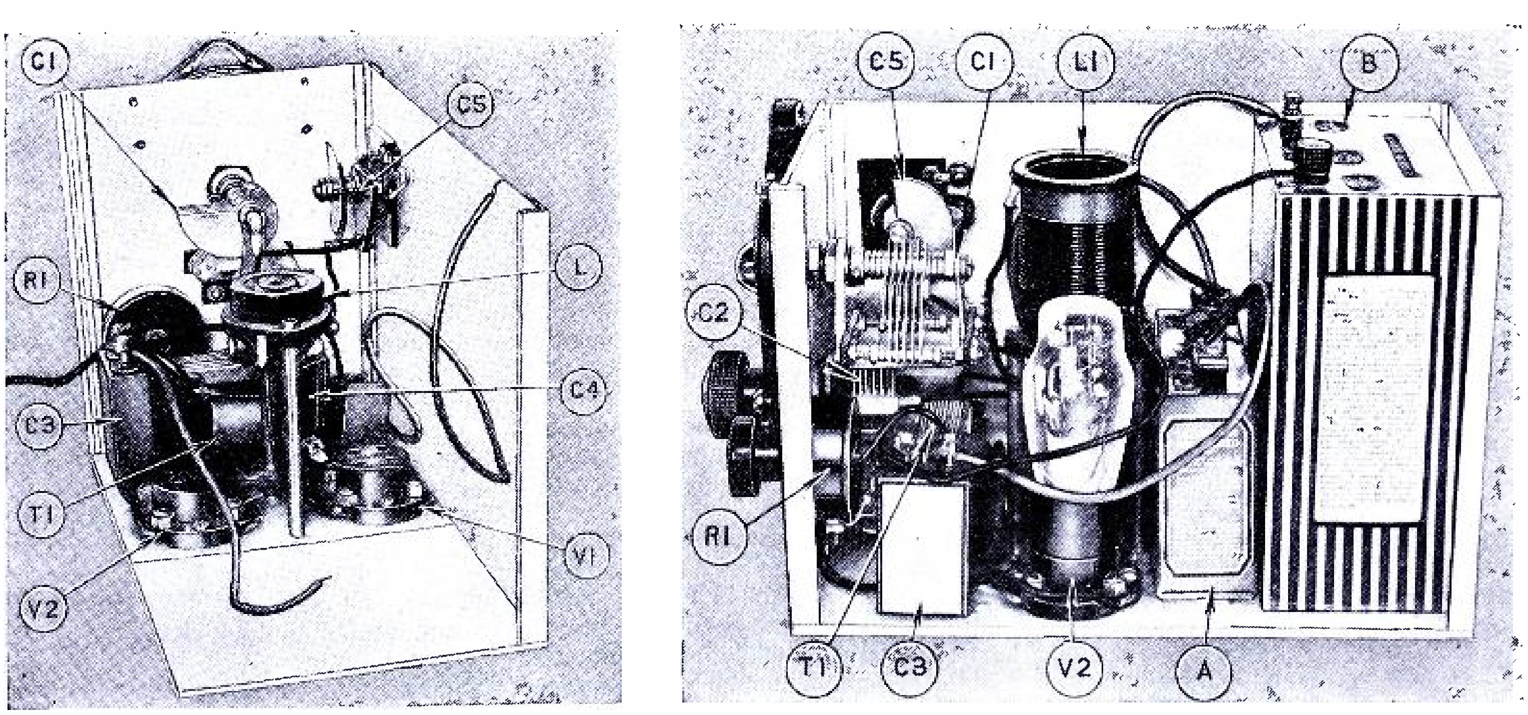
PLACEMENT OF PARTS ON FRONT PANEL

The cover of the shield can is fitted with a 10c door-handle and simply screws in place. To change coils, it is necessary to unscrew the cover. This sounds like a nuisance, but actually the 40-meter coil is used most of the time. If coil-changing is contemplated, the cover is simply left off and not replaced until another move is made.

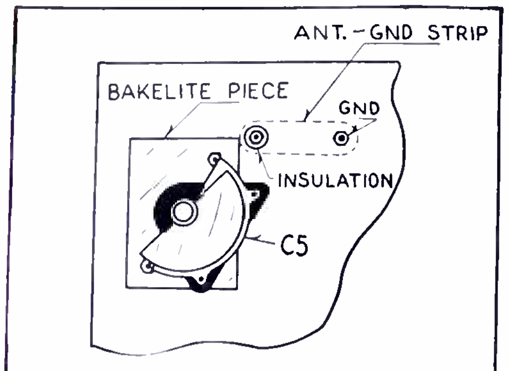
In Chicago this receiver brought in amateurs from every district in United States and Canada and numerous foreign amateurs as well, with nothing more than 10 feet of flexible Christmas-tree wire for an aerial and a steam radiator for the ground. The wire was simply dropped from a hotel window. On the 49-meter broadcast channel, short-wave broadcast stations in Central America, England, and Germany were heard. Of course the volume with a two-tube set is not very great, but the absolute absence of background noise of any kind makes reception of even weak signals very easy.

May Be Used as Monitor

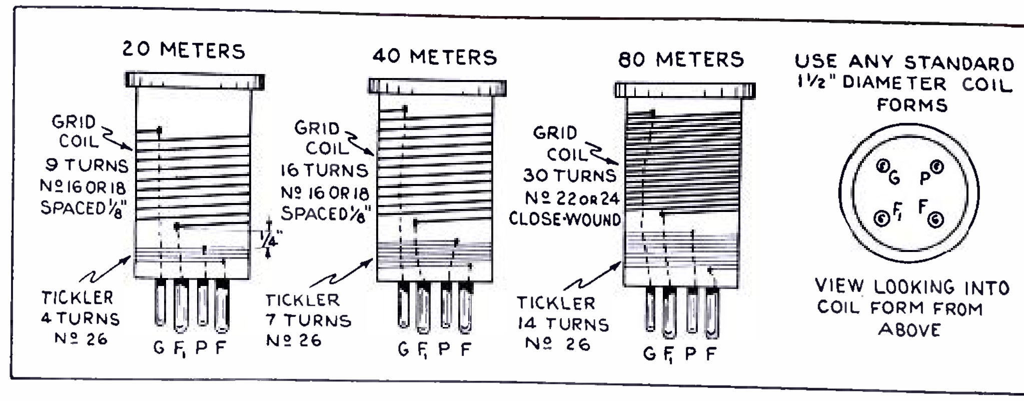
Since it is completely self-contained and also pretty thoroughly shielded, this little receiver makes a very simple and reliable monitor for an amateur transmitting station. It may be calibrated quite easily by using it first as a regular receiver and spotting the positions of marker stations of known frequency on any particular frequency band. In this connection, it is important to take



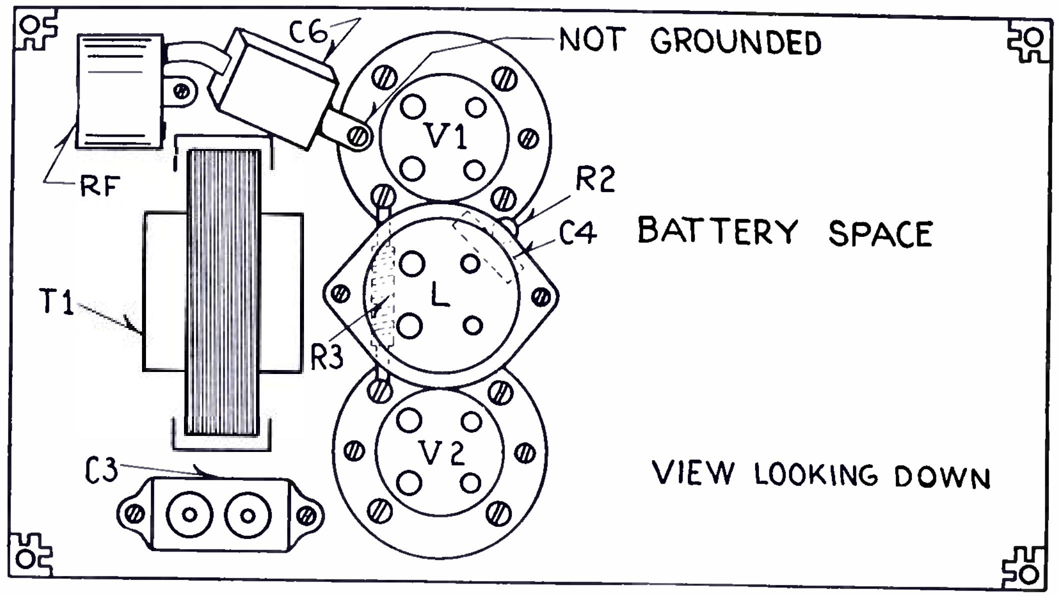
TWO INSIDE VIEWS OF THE PORTABLE RECEIVER MARKED FOR CONVENIENCE



DETAILS OF C5 MOUNTING



CONSTRUCTION DETAILS OF THE COILS USED IN THE PORTABLE RECEIVER



TOP VIEW, LOOKING DOWN, SHOWING PARTS PLACEMENT

into account the detuning effect of the antenna. To insure accuracy for monitoring purposes, calibrate the dial with an extremely short antenna—say, three or five feet in length. Fix the antenna condenser C5 in one spot and leave it there, and then use this entire setup for monitoring. If a three- or five-foot antenna picks up too strong a signal from the transmitter being monitored, cut it down a foot at a time. Even with a wire only a foot or so long, good recognizable signals can be picked up from amateur and commercial stations for calibration purposes.

Editor's Note

The editors of SHORT WAVE RADIO had an opportunity to play with Mr. Lester's receiver for several days. It was carried by hand in the New York subway during rush hours and was tried in a number of different locations, some noticeably good and some noticeably bad. One of the good spots, for instance, was upper Riverside Drive, just south of the George Washington Bridge across the Hudson River, which is shown in one of the accompanying illustrations. A ten-foot length of wire hung between a bench and a small tree brought in hundreds of amateurs on the 40-meter band and a number of domestic short-wave broadcasting stations.

In Central Park, which is one of the poorest radio locations in New York, the results were not as good, but were still very interesting. Because it could be gotten into operation in less than a minute, this little outfit provided some extremely interesting experimentation. The shielding effects of large buildings were readily noticeable, as signals could be received quite well from one direction, but not another. By walking around with the set in one hand, the phones clamped on and the aerial trailing along on the ground, it was possible to determine the limits of the dead spot areas quite accurately.

A Codeless Amateur License? No!

ALTHOUGH we doubt if anyone in Government circles is giving the matter any serious thought, there seems to be a lot of noise at the present time about creating a special class of amateur license that will not involve a code test. Considering the numerous and unmatched privileges already enjoyed by the American amateur, it seems to us that any demands for a license class of this kind are ridiculous. Many honest amateurs admit that even the present test is too easy, and is bringing many irresponsible persons on the air. Of course, everyone has to begin some time, so we must forgive the beginner his rotten fist or his hoarse modulation, as long as he stays within band, uses d.c. for plate supply and otherwise conforms to the spirit, as well as the letter, of the Federal Radio Commission regulations.

When you stop to consider that the American amateur is not even required to pay a cent in the way of license fees, that he is permitted to operate absolutely unhampered, and that the Army and the Navy defend him at international conferences while the highly military governments of other nations try to wipe him off the map, we think it is time to stop biting the hand that feeds us, so to speak.

The recent federal economy wave was responsible for a serious reduction in the technical administrative staff of the F.R.C. You can just about imagine the mess that would be created by a lot of unchecked so-called "amateurs" who are willing to jeopardize their own freedom by their unwillingness to learn the code, which, after all, is the real language of radio.

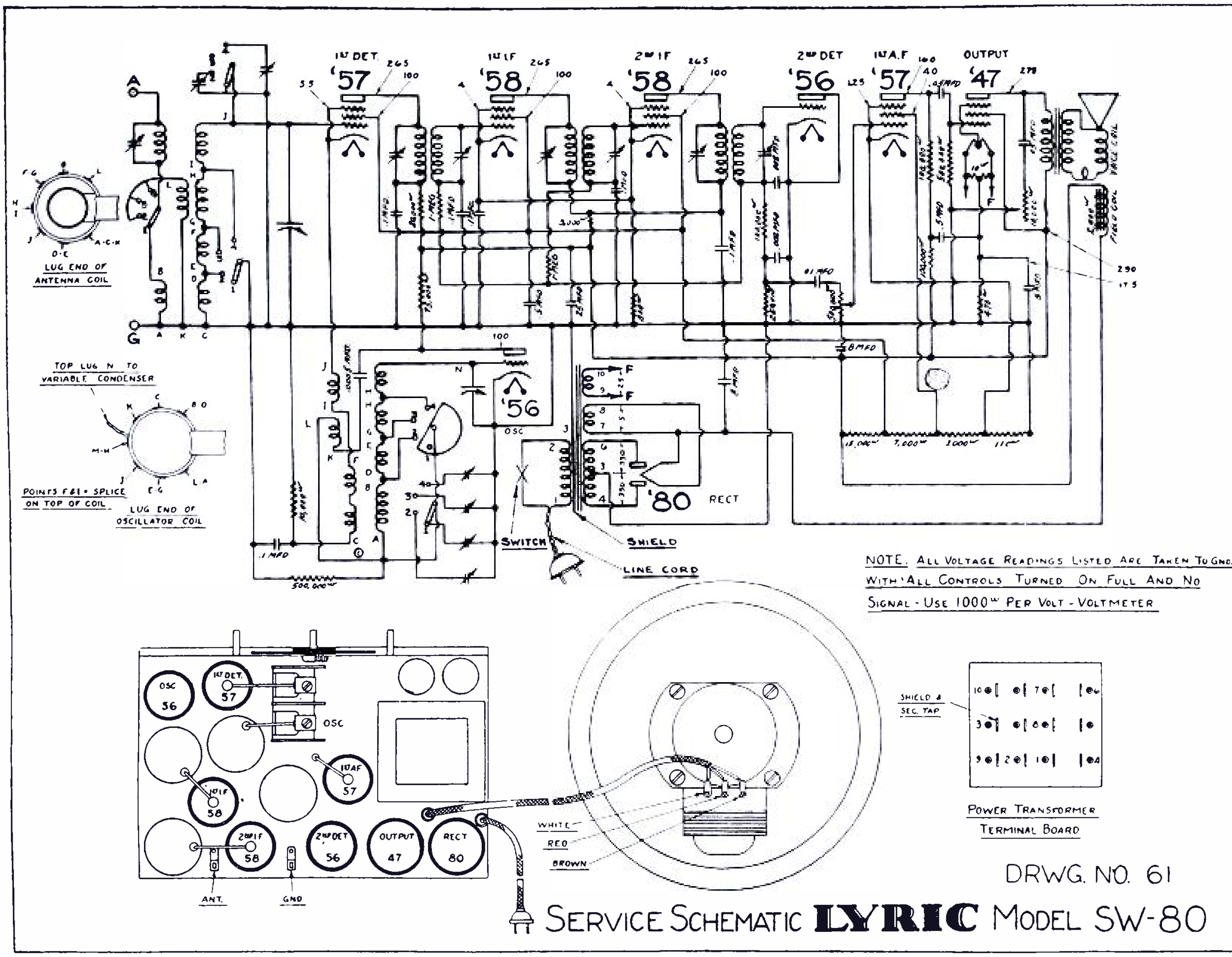
Why do some people consider the code a stumbling-block? It is really very easy to learn, as 10-year old children and 75-year old patriarchs have discovered. Besides, a knowledge of the code greatly increases the enjoyment that you can obtain from a short-wave receiver, even if you have no intention of applying for an amateur license.

To many people not familiar with the code, the host of mysterious dots and dashes that sometimes interrupts music are things which should be eliminated by law; but to those with even a slight knowledge of the code, these mysterious interruptions are highly interesting.

Airplane, coastal and naval stations, all transmitting information that really makes sense, may easily provide hours and hours of entertainment, especially when you want to get away from the beaten path.

—*R. H.*

Diagram of New Lyric All-Wave Receiver



THE growing interest in short-wave reception is reflected in the appearance of a number of excellent all-wave receivers, produced by firms that heretofore have specialized exclusively in straight broadcast sets. One of the latest receivers of this type is the Lyric model SW88, which uses a chassis designated as SW80. A complete schematic diagram and service sheet, with the values of all parts indicated, appears herewith. This was furnished through the courtesy of E. Wesselman, of the Engineering Department of the Rudolph Wurlitzer Mfg. Company, the manufacturers.

This receiver is designed for the reception of broadcast signals on all frequencies between 550 kilocycles and 22 megacycles, or between 546 and 13.64 meters. The selection of any desired band is made by means of a four-position change-over switch. The intermediate frequency is 485 kc. No provision is made for the reception of continuous wave (telegraph) signals, as the set is intended primarily for use on broadcast stations.

Book Review—"The Inductance Authority"

THE INDUCTANCE AUTHORITY by Edward M. Shiepe, B.S., M.E.E., published by Herman Bernard, New York, N. Y., 9 by 12 inches, 50 pages, practically all illustrations, leatherette cover. Price, $2.00.

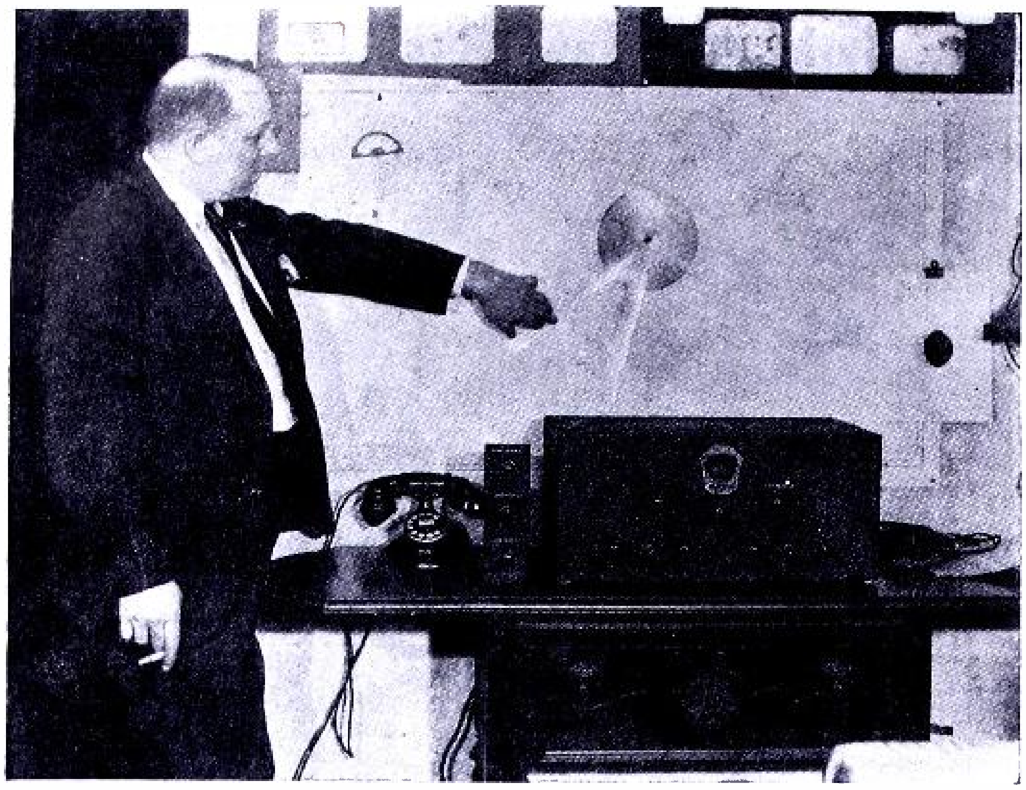
Probably the greatest factor that tends to confuse the mind of the average set constructor is that of coil information. The question, "How many turns shall I wind on that coil?" is asked by the same experimenters over and over again, for it seems that every set requires just a little different coil design than the preceding one. This holds true regardless of whether coils are used for the short waves or for the broadcast band.

The author of this book has made, in the opinion of your reviewer, a very excellent and practical contribution to the field of radio. One of the most significant factors is that of the 50 pages in the book, over 40 are completely filled with charts; about 10 pages are devoted to explanations of the use of the charts.

Although the information available from these is valid for close-wound coils, the author, nevertheless, gives good data on how to calculate space-wound coils specially suitable for short-wave work.

Another valuable feature of the book is the numerous numerical examples which serve to illustrate the principles set forth. These examples not only aid in interpreting the curves, but more than that, they represent actual figures usually found in practice. Complete coil winding data for various diameter forms and for frequencies between 160 and 20,000 kilocycles (1875 to 15 meters) are included. Data are also given for various sizes of wire between No. 14 and No. 32 for enameled, single cotton covered, double silk covered, single silk covered, and double cotton covered insulation.

This book should prove an excellent standby for those who find the need for quickly determining the size of inductance and number of turns for radio work. L. M.



The Captain with his charts, distance finders, and a new Postal "International" receiver.

Capt. Hall's Department on Foreign Stations

Day Waves and Night Waves

When reading magazines which devote space to the short waves, I have seen many articles about tuning receivers. The chief point that interests me and all up-to-date short-wave fans is the writers' beliefs that for good tuning results it is rather a waste of time to fish on the low wavelengths after dark. By the "low wavelengths" we must naturally take into consideration the nineteen-meter band, as that band is a very interesting one for all fans.

Now to go back to 1928, my own first short-wave tuning days. Everything that was told me about "don'ts" and "do's" in tuning I listened to, thought over, and then tried out for myself. Fellow fans always used to tell me that my coils that took in the nineteen-meter band were known as the "daylight coils" and that the other extreme end, the forty-nine-meter band coils, were known as the "night time" coils. Not sure that these advisers really knew what they were talking about, and with nothing else to do, I fished many a time with "daylight" coils in the night time and vice versa. The results were startling even to my friends, who, not wanting to be proven wrong by a beginner in the game, and still holding to their antiquated views about night and day wavelengths, used to pass over the subject of my results with, "Well, that was just an accident!"

To the short-wave fans who believe in these ideas, the report that Pontoise, France, was going to broadcast on 25.60 meters until midnight came as a decided shock. They really seemed to resent the idea of any station daring to attempt to operate on a "daytime" wavelength in the night time. Days passed and these fans were just beginning to rejoice in the idea that France could not be heard here because of the wave they were using, when the true reason was that Pontoise had not started to put across their programs. One night over came the transmissions from Pontoise, loud and clear, with tremendous volume—and on 25.60 meters!

The foundation under my short-wave friends' feet was weakening. Their pet theory was nearly overthrown, but not quite. Then, like a bombshell exploding at their feet, we heard that Daventry was starting to send test programs on 19.82 meters *at night*. This was too much for these loyal "day" and "night" band believers. No one need ask any tuner how Daventry came over on that wave! They were clearer and far more satisfactory than when they were among the "forty niners."

Germany has since followed suit, and shoots programs over to her listeners here in the states on 25.51 meters until after seven o'clock, and then jumps to 31.38 meters, where they continue to transmit enjoyable programs.

> **This Department**
>
> *In this department, which is conducted exclusively by Capt. Hall, the latest "meat" on foreign stations is given. The photographs which appear here have been collected by the Captain and are reproduced to illustrate what can be received from foreign stations aside from programs.*
>
> *The Captain wants you listeners to write to him about your own results. If any of your comments are printed, you get full credit. Write your letters to the editors, attention of Captain Hall. They will be forwarded immediately.*

More on "Veries"

Swapping stories on verifications is a topic of conversation among fan friends, and when three or four ardent tuners get together, much information and misinformation fills the air.

When fellow short-wave fans view my collection of verifications, which I have gathered from thirty countries, they invariably ask the following questions: "Just how do you know what language to write in?" Secondly: "How do you know what they are talking about when they answer you?" And thirdly: "What is the secret of your success in getting answers from these foreign stations?"

In my opinion, answering the last question is the most important and probably by far the one that will benefit other prospective collectors of "veries." Now to detour slightly from the subject, I know that these few remarks will be found to have bearing on the answer. In my mail bag there are always letters from fans asking questions, giving station data, etc. Sometimes I have real difficulty reading these otherwise interesting letters, simply because the writing is so poor. Now, I sometimes think of how difficult it is for the officials in charge of *foreign* stations to read these illegible letters. How can a director of a station verify a program when he cannot even understand what has been written to him? To put this paragraph into one sentence: typewritten letters are the best, almost a necessity when writing for verifications. If you haven't a typewriter yourself, find a fellow fan or a friendly neighbor with one, who will type your letter.

Now we will go back to the first question. Although I recognize many languages when I hear them on the air, which probably benefits me by helping me to identify stations I have not heard before, I cannot write in these foreign languages. being limited in that respect to our own English. Being so "language bound," it is an impossibility for me to write to these foreign stations in their own language. Very few fans are linguists, and, therefore, they are in exactly the same predicament as I am in. I always write in English, and ninety percent of the answers are written in the same language.

The answer to the second question is longer and more complicated. but very interesting. In 1928 I received my first short-wave "veri." That was from VK2ME, which acknowledged on a card. This naturally was written in English, as we all know that it is the language used in Australia. From 1928 to 1931 my interest in the short waves lagged. due to lack of capable receivers and the absence of information on the short-wave stations as to their schedule of time on the air, etc.

In the later part of 1931, I reentered this game and started collecting veries on a large scale. The next one was from F3ICD, Saigon, Indo-China. There was quite some difficulty attached to getting a response from this distant country. I had been receiving this station daily, although the program I was hearing was only of fifteen minutes duration, due to the fact that the scheduled time on the air of W2XE, New York, was such that they came on the air and completely blanketed Saigon. After hearing several programs from this Asiatic station, I decided to take a chance and write them and see if and when they would answer my communication. I addressed the letter to "Radio Station F3ICD, Saigon, French, Indo-China." I waited what seemed an endless time, and then, receiving no answer, I wrote again, enclosing another program. Still no answer. Again I wrote and enclosed still another program.

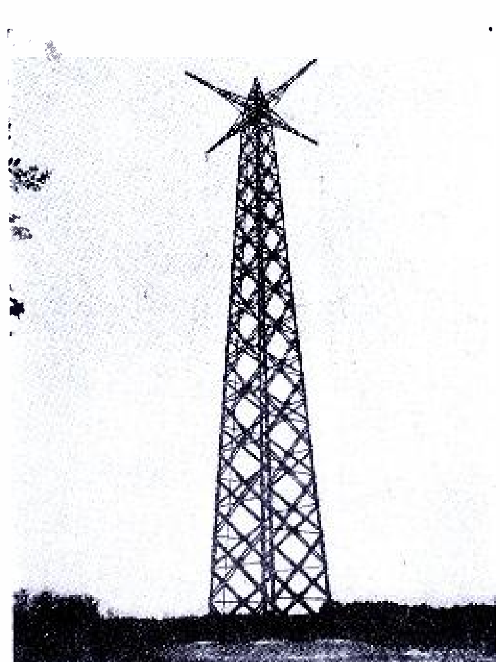
A Real "Veri"

After three months I received a letter written in perfect English, from *"L'Ingenieur chef de Station,"* in which he acknowledged receipt of my letter and informed me that enclosed I would find several articles: (1) A notice of our broadcasting station; (2) a copy of our weekly publication "Radio Saigon," subscription five dollars in Indo-China dollars; (3) a subscription form for a Listeners Assistance to the development and the improvement of our transmissions. The yearly subscription is $25 (Indo-China dollars, also). There followed a paragraph or two on whom to make checks payable to and the ordinary forms of sending a letter followed. Within a day of two I received a heavy magazine from the station with pictures of the interior of the station and letters or testimonials from other listeners; also reception results of individual tuners from one corner of the globe to the other. This book was very interesting and still is my star veri.

A SECTION OF THE WALL OF DX CARDS IN THE CAPTAIN'S DEN

While waiting for Saigon to answer I had been sending out letters to foreign stations which included Germany, England, France, etc. Germany did send and still sends a stereotyped letter to all listeners who send in reports of reception. The "D" stations are very thankful for these reports. Letters are in German and very long. They include no scheduled time on the air, but the wavelength and call letters are mentioned, and also, details on power, etc.

France sends a card written in French with blank spaces on it for the *"Directeur du Service de la Radiodiffusione"* to fill in. This country takes a long time to answer, if ever.



PHOTOGRAPH OF THE DIRECTIONAL AERIAL USED AT BERLIN

Daventry sends a card acknowledging receipt of your letter, but cannot verify specific reports due to more than one wavelength being used simultaneously.

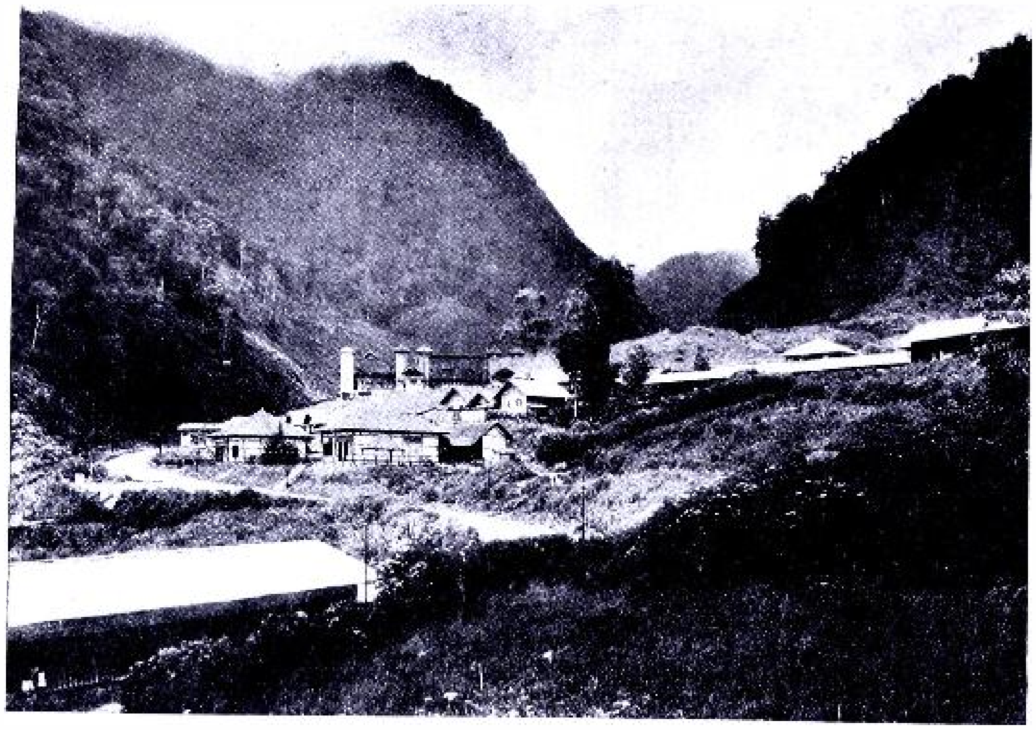
2RO, Rome, Italy, is another station that is easy to hear, but hard to hear from. When they answer, they send a card written in Italian. The card is printed in three colors: red, white, and black. The letters 1RO and 2RO take in the entire length of the station card.

The most interesting and thrilling veries come from the Far East. On the envelope are letters in Siamese which are printed in a heavy ink, resembling paint. Under these characters are the words in English, "Post and Telegraph Department." On the flap of the envelope is the official crest, which resembles an idol, or Buddah, with spread double wings and a head.

This same crest is printed in the upper left-hand corner of the letter with *"Telepost Bangkok"* printed in this same heavy ink. The letter is numbered for future reference and the body of this message is written in perfect English and signed by the "Superintending Engineer of Radio." This is a veri well worth the necessary three months to get.

From Java we also get a letter of interest, not so truly Oriental as the one from Siam, but just as "rare" a catch. The letter is written on a very heavy paper with no water mark. The firm name and address are written in Dutch. The communication sent by the listener has been numbered and the answer is written in English.

Now a certain station in Japan, not J1AA, sends out a very pretty post card picture of its antenna system. This card is enclosed in an envelope of transparent paper. On this envelope is a sketch of the volcanic mountain Fujiyama and also



MALABAR TRANSMITTING STATION NEAR BANDOENG, JAVA
The vertical fan antenna is strung between two mountain peaks!

some Japanese lettering. Under this in the same language is the time schedule and other information concerning the station.

A station in the Far East that does not QSL with a card or letter is VUC, Calcutta, India. An official magazine printed by the station devotes several pages to letters from listeners who report reception of this "rare" one. The magazine has many pictures in it and much information. One paragraph in this booklet says, "Those desirous of a reply to their correspondence must always send a stamped addressed envelope for a reply. No replies will be sent otherwise. Also please remember to write legibly or in block letters if typewriter is not used. We do not keep hand writing experts to decipher unintelligible writings and signatures." In the July 7th issue only two Americans have received recognition.

A station that verifies in French is the Indo-China phone, FZS. The mother station is in Paris, and controls FTE and FTA, St. Assisse, France. This veri is in French and is one that is difficult to understand

British Amateur Regulations

In the mail bag was a very interesting letter from a British shortwave fan who has just become an amateur. The rules and regulations of the Government of Great Britain for amateurs are very exacting. Amateurs here in the States may be interested in knowing some of them.

All sending stations must be equipped for reception. Applicant for a license must be of British birth. For those who want a radiating aerial the examination requires that he have an adequate knowledge of the adjustment and operation of the apparatus and an operating speed of at least twelve Morse words a minute, sending and receiving. A fee of five shillings is charged for this examination.

For each station authorized to use power up to ten watts the initial licensing fee is ten shillings plus an annual fee of one pound. Higher fees are charged for more powerful stations. If apparatus is also used for receiving broadcast programs for entertainment, a wireless receiving license must also be held.

Amateurs are limited to the following wavelengths:

173.4 to 151.1 meters.
42.7 to 41.24 meters.
31.33 to 20.88 meters.

If special justification is shown the licensing officials, the following meters may be permitted:

10.7 to 10.02 meters.
5.35 to 5.005 meters.

Ordinary transmission will be limited to code work and telephony.

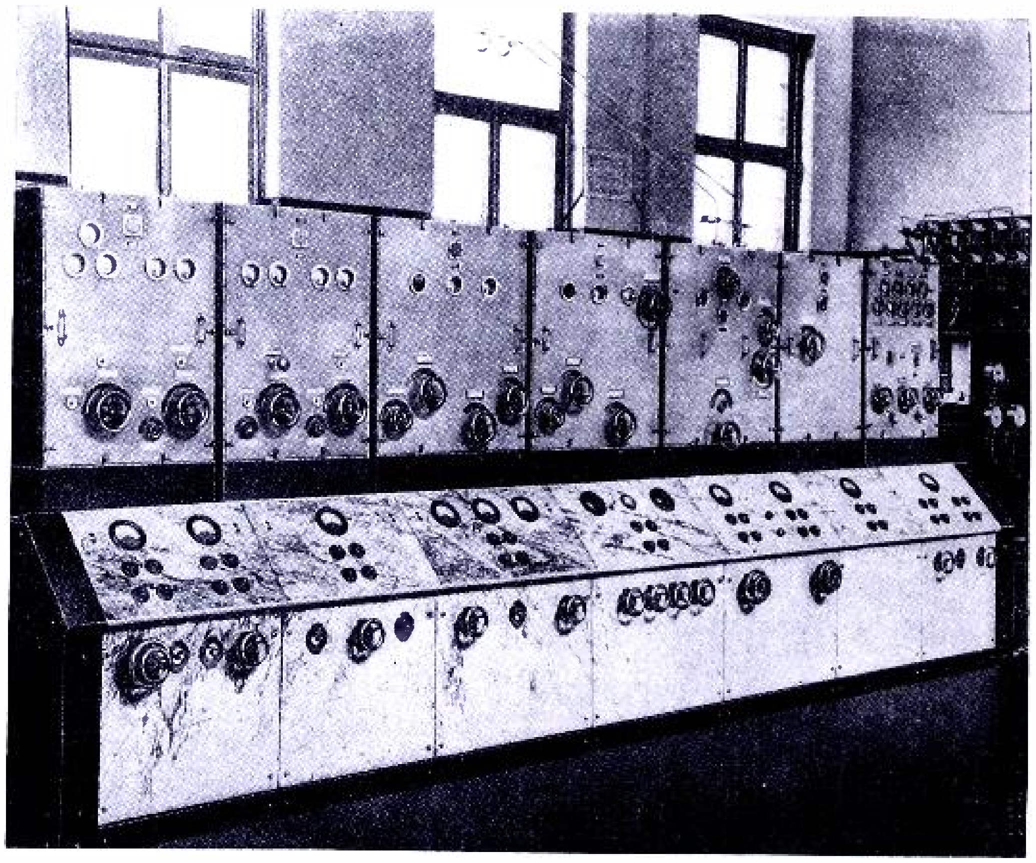
Aerials are limited to the following dimensions: combined height and length not to exceed one hundred feet.

Licenses are also given to chaps who desire to transmit with an "artificial aerial," that is a non-radiating aerial. No Morse qualifications are necessary.

The last mentioned license is the type my friend has obtained.

An "artificial aerial" means a closed, no ground, oscillator circuit possessing inductance, capacity, and resistance, and functioning in place of the usual aerial-earth system. It must be as near non-radiating as possible. The inductance should be in one piece and of small dimensions, as distinct from an inductance of large dimensions, such as a frame aerial. The maximum area formed by the turns of the inductance shall not exceed one square foot, and any lateral dimension or, in the case of a circular or oval inductance, shall not exceed one linear foot.

The "artificial" aerial circuit must be so arranged as to reduce radiation to a point at which signals from it will not be perceptible outside the building in which the apparatus is installed, and no attempt shall be made to send signals to other stations. It is intended that the effects produced by the sending apparatus shall be ascertained by means of suitable detecting or measuring devices coupled with or used within a few feet of the inductance of the "artificial" area.



THE MAIN TRANSMITTER USED AT THE BERLIN STATION
The fancy sloping panels are characteristic of German radio apparatus.

For the Station List

With the help of our innumerable correspondents we were able to greatly improve our list of stations heard.

PSH, 29.35 meters, Rio de Janeiro, Brazil, sending programs for the Radio Club of Brazil.

LSX, 28.98 meters, Buenos Aires, sending tests programs to America.

XETE, Mexico City, Mexico, roaming all over the dials from 29 to 31.25 meters; most irregular.

RV59, 50.00 meters, Moscow, U. S. S. R. This station will be heard now that the winter is approaching.

JAVA, 48.3 and 49.15 meters, testing and using a speech scrambler.

VE9JR, 25.60 meters, Winnipeg, Canada.

VE9HX, 49.10 meters, Halifax, Nova-Scotia, Canada.

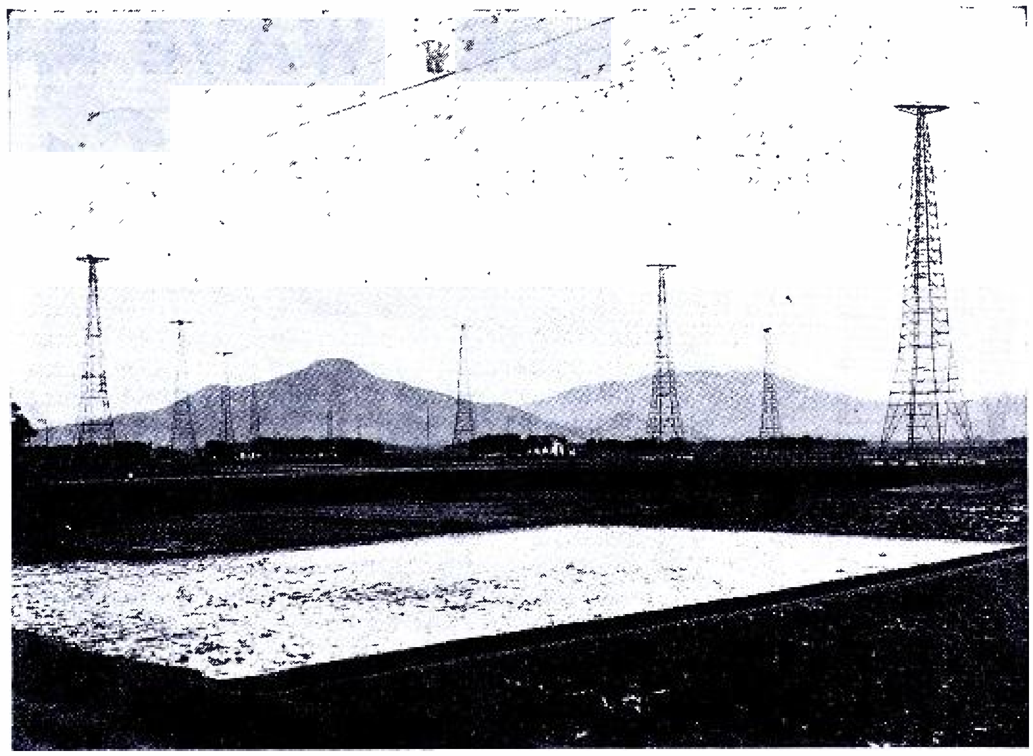
PRADO, 45.31 meters, Rio Bamba, Ecuador. Thursdays from 9 to 11.30 p. m., sending very fine programs.

EAQ, Madrid, Spain, 30.00 meters, always coming in with an R-9 signal.

HI1A, 49.89 meters, Santo Domingo, Dominican Republic, has been sending some wonderful programs.

YV3BC, 48.95 meters, Caracas, Venezuela, has been sending programs received here with fine volume and clarity.

YV1BC, 49.1 meters, Caracas, Venezuela, hard to pull in when band is busy.



THE RANBJA EKEK RECEIVING STATION NEAR BANDOENG, JAVA
The antenna consists of wires—usually two—strung between the towers.

RADIO CENTRE, SOLIANKA 12, MOSCOW U. S. S. R.

PROGRAMME FOR OCTOBER, 1933

PART 1		HOURS OF BROADCASTS	
DAYS	23–24 Moscow Time 21–22 Cen. Europe T. 20–21 Greenwich T.	0–1 Moscow Time 22–23 Cen. Europe T. 21–22 Greenwich T.	1–2 Moscow Time 23–24 Cent. Europe Time 22–23 Greenwich Time
	Language and Wavelength	Language and Wavelength	Language and Wavelength
Mon.	German 1481 and 50 m.	*English* 1481 m. 50 m. Hungary 424.3 m. and 45.38 m.	German 1481 and 50 m.
Tues.	German 1481 and 50 m.	French 1481 m. 50 m. Dutch 424.3 m. and 45.38 m.	*English* 424.3 m. and 45.38 m. German 1481 and 50 m.
Wed.	German 1481 and 50 m.	*English* 1481 m. 50 m. Czech. 424.3 m. and 45.38 m.	German 1481 and 50 m.
Thurs.	German 1481 and 50 m.	French 1481 m. 50 m. Swedish 424.3 m. and 45.38 m.	*English* 424.3 m. and 45.38 m. Spanish 1481 and 50 m.
Fri.	German 1481 and 50 m.	*English* 1481 m. 50 m. Czech. 424.3 m. and 45.38 m.	German 1481 and 50 m.
Sat.	German 1481 and 50 m.	French 1481 m. 50 m. Czech. 424.3 m. and 45.38 m.	*English* 424.3 m. and 45.38 m. Spanish 1481 and 50 m.
Sun.	German 1481 and 50 m.	*English* 1481 m. and 50 m. Swedish 424.3 m. and 45.38 m.	German 1481 and 50 m.
Sun.	4–5, 6–7 Moscow T. 2–3, 4–5 Cent. E. T. 1–2, 3–4 Greenw. T.	English 50 m. News Bulletin	

A typical program issued by the U. S. S. R.

The Jamestown N. Y., Amateur Radio Association

President, Harry Stewart, W8CQW, 143 Fairview Ave.; Vice-President, Waldemer Jaderstrom, W8HJN, R. F. D. No. 3; Secretary-Treasurer and Publicity Manager, Norman W. Smith, P. O. Box 273.

Club meetings are held on alternate Friday evenings in Room 2 of the Central High School at 7:30 p. m. The club conducts a class in code for beginners on Wednesday and alternate Friday evenings at the Central High School. Twenty-three registered for this class. Carl Ornehaug, W8CDK, is the instructor, and rapid progress is being made.

The club is affiliated with the A. R. R. L., and a large number of its members are also members of the League.

We boast of over fifty members, of whom, perhaps, thirty are really active. Hamfests, treasure hunts, and picnics are held from time to time. QSO contests, etc., create much interest. Lectures on radio fundamentals are part of the club meetings during the winter season.

(The editors would be pleased to receive descriptions of local radio clubs for publication. The descriptions do not, necessarily, have to be lengthy; in fact, the shorter the better. Include, though, the names of the officers as well as their call letters—it helps, you know.

If possible, get hold of some good pictures; small snapshots, if they are clear, will do the trick.

SHORT WAVE RADIO'S

Short-Wave Station List

THE following list, conveniently arranged alphabetically according to call letters, represents practically all the short-wave stations of the world, except amateur, that use voice transmission and are therefore recognizable by listeners who do not know the code. In most cases the frequency in kilocycles, the corresponding wavelength in meters, and the location by city are given; the country of origin, where it is not obvious, may quickly be determined from the preliminary list of international call letter assignments. Amateur and some special experimental calls consist of the assigned prefix, followed by a number and usually two or three more letters.

Stations listed as "experimental" change around a great deal and may use code or voice; definite frequencies cannot be given for them.

No attempt has been made to include operating schedules in this list, as a great majority of the stations are experimental in nature, and have the habit of changing announced programs without warning. Up-to-the-minute information on the best stations of the month is contained in another department in this issue.

For the sake of brevity, a number of abbreviations of operating company names are used. These are RCA, Radio Corporation of America; GPO, General Post Office; BBC, British Broadcasting Corporation; CBS, Columbia Broadcasting System; NBC, National Broadcasting Company; GE, General Electric Company; ATT, American Telegraph & Telephone Co.; MRT, Mackay Radio Telegraph Co.

List of International Call Assignments

Block of Calls	Country	Amateur Prefix
CAA-CEZ	Chile	CE
CFA-CKZ	Canada	VE
CLA-CMZ	Cuba	CM
CNA-CNZ	Morocco	CN
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
CA-CVZ	Rumania	CV
CWA-CXZ	Uruguay	CX
CZA-CZZ	Monaco	CZ
D	Germany	D
EAA-EHZ	Spain	EAR
EIA-EIZ	Irish Free State	EI
ELA-ELZ	Liberia	EL
ESA-ESZ	Esthonia	ES
ETA-ETZ	Ethiopia (Abyssinia)	ET
F	France (including colonies):	
	France proper	F
	French Indo-China	F1
	Tunis	FM4
	Algeria	FM8
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
HRA-HRZ	Honduras	HR
HSA-HSZ	Siam	HS
I	Italy and colonies	I
J	Japan	J
K	United States of America:	
	Continental United States	W
	Philippine Ids.	KA
	Porto Rico and Virgin Ids.	K4
	Territory of Hawaii	K6
	Territory of Alaska	K7
LAA-LNZ	Norway	LA
LOA-LVZ	Argentine Republic	LU
LZA-LZZ	Bulgaria	LZ
M	Great Britain	G
N	United States of America	W
OAA-OCZ	Peru	OA
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
RAA-RQZ	U. S. S. R. ("Russia")	RA
RVA-RVZ	Persia	RV
RXA-RXZ	Republic of Panama	RX
RYA-RYZ	Lithuania	RY
SAA-SMZ	Sweden	SM
SPA-SRZ	Poland	SP
STA-SUZ	Egypt:	
	Sudan	ST
	Egypt proper	SU
SVA-SZZ	Greece	SV
TAA-TCZ	Turkey	TA
TFA-TFZ	Iceland	TF
TGA-TGZ	Guatemala	TG
TIA-TIZ	Costa Rica	TI
TSA-TSZ	Territory of the Saar Basin	TS
UHA-UHZ	Hedjaz	UH
UIA-UKZ	Dutch East Indies	PK
ULA-ULZ	Luxemburg	UL
UNA-UNZ	Yugoslavia	UN
UOA-UOZ	Austria	UO
UWA-VGZ	Canada	VE
VHA-VMZ	Australia	VK
VOA-VOZ	Newfoundland	VO
VPA-VSZ	British colonies and protectorates	
	British Guiana	VP
	Fiji, Ellice Ids., Zanzibar	VP1
	Bahamas, Barbados, Jamaica	VP2
	Bermuda	VP9
	Fanning Id.	VQ1
	Northern Rhodesia	VQ2
	Tanganyika	VQ3
	Kenya Colony	VQ4
	Uganda	VQ5
	Malaya (including Straits Settlements)	VS1-2-3
	Hongkong	VS6
	Ceylon	VS7
VTA-VWZ	British India	VU
W	United States of America:	
	Continental United States	W
	(for others, see under K.)	
XAA-XFZ	Mexico	X
XGA-XUZ	China	AC
YAA-YAZ	Afghanistan	YA
YHA-YHZ	New Hebrides	YH
YIA-YIZ	Iraq	YI
YLA-YLZ	Latvia	YL
YMA-YMZ	Danzig	YM
YNA-YNZ	Nicaragua	YN
YSA-YSZ	Republic of El Salvador	YS
YVA-YVZ	Venezuela	YV
ZAA-ZAZ	Albania	ZA
ZBA-ZHZ	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

STATIONS ALPHABETICALLY BY CALL LETTERS

—C—

CEC	10,670 kc.,	28.12 m.
	15,860 kc.,	18.91 m.
	19,690 kc.,	15.24 m.
Santiago, Chile		
CFA	6,840 kc.,	43.8 m.
Drummondville, Quebec, Canada		
CGA	4,780 kc.,	62.7 m.
	13,340 kc.,	22.55 m.
	13,750 kc.,	21.82 m.
	9,330 kc.,	32.15 m.
	18,170 kc.,	16.5 m.
Quebec, Canada		
CM6XJ	15,000 kc.,	19.99 m.
Central Tuinucu, Cuba		
CMCI	6,060 kc.,	49.5 m.
Havana, Cuba		
CN8MC	6,250 kc.,	48 m.
Casablanca, Morocco		
CNR	8,050 kc.,	37.33 m.
	9,300 kc.,	32.26 m.
	12,880 kc.,	23.38 m.
Rabat, Morocco, Africa		
CT1AA	6,990 kc.,	42.9 m.
	9,600 kc.,	31.25 m.
Lisbon, Portugal		
CT3AQ	11,181 kc.,	26.33 m.
Funchal, Madeira		

—D—

DAF	8,470 kc.,	35.42 m.
	12,400 kc.,	24.19 m.
	17,270 kc.,	17.37 m.
Norden, Germany		
DAN	11,340 kc.,	26.44 m.
Nordeich, Germany		
DFA	4,400 kc.,	68.17 m.
	19,240 kc.,	15.58 m.
DFB	18,520 kc.,	17.12 m.
DGK	6,680 kc.,	44.91 m.
DGU	9,620 kc.,	31.2 m.
DHC	11,435 kc.,	26.22 m.
DHO	20,040 kc.,	14.97 m.
DIH	19,950 kc.,	15.03 m.
DIQ	10,290 kc.,	29.15 m.
DIS	10,150 kc.,	29.54 m.
Nauen, Germany		
DJA	9,560 kc.,	31.38 m.
Konigswusterhausen, Germany		
DJB	15,200 kc.,	19.73 m.
DJC	6,020 kc.,	49.83 m.
DJD	11,760 kc.,	25.51 m.
Zeesen, Germany		
DOA	7,230 kc.,	41.46 m.
	7,390 kc.,	37.8 m.
	4,430 kc.,	67.5 m.
	3,620 kc.,	82.9 m.
Doeberitz, Germany		

—E—

EAJ25	6,000 kc.,	50 m.
Barcelona, Spain		
EAR110	6,980 kc.,	43.0 m.
Madrid, Spain		
EAQ	19,700 kc.,	15.23 m.
	10,000 kc.,	30 m.
Alcalda 43—Madrid, Spain		
EHY	10,100 kc.,	29.7 m.
Madrid, Spain		

—F—

F8KR	3,750 kc.,	80 m.
F8KR	6,660 kc.,	45 m.
Constantine, Algeria		
F8MC	6,875 kc.,	43.6 m.
Casablanca, Morocco		
FIGA	6,000 kc.,	49.97 m.
Tananarive, Madagascar		
FL	6,120 kc.,	49.02 m.
FLJ	9,230 kc.,	32.5 m.
Paris, France		
FQE	12,150 kc.,	24.68 m.
FQO	12,150 kc.,	24.68 m.
FRE	18,240 kc.,	16.44 m.
FRE	19,400 kc.,	15.45 m.
FRO	18,240 kc.,	16.44 m.
St. Assise, France		
FSR	20,680 kc.,	14.5 m.
Paris, France		
FTA	11,950 kc.,	25.12 m.
FTD	19,830 kc.,	15.12 m.
FTF	7,770 kc.,	38.6 m.
FTK	15,690 kc.,	19.12 m.
FTK	15,860 kc.,	18.9 m.
St. Assise, France		
FYA	11,705 kc.,	25.6 m.
FYA	11,905 kc.,	25.16 m.
FYA	15,240 kc.,	19.68 m.
Pontoise (Paris) France		
FZG	12,000 kc.,	24.98 m.
FZR	16,200 kc.,	18.5 m.
FZS	11,900 kc.,	25.02 m.
FZS	18,310 kc.,	16.38 m.
Saigon, Indo-China		

—G—

GAA	20,380 kc.,	14.72 m.
GAG	18,970 kc.,	15.81 m.
GAS	18,410 kc.,	16.38 m.
GAU	18,620 kc.,	16.11 m.
GBB	13,580 kc.,	22.09 m.
GBC	17,080 kc.,	17.55 m.
GBC	12,780 kc.,	23.46 m.
GBC	9,310 kc.,	32.22 m.
GBC	8,680 kc.,	34.56 m.
GBC	4,980 kc.,	60.26 m.
Rugby, England		
GBJ	18,620 kc.,	16.1 m.
GBK	16,100 kc.,	16.57 m.
	9,250 kc.,	32.4 m.
	11,490 kc.,	26.1 m.
Bodmin, England		
GBP	10,770 kc.,	28.04 m.
GBS	18,310 kc.,	16.38 m
	12,250 kc.,	24.46 m.
	12,150 kc.,	24.68 m.
GBU	18,620 kc.,	16.11 m.
	22,300 kc.,	13.45 m.
	12,290 kc.,	24.41 m.
	9,950 kc.,	30.15 m.
GBW	14,480 kc.,	20.7 m.
	9,790 kc.,	30.64 m.
GPO, Rugby, Eng.		
GBX	16,150 kc.,	18.56 m.
	10,390 kc.,	28.86 m.
GCA	9,710 kc.,	30.9 m.
GCB	9,280 kc.,	32.33 m.
GCS	9,020 kc.,	33.26 m.
GCU	9,950 kc.,	30.15 m.
GCW	9,800 kc.,	30.60 m.
GDS	6,900 kc.,	43.45 m.
GDW	4,840 kc.,	62.0 m.
Rugby, England		
GSA	6,050 kc.,	49.58 m.
GSB	9,510 kc.,	31.55 m.
GSC	9,585 kc.,	31.29 m.
GSD	11,750 kc.,	25.53 m.
GSE	11,865 kc.,	25.28 m.
GSF	15,140 kc.,	19.81 m.
GSG	17,770 kc.,	16.88 m.
GSH	21,470 kc.,	13.97 m.
BBC, Daventry, Eng.		
G6RX	4,320 kc.,	69.44 m.
Rugby, England		

—H—

HB9D	7,200 kc.,	41.5 m.
Zurich, Switzerland		
HBF	18,900 kc.,	15.78 m.
HBJ	14,560 kc.,	20.6 m.
Pragins, Switzerland		
HBL	9,595 kc.,	31.27 m.
HBP	7,800 kc.,	38.47 m.
Geneva, Switzerland		
HC1DR	6,382 kc.,	47 m.
Quito, Ecuador		
HC2JSB	8,000 kc.,	37.5 m.
Guayaquil, Ecuador		
HCJB	8,110 kc.,	37.0 m.
	5,714 kc.,	52.5 m.
Quito, Ecuador, S. A.		
HJ1ABB	5,800 kc.,	51.75 m.
Barranquilla, Colombia		
HJ2ABA	5,880 kc.,	51.49 m.
Tunja, Colombia		
HJ3ABD	7,400 kc.,	40.55 m.
HJ3ABF	6,250 kc.,	48.0 m.
Bogota, Colombia		
HJ4ABB	7,150 kc.,	41.6 m.
Manizales, Colombia		
HJ4ABE	5,930 kc.,	5.06 m.
Medellin, Colombia		
HJ5ABD	6,380 kc.,	47.0 m.
Cali, Colombia		
HJB	7,470 kc.,	40.16 m.
HJY	9,930 kc.,	30.2 m.
	18,460 kc.,	16.25 m.
HKC	6,270 kc.,	47.81 m.
Bogota, Colombia		
HKF	7,612 kc.,	39.14 m.
HKM	6,660 kc.,	45 m.
Bogota, Colombia		
HKO	5,900 kc.,	50.8 m.
Medellin, Colombia		
HKX	7,140 kc.,	42.02 m.
Bogota, Colombia		
HSP2	9,640 kc.,	31.1 m.
HSP	17,750 kc.,	16.92 m.
Bangkok, Siam		
HVJ	5,970 kc.,	50.26 m.
	75,110 kc.,	19.84 m.
	15,120 kc.,	19.83 m.
Vatican City, Rome, Italy		

—I—

I2RO	11,810 kc.,	25.4 m.
Rome, Italy		
I3RO	3,750 kc.,	80 m.
Rome, Italy		
IAC	8,380 kc.,	35.8 m.
	6,650 kc.,	45.1 m.
	12,800 kc.,	23.45 m.
Pisa, Italy		
IBDK	11,470 kc.,	26.15 m.
S. S. Elettra (Marconi's Yacht)		
IRW	19,540 kc.,	15.25 m.
Italy		

J

JB	6,069 kc.,	49.43 m.
Johannesburg, South Africa		
J1AA	7,880 kc.,	38.07 m.
	13,090 kc.,	22.93 m.
	9,870 kc.,	30.4 m.
	15,490 kc.,	19.36 m.
Tokio, Japan		

—K—

K6XQ	Experimental	
S. S. Lake Miraflores		
KAZ	9,970 kc.,	30.09 m.
Manila, P. I.		
KDK	7,520 kc.,	39.89 m.
KEJ	9,020 kc.,	33.27 m
Kauhuku, T. H.		
KEL	6,860 kc.,	43.7 m.
Bolinas, Cal.		
KEQ	7,370 kc.,	40.71 m.
Kauhuku, T. H.		
KES	10,410 kc.,	28.80 m.
KEZ	10,410 kc.,	28.80 m.
Bolinas, Cal.		
KGHO	1,534 kc.,	191.1 m.
Des Moines, Iowa		
KGJX	1,712 kc.,	175.15 m.
Pasadena, Cal.		
KGOZ	2,470 kc.,	121.5 m.
Cedar Rapids, Iowa		
KGPA	2,414 kc.,	124.2 m.
Seattle, Wash.		
KGPB	2,416 kc.,	124.1 m.
Minneapolis, Minn.		
KGPC	1,712 kc.,	175.15 m.
St. Louis, Mo.		
KGPD	2,470 kc.,	121.5 m.
San Francisco, Cal.		
KGPE	2,422 kc.,	123.8 m.
Kansas City, Mo.		
KGPG	2,422 kc.,	123.8 m.
Vallejo, Cal.		
KGPH	2,450 kc.,	122.4 m.
Oklahoma City, Okla.		
KGPI	2,470 kc.,	121.5 m.
Omaha, Neb.		
KGPJ	1,712 kc.,	175.15 m.
Beaumont, Tex.		
KGPL	1,712 kc.,	175.15 m.
Los Angeles, Cal.		
KGPM	2,470 kc.,	121.5 m.
San Jose, Cal.		
KGPN	2,470 kc.,	121.5 m.
Davenport, Iowa		
KGPO	2,450 kc.,	122.4 m.
Tulsa, Okla.		
KGPP	2,442 kc.,	122.8 m.
Portland, Ore.		
KGPQ	2,450 kc.,	122.4 m.
Honolulu, T. H.		
KGPS	2,414 kc.,	124.2 m.
Bakersfield, Cal.		
KGPW	2,470 kc.,	121.5 m.
Salt Lake City, Utah		
KGPX	2,442 kc.,	122.8 m.
Denver, Colo.		
KGPY	1,574 kc.,	189.5 m.
Shreveport, La.		
KGPZ	2,450 kc.,	122.4 m.
Wichita, Kans.		
KGTP	Various aero frequencies	
KGZB	1,712 kc.,	175.15 m.
Houston, Tex.		
KGZD	2,430 kc.,	123.4 m.
San Diego, Cal.		
KGZE	2,506 kc.,	120 m.
San Antonio, Tex.		
KGZF	2,450 kc.,	122.4 m.
Chanute, Kans.		
KGZH	2,442 kc.,	122.8 m.
Klamath Falls, Ore.		
KGZI	1,712 kc.,	175.15 m.
Wichita Falls, Tex.		
KGZL	1,712 kc.,	175.15 m.
Shreveport, La.		
KGZM	2,414 kc.,	124.2 m.
El Paso, Tex.		
KGZN	2,414 kc.,	124.2 m.
Tacoma, Wash.		
KGZP	2,450 kc.,	122.4 m.
Coffeyville, Kans.		
KGZQ	1,712 kc.,	175.15 m.
Waco, Tex.		
KGZR	2,442 kc.,	122.8 m.
Salem, Ore.		
KGZX	2,414 kc.,	124.2 m.
Albuquerque, N. M.		
KIO	11,670 kc.,	25.68 m.
KKH	7,520 kc.,	39.89 m.
KKP	16,040 kc.,	18.71 m.
Kauhuku, T. H.		
KKQ	11,945 kc.,	25.1 m.
KKW	13,780 kc.,	21.77 m.
KKZ	14,150 kc.,	21.17 m.
KQJ	18,050 kc.,	16.61 m.
Bolinas, Cal.		
KSW	1,658 kc.,	180.7 m.
Berkeley, Cal.		
KVP	1,712 kc.,	175.15 m.
Dallas, Tex.		
KWN	21,060 kc.,	14.24 m.
KWO	15,420 kc.,	19.46 m.
KWU	15,350 kc.,	19.54 m.
KWV	10,840 kc.,	27.67 m.
KWX	7,610 kc.,	39.42 m.
KWY	7,560 kc.,	39.65 m.
KWZ	10,400 kc.,	28.8 m.
Dixon, Cal.		

—L—

LGN	9,600 kc.,	31.23 m.
Bergen, Norway		
LQA	9,600 kc.,	31.25 m.
LSA	9,890 kc.,	30.3 m.
LSA	14,530 kc.,	20.65 m.
LSG	19,950 kc.,	15.03 m.
LSG	19,906 kc.,	15.07 m.
LSL	10,300 kc.,	29.12 m.
LSL	21,160 kc.,	14.17 m.
Buenos Aires		
LSM	21,130 kc.,	14.15 m.
Monte Grande, Argentina (Buenos Aires)		
LSN	14,530 kc.,	20.65 m.
LSN	21,020 kc.,	14.27 m.
LSN	20,680 kc.,	14.5 m.
LSR	18,960 kc.,	15.82 m.
LSX	10,350 kc.,	28.98 m.
LSY	20,730 kc.,	14.47 m.
LSY	10,410 kc.,	28.8 m.
LSY	18,130 kc.,	16.55 m.
Buenos Aires		

—N—

NAA	16,060 kc.,	18.68 m.
NAA	12,045 kc.,	24.89 m.
NAA	4,105 kc.,	74.72 m.
Arlington, Va. (time signals)		
NPO	8,872 kc.,	33.81 m.
Cavite, P. I. (time signals)		
NSS	12,045 kc.,	24.89 m.
Annapolis, Md. (time signals)		

—O—

OCI	18,680 kc.,	16.06 m.
OCJ	15,620 kc.,	19.19 m.
Lima, Peru		
OKI	21,000 kc.,	14.28 m.
Podebrady, Czechoslovakia		
OKIMPT	5,145 kc.,	58.31 m.
OKIMPT	5,170 kc.,	58 m.
Prague, Czechoslovakia		
OPL	20,040 kc.,	14.97 m.
OPM	10,140 kc.,	29.58 m.
Leopoldsville, Belgian Congo		
ORG	19,210 kc.,	15.62 m.
ORK	10,330 kc.,	29.04 m.
Brussels, Belgium		

OXY 15,300 kc., 19.6 m.
Lyngby, Denmark
OXY 6,075 kc., 49.4 m.
OXY 9,520 kc., 31.51 m.
Skamleback, Denmark
OZ7RL 3,560 kc., 84.24 m.
Copenhagen, Denmark

—P—

PCK 7,770 kc., 38.6 m.
18,400 kc., 16.3 m.
PCL 16,300 kc., 18.4 m.
PCV 17,830 kc., 16.82 m.
PDK 10,410 kc., 28.8 m.
PDU 7,830 kc., 38.3 m.
PDV 12,060 kc., 24.88 m.
Kootwijk, Holland
PHI 17,770 kc., 16.88 m.
11,730 kc., 25.57 m.
Huizen, Holland
PK2AG 3,156 kc., 95 m.
Samarang, Java
PK3AN 6,040 kc., 49.67 m.
Sourabaya, Java
PLE 18,200 kc., 15.94 m.
PLF 17,850 kc., 16.8 m.
PLG 15,950 kc., 18.8 m.
PLM 12,250 kc., 24.46 m.
PLR 10,630 kc., 28.2 m.
PLV 9,420 kc., 31.86 m.
PLW 8,120 kc., 36.92 m.
9,480 kc., 31.63 m.
PMB 20,620 kc., 14.54 m.
5,170 kc., 58 m.
PMC 18,370 kc., 16.33 m.
PMN 10,360 kc., 29.25 m.
PMY 5,170 kc., 58.0 m.
Bandoeng, Java
PPG 11,660 kc., 27.73 m.
PPU 19,270 kc., 15.57 m.
Rio de Janeiro
PRADO 6,620 kc., 45.31 m.
Riobamba, Ecuador
PRAG 8,450 kc., 35.5 m.
Porto Algero, Brazil
PSA 21,080 kc., 14.23 m.
PSH 10,220 kc., 29.35 m.
PSK 8,190 kc., 36.65 m.
Rio de Janeiro

—R—

RABAT 12,830 kc., 23.38 m.
8,035 kc., 37.33 m.
Morocco
RAU 15,100 kc., 19.85 m.
Tachkent, Turkestan
REN 6,610 kc., 45.38 m.
RIM 7,630 kc., 39.34 m.
RKI 7,500 kc., 39.97 m.
U. S. S. R.
RV15 4,273 kc., 70.2 m.
Khabarovsk, Siberia
RV59 6,000 kc., 50 m.
Radio Moscow, U.S.S.R.
RXF 14,500 kc., 20.69 m.
Panama City, Panama

—S—

SAJ 6,065 kc., 49.46 m.
Motola, Sweden
SRI 9,570 kc., 31.35 m.
Poznan, Poland
SUV 10,050 kc., 29.83 m.
Cairo, Egypt

—T—

TI4NRH 9,675 kc., 31 m.
Heredia, Costa Rica, C. A.
TIR 8,790 kc., 34.13 m.
14,500 kc., 20.69 m.
Cartago, Costa Rica
TGA 14,500 kc., 20.69 m.
TGW 6,660 kc., 45 m.
6,180 kc., 48.5 m.
TGX 5,940 kc., 50.5 m.
Guatemala City, C. A.

—U—

UIG 10,400 kc., 28.8 m.
Medan, Sumatra
UOR2 6,072 kc., 49.41 m.
Vienna, Austria

—V—

VE9AP 6,335 kc., 47.35 m.
Drummondville, Canada
VE9BJ 6,090 kc., 49.29 m.
St. John's, N. B., Canada
VE9BY 4,795 kc., 62.56 m.
6,425 kc., 46.7 m.
8,650 kc., 34.68 m.
London, Ontario, Canada
VE9CA 6,030 kc., 49.75 m.
Calgary, Alta., Canada
VE9CF 6,050 kc., 49.59 m.
6,100 kc., 49.15 m.
Halifax, N. S., Canada
VE9CG 6,110 kc., 49.1 m.
Calgary, Alta., Canada
VE9CL 5,710 kc., 52.5 m.
6,147 kc., 48.8 m.
Winnipeg, Canada
VE9CS 6,069 kc., 49.43 m.
Vancouver, B. C., Canada
VE9CU 6,005 kc., 49.99 m.
Calgary, Alta., Canada
VE9DR 11,780 kc., 25.47 m.
6,005 kc., 49.96 m.
Drummondville, Quebec, Canada
VE9GW 6,095 kc., 49.17 m.
11,800 kc., 25.42 m.
Bowmanville, Ontario, Canada
VE9HK 6,120 kc., 48.98 m.
VE9HX 6,125 kc., 48.98 m.
Halifax, N. S., Canada
VE9JR 11,720 kc., 25.6 m.
Winnipeg, Canada
VK2ME 9,760 kc., 30.75 m.
10,520 kc., 28.51 m.
Sydney, Australia
VK3LR 9,510 kc., 31.55 m.
5,680 kc., 52.8 m.
Melbourne, Australia
VLJ 9,980 kc., 37.59 m.
VLK 9,760 kc., 30.75 m.
10,520 kc., 28.51 m.
Sydney, Australia
VPD 7,890 kc., 38.0 m.
Suva, Fiji Islands
VPN 4,510 kc., 66.5 m.
Nassau, Bahamas
VQ7LO 6,000 kc., 49.5 m.
Nairobi, Kenya, Africa
VRT 5,050 kc., 59.42 m.
10,070 kc., 29.8 m.
Hamilton, Bermuda
VSIAB 7,195 kc., 41.67 m.
Singapore, S. S.
VUC 6,110 kc., 49.1 m.
Calcutta, India
VWY 18,540 kc., 17.1 m.
Poona, India

—W—

W1XAB 4,700 kc., 63.79 m.
Portland, Me.
W1XAL 11,790 kc., 25.45 m.
W1XAL 6,040 kc., 49.67 m.
W1XAU 1,560 kc., 199.35 m.
W1XAV 1,600 kc., 187.5 m.
Boston, Mass.
W1XAZ 9,570 kc., 31.35 m.
Westinghouse, Springfield, Mass.
W1XG 43,000 kc., 6.52 m.
W1XL 6,040 kc., 49.67 m.
Boston, Mass.
W2XAA Experimental
Bell Labs., Port. & Mob.
W2XAB 2,750 kc., 109.1 m.
CBS, New York, N. Y.
W2XAC 8,690 kc., 34.5 m.
W2XAD 15,340 kc., 19.56 m.
W2XAF 9,530 kc., 31.48 m.
GE, Schenectady, N. Y.
W2XAK 43,000 kc., 6.52 m.
W2XAK 48,500 kc., 6.18 m.
W2XAK 60,000 kc., 5.00 m.
CBS, New York, N. Y.
W2XAO 17,850 kc., 16.8 m.
W2XAR Experimental
Long Island City, N. Y.
W2XAV Experimental
Bell Labs., Port. & Mob.
W2XAW Experimental
GE, Schenectady, N. Y.
W2XBB Experimental
RCA, New York, N. Y.
W2XBC 25,700 kc., 11.67 m.
RCA, New Brunswick, N. J.
W2XBG Experimental
Radio Marine, New York, N. Y.
W2XBI Experimental
RCA, Rocky Point, N. Y.
W2XBJ 14,700 kc., 20.27 m.
Rocky Point, N. Y.
W2XBL Experimental
RCA, Port. & Mob.
W2XBS 2,100 kc., 136.4 m.
W2XBT 43,000 kc., 6.52 m.
W2XBT 48,500 kc., 6.18 m.
W2XBT 60,000 kc., 5.00 m.
NBC, Portable
W2XBW Experimental
Globe Wireless, Garden City, N. Y.
W2XBX Plane, Experimental
Bell Labs.
W2XCJ Experimental
Police, Bayonne, N. J.
W2XCS Experimental
W2XCT Experimental
Police, Eastchester, N. Y.
W2XCU 12,850 kc., 23.35 m.
W2XCU 8,650 kc., 34.68 m.
Rocky Point, N. Y.
W2XDC Experimental
RCA, Portable & Mobile
W2XDJ 21,420 kc., 14. m.
ATT, Deal, N. J.
W2XDK Experimental
Polin, Inc., Port. & Mob.
W2XDO 17,110 kc., 17.52 m.
W2XDO 8,630 kc., 34.74 m.
ATT, Ocean Gate, N. J.
W2XDT Experimental
Press Wireless, Port. & Mob.
W2XDV Experimental
CBS, New York, N. Y.
W2XDY Experimental
W2XDZ Experimental
Central Hudson Gas & Electric Co.
Portable
W2XE 15,270 kc., 19.65 m.
W2XE 11,830 kc., 25.36 m.
W2XE 6,120 kc., 49.02 m.
CBS, Wayne, N. J.
W2XEA Experimental
W2XEB Experimental
W2XEC Experimental
W2XED Experimental
W2XEE Experimental
W2XEF Experimental
W2XEG Experimental
W2XEH Experimental
Police, Bayonne, N. J.
W2XEI Experimental
P. J. Golihofer, Port. & Mob.
W2XEJ Experimental
D. B. Whittemore, Yonkers, N. Y.
W2XEK Experimental
Knickerbocker Broad. Co., Port. & Mob.
W2XEL Experimental
Police, Eastchester, N. Y.
W2XER Experimental
D. B. Whittemore, Yonkers, N. Y.
W2XF 43,000 kc., 6.52 m.
W2XF 48,500 kc., 6.18 m.
W2XF 60,000 kc., 5.00 m.
NBC, New York
W2XG Experimental
Bell Labs., Ocean Township, N. J.
W2XGG Experimental
Police, Bayonne, N. J.
W2XJ Experimental
Bell Labs., Ocean Township, N. J.
W2XK Experimental
NBC, New York, N. Y.
W2XL Experimental
Bell Labs., Port & Mobile
W2XM Experimental
W2XN Experimental
Bell Labs., Holmdel, N. J.
W2XO 12,850 kc., 23.35 m.
GE, Schenectady, N. Y.
W2XP Experimental
RCA, Riverhead, N. Y.
W2XR 1,600 kc., 176.5 m.
W2XR 43,000 kc., 6.97 m.
W2XR 48,500 kc., 6.18 m.
W2XR 60,000 kc., 5.00 m.
W2XS Experimental
W2XT Experimental
RCA, Rocky Point, N. Y.
W2XU Experimental
Bell Labs., Portable
W2XV 8,650 kc., 34.68 m.
W2XV 4,975 kc., 60.30 m.
Long Island City, N. Y.
W2XW Experimental
W2XY Experimental
Bell Labs., Portable
W3XAB Experimental
RCA, Camden, N. J.
W3XAD 43,000 kc., 6.97 m.
W3XAD 48,500 kc., 6.18 m.
W3XAD 60,000 kc., 5.00 m.
RCA, Camden, N. J.
W3XAJ Experimental
RCA, Camden, N. J.
W3XAK 2,100 kc., 136.4 m.
NBC, Portable
W3XAL 17,780 kc., 16.87 m.
W3XAL 6,100 kc., 49.15 m.
NBC, Bound Brook, N. J.
W3XAM Experimental
RCA, Port. & Mob.
W3XAN Experimental
Harrisburg, Pa.
W3XAU 9,580 kc., 31.32 m.
W3XAU 6,060 kc., 49.5 m.
CBS, Philadelphia, Pa.
W3XAW Experimental
W3XAX Experimental
M. & H. Sporting Goods Co., Port.
W3XB Experimental
College Park, Md.
W3XE 9,580 kc., 31.32 m.
W3XE 43,000 kc., 6.52 m.
W3XE 48,500 kc., 6.00 m.
W3XE 60,000 kc., 3.75 m.
Philco, Philadelphia, Pa.
W3XE 8,650 kc., 34.68 m.
Baltimore, Md.
W3XL Experimental
NBC, Bound Brook, N. J.
W3XN Experimental
Bell Labs., Whippany, N. J.
W3XR Experimental
Bell Labs., Mendham Township, N. J.
W3XV Experimental
RCA, Arneys-Mount, N. J.
W3XW Experimental
Boonton, N. J.
W3XX 8,650 kc., 34.68 m.
W3XZ 4,795 kc., 62.56 m.
Washington, D. C.
W4XB 6,040 kc., 49.67 m.
Miami Beach, Fla.
W4XC Experimental
Portable
W4XD Experimental
Port. & Mob.
W4XG 8,650 kc., 34.68 m.
Miami, Fla.
W5XC Experimental
Shreveport, La.
W6XAC Experimental
Fred W. Christian, Jr., Portable
W6XAD Experimental
San Francisco, Calif.
W6XAH 2,000 kc., 150 m.
Bakersfield, Cal.
W6XAJ Experimental
Portable
W6XAO 43,000 kc., 6.97 m.
W6XAO 48,500 kc., 6.18 m.
W6XAO 60,000 kc., 5.00 m.
Los Angeles, Cal.
W6XAP Experimental
Port. & Mob.
W6XAR Experimental
W6XAS Experimental
Julius Brunton & Sons Co., Port. & Mob.
W6XBB Experimental
Port. in Calif.
W6XD 27,800 kc., 10.79 m.
MRT, Palo Alto, Cal.
W6XF Experimental
Port. in Calif.
W6XJ Experimental
Port. in Calif.
W6XP Experimental
Press Wireless, Portable and Mobile
W6XQ 24,000 kc., 12.48 m.
San Mateo, Cal.
W6XR Experimental
San Francisco, Calif.
W6XS 2,100 kc., 136.4 m.
Los Angeles, Calif.
W7XAW 2,342 kc., 128.09 m.
Seattle, Wash.
W7XC Experimental
Edmonds, Wash.
W7XL Experimental
Northern Radio Co., Portable
W8XAG 8,650 kc., 34.68 m.
Dayton, Ohio
W8XAL 6,060 kc., 49.5 m.
Crosley, Cincinnati, O.
W8XAN 43,000 kc., 6.97 m.
W8XAN 48,500 kc., 6.18 m.
W8XAN 60,000 kc., 5.00 m.
W8XAN 1,600 kc., 176.5 m.
Jackson, Mich.
W8XF 43,000 kc., 6.97 m.
W8XF 48,500 kc., 6.18 m.
W8XF 60,000 kc., 5.00 m.
Pontiac, Mich.
W8XI 31,000 kc., 9.68 m.
W8XJ 5,550 kc., 54.02 m.
Columbus, O.
W8XK 21,540 kc., 13.93 m.
W8XK 17,780 kc., 16.87 m.
W8XK 15,210 kc., 19.72 m.
W8XK 11,870 kc., 25.26 m.
W8XK 6,140 kc., 48.86 m.
Westinghouse, E. Pittsburgh, Pa.

W8XL 17,300 kc., 17.34 m.
Dayton, O.
W8XL 43,000 kc., 6.97 m.
W8XL 48,500 kc., 6.18 m.
W8XL 60,000 kc., 5.00 m.
Cuyahoga Hts., Ohio
W8XN 1,600 kc., 176.5 m.
Jackson, Mich.
W9XAA 6,080 kc., 49.31 m.
Chicago, Ill.
W9XAI Experimental
W9XAJ Experimental
Milwaukee, Wis., Portable
W9XAK 2,100 kc., 142.9 m.
Manhattan, Kans.
W9XAL 2,200 kc., 136.4 m.
Kansas City, Mo.
W9XAM 4,795 kc., 62.56 m.
Elgin, Ill.
W9XAO 11,840 kc., 25.34 m.
W9XAO 2,000 kc., 150 m.
W9XAP 2,100 kc., 142.9 m.
Chicago, Ill.
W9XAT 43,000 kc., 6.97 m.
W9XAT 48,500 kc., 6.18 m.
W9XAT 60,000 kc., 5.00 m.
Dr. G. W. Young, Portable
W9XD 43,000 kc., 6.97 m.
W9XD 48,500 kc., 6.18 m.
W9XD 60,000 kc., 5.00 m.
Milwaukee, Wis.
W9XE 43,000 kc., 6.97 m.
W9XE 48,500 kc., 6.18 m.
W9XE 60,000 kc., 5.00 m.
Marion, Ind.
W9XF 17,780 kc., 16.87 m.
W9XF 11,880 kc., 25.24 m.
W9XF 6,100 kc., 49.18 m.
NBC, Chicago, Ill.
W9XG 2,750 kc., 109.1 m.
W. Lafayette, Ind.
W9XK 2,000 kc., 150 m.
Iowa City, Iowa
W9XL 17,300 kc., 17.34 m.
W9XL 12,850 kc., 23.35 m.
W9XL 6,425 kc., 46.70 m.
Anoka, Minn.
W10XAA Plane, Experimental
Bell Labs.
W10XAC Experimental
Milwaukee, Wis., Port. & Mobile
W10XAF Experimental
Larry L. Smith, Portable
W10XAG Experimental
N. Y. Conservation Dept., Port. and Mobile
W10XAH Experimental
W10XAI Experimental
NBC, Portable and Mobile
W10XAJ Experimental
N. Y. Conservation Dept., Port. and Mobile
W10XAK Experimental
NBC, Portable and Mobile
W10XAL Experimental
CBS, Portable and Mobile
W10XAM Experimental
W10XAN Experimental
W10XAP Experimental
NBC, Portable and Mobile
W10XAQ Experimental
Westinghouse, Portable & Mobile
W10XAY Experimental
Polin, Inc., Portable and Mobile
W10XBA Plane, Experimental
W10XBB Plane, Experimental
W10XBC Plane, Experimental
Aeronautical Radio Inc.
W10XBE Experimental
N. Y. Conservation Dept., Port. and Mobile
W10XBF Experimental
W10XBG Experimental
W. G. H. Finch, Portable & Mob.
W10XBI Plane, Experimental
Roland Reed
W10XBK Experimental
W. G. H. Finch, Portable & Mob.
W10XE Experimental
RCA, Portable and Mobile
W10XI Plane, Experimental
Aircraft Radio Corp.

W10XJ Experimental
Bell Labs., Portable
W10XN Experimental
NBC, Portable and Mobile
W10XT Experimental
RCA, Portable and Mobile
W10XX 43,000 kc., 6.97 m.
W10XX 48,500 kc., 6.18 m.
W10XX 60,000 kc., 5.00 m.
RCA, Portable
W10XY Experimental
NBC, Portable and Mobile
W10XZ Experimental
CBS, Portable and Mobile
WAEQ Various aero frequencies
Elmira, N. Y.
WAJ 13,480 kc., 22.26 m.
Rocky Point, N. Y.
WBA 257 kc., 1,123 m.
Harrisburg, Pa.
WBR 257 kc., 1,123 m.
Butler, Pa.
WCK 2,414 kc., 124.2 m.
Belle Island, Mich.
WCN 5,070 kc., 59.08 m.
Lawrenceville, N. J.
WDX 257 kc., 1,123 m.
Wyoming, Pa.
WEA 10,610 kc., 28.28 m.
WEB 6,940 kc., 43.23 m.
WEC 8,930 kc., 33.59 m.
WEF 9,590 kc., 31.6 m.
WEL 8,950 kc., 33.52 m.
WEM 7,400 kc., 40.54 m.
WES 9,450 kc., 31.74 m.
WGN 5,260 kc., 57.03 m.
WIY 13,870 kc., 21.63 m.
Rocky Point, N. Y.
WJL 257 kc., 1,123 m.
Greensburg, Pa.
WKA 21,060 kc., 14.25 m.
Lawrenceville, N. J.
WKDU 1,712 kc., 175.15 m.
Cincinnati, Ohio
WKF 19,220 kc., 15.61 m.
WKF 4,750 kc., 63.21 m.
Lawrenceville, N. J.
WKJ 9,590 kc., 31.6 m.
Rocky Point, N. Y.
WKK 21,410 kc., 14.01 m.
WKN 19,830 kc., 15.13 m.
Lawrenceville, N. J.
WKU 14,700 kc., 20.27 m.
WKW 19,020 kc., 15.77 m.
Rocky Point, N. Y.
WLA 18,350 kc., 16.35 m.
WLK 16,330 kc., 18.44 m.
WLO 21,400 kc., 14.01 m.
WLO 16,300 kc., 18.4 m.
WLO 10,540 kc., 28.44 m.
ATT, Lawrence, N. J.
WMA 13,390 kc., 22.4 m.
Lawrenceville, N. J.
WMB 267 kc., 1,123 m.
West Reading, Pa.
WMDZ 2,442 kc., 122.8 m.
Indianapolis, Ind.
WMF 14,470 kc., 20.73 m.
Lawrenceville, N. J.
WMI 19,850 kc., 15.1 m.
WMI 9,700 kc., 30.9 m.
ATT, Deal, N. J.
WMJ 2,422 kc., 123.8 m.
Buffalo, N. J.
WMN 14,590 kc., 20.56 m
Lawrenceville, N. J.
WMO 2,414 kc., 124.2 m.
Highland Park, Mich.
WMP 1,574 kc., 189.5 m.
Framingham, Mass.
WNA 9,170 kc., 32.72 m.
WNB 10,680 kc., 28.09 m.
Lawrenceville, N. J.
WNC 19,200 kc., 15.6 m.
WNC 14,480 kc., 20.7 m.
WNC 9,750 kc., 30.75 m.
WND 18,350 kc., 16.35 m.
WND 13,400 kc., 22.38 m.
WND 6,753 kc., 44.4 m.
ATT, Deal, N. J.

WOA 6,750 kc., 44.41 m.
WOB 5,850 kc., 51.26 m.
WOF 9,750 kc., 30.77 m.
WOK 10,550 kc., 28.44 m.
WON 9,870 kc., 30.40 m.
Lawrenceville, N. J.
WOO 17,110 kc., 17.52 m.
WOO 8,550 kc., 35.09 m.
WOO 6,515 kc., 46.05 m.
WOO 8,630 kc., 34.74 m.
WOO 4,750 kc., 63.13 m.
WOO 4,116 kc., 72.87 m.
WOO 3,124 kc., 96.03 m.
WOP 19,380 kc., 15.48 m.
Ocean Gate, N. J.
WOU 2,590 kc., 115.8 m.
Green Harbor, Mass.
WOX 2,540 kc., 118.06 m.
New York, N. Y.
WPDA 2,414 kc., 124.2 m.
Tulare, Cal.
WPDB 1,712 kc., 175.15 m.
WPDC 1,712 kc., 175.15 m.
WPDD 1,712 kc., 175.15 m.
Chicago, Ill.
WPDE 2,442 kc., 122.8 m.
Louisville, Ky.
WPDF 2,442 kc., 122.8 m.
Flint, Mich.
WPDH 2,442 kc., 122.8 m.
Richmond, Ind.
WPDI 2,430 kc., 123.4 m.
Columbus, Ohio
WPDK 2,450 kc., 122.4 m.
Milwaukee, Wis.
WPDL 2,442 kc., 122.8 m.
Lansing, Mich.
WPDM 2,430 kc., 123.4 m.
Dayton, Ohio
WPDN 2,458 kc., 122. m.
Auburn, N. Y.
WPDO 2,458 kc., 122. m.
Akron, Ohio
WPDP 2,470 kc., 121.5 m.
Philadelphia, Pa.
WPDR 2,458 kc., 122. m.
Rochester, N. Y.
WPDS 2,416 kc., 124.1 m.
St. Paul, Minn.
WPDT 2,470 kc., 121.5 m.
Kokomo, Ind.
WPDU 1,712 kc., 175.15 m.
Pittsburgh, Pa.
WPDV 2,458 kc., 122. m.
Charlotte, N. C.
WPDW 2,422 kc., 123.8 m.
Washington, D. C.
WPDX 2,414 kc., 124.2 m.
Detroit, Mich.
WPDY 2,414 kc., 124.2 m.
Atlanta, Ga.
WPDZ 2,470 kc., 121.5 m.
Fort Wayne, Ind.
WPEA 2,458 kc., 122.8 m.
Syracuse, N. Y.
WPEB 2,442 kc., 122.8 m.
Grand Rapids, Mich.
WPEC 2,470 kc., 121.5 m.
Memphis, Tenn.
WPEE 2,450 kc., 122.4 m.
WPEF 2,450 kc., 122.4 m.
WPEG 2,450 kc., 122.4 m.
New York, N. Y.
WPEH 1,712 kc., 175.15 m.
Somerville, Mass.
WPEI 1,712 kc., 175.15 m.
E. Providence, R. I.
WPEK 2,422 kc., 123.8 m.
New Orleans, La.
WPEL 1,574 kc., 189.5 m.
W. Bridgewater, Mass.
WPEP 1,712 kc., 175.15 m.
Arlington, Mass.
WPET 1,712 kc., 175.15 m.
Lexington, Mass.
WPEV 1,574 kc., 189.5 m.
Portable, Mass.
WPEW 1,574 kc., 189.5 m.
Northampton, Mass.
WPEZ
Miami, Fla.

WPFA 1,712 kc., 175.15 m.
Newton, Mass.
WPFC 2,442 kc., 122.8 m.
Muskegon, Mich.
WPFD 2,430 kc., 123.4 m.
Highland Park, Ill.
WPFE 2,442 kc., 122.8 m.
Reading, Pa.
WPFF 2,430 kc., 123.4 m.
Toms River, N. J.
WPFG 2,442 kc., 122.8 m.
Jacksonville, Fla.
WPFH 2,414 kc., 124.2 m.
Baltimore, Md.
WPFI 2,414 kc., 124.2 m.
Columbus, Ga.
WPFJ 1,712 kc., 175.15 m.
Hammond, Ind.
WPFK 2,430 kc., 123.4 m.
Hackensack, N. J.
WPFL 2,470 kc., 121.5 m.
Gary, Ind.
WPFM 2,414 kc., 124.2 m.
Birmingham, Ala.
WPFN 1,712 kc., 175.15 m.
Fairhaven, Mass.
WPFO 2,470 kc., 121.5 m.
Knoxville, Tenn.
WPFP 2,414 kc., 124.2 m.
Clarksburg, W. Va.
WPFQ 2,470 kc., 121.5 m.
Swarthmore, Pa.
WPFR 2,470 kc., 121.5 m.
Johnson City, Tenn.
WPGD 2,458 kc., 122.8 m.
Rockford, Ill.
WPGS 2,414 kc., 124.2 m.
Mineola, N. Y.
WRDH 2,458 kc., 122 m.
Cleveland, Ohio
WRDR 2,414 kc., 124.2 m.
Grosse Pt. Village, Mich.
WRDQ 2,470 kc., 121.5 m.
Toledo, Ohio.

—X—

X2GA 7,612 kc., 39.4 m.
Nuevo Laredo, Mexico
XAM 11,540 kc., 26.0 m.
Merida, Yucatan
XDA 5,857 kc., 51.22 m.
11,760 kc., 25.5 m.
14,620 kc., 20.5 m.
XDC 9,400 kc., 31.9 m.
XETE 9,600 kc., 31.25 m.
XEW 6,023 kc., 49.8 m.
XIF 6,167 kc., 48.65 m.
Mexico City, Mex.

—Y—

YNA 14,500 kc., 20.69 m.
Managua, Nicaragua
YV1BC 6,110 kc., 49.1 m.
YV11BMO 6,130 kc., 48.95 m.
YV1BC 6,120 kc., 49.02 m.
Caracas, Venezuela
YV2AM 14,110 kc., 21.26 m.
Maracaibo, Venezuela
YV3BC 6,130 kc., 48.9 m.
9,510 kc., 31.56 m.
Caracas, Venezuela
YVQ 11,690 kc., 25.65 m.
13,500 kc., 22.48 m.
YVR 18,300 kc., 16.39 m.
Maracay, Venezuela

—Z—

ZGE 6,000 kc., 50 m.
Kuala, Lumpur, Malay States
ZL2ZX 6,060 kc., 49.5 m.
ZLT 7,390 kc., 40.6 m.
10,990 kc., 27.3 m.
ZLW 12,300 kc., 24.4 m.
18,340 kc., 16.35 m.
10,980 kc., 27.3 m.

Readers will observe that this list is growing steadily, now being about a half-page larger than the first list, published in the November, 1933 issue. Just before the closing date of each issue the list is checked carefully against the official bulletins issued by the Federal Radio Commission and also against the log book of Capt. H. L. Hall.

Please remember that changes may take place between the time the magazine is closed and the date it reaches you. The majority of short-wave telephone stations are experimental in nature, and their own owners do not always know what they will be doing from one week to the next. We would appreciate reports from listeners.

Satisfactory S. W. Reception

(*Continued from page 13*)

than a year ago.

The Directional Doublet

A study of the various types of antennas which can be erected in congested areas with the least expense and with the best possible results for the particular service required has led to the selection of one of three fundamental types, with possible variations to suit special requirements.

Where the space permits, the use of the horizontal doublet, with a transposed transmission line lead, is just about the ideal type.

This antenna is made of two single wires of equal length, run in a straight line, or 180 degrees apart, separated from each other by a suitable insulator, thoroughly insulated from their supporting elements, and as thoroughly isolated from all surrounding objects as possible. The dimensions and the general instructions for the erection of an antenna of this type are now quite generally known. The outer ends of the antenna should not come closer than twenty feet from the sides of the building which supports them. If masts are used to raise the whole system above the level of the roof, so much the better. In any event, it is safe to figure on permitting the antenna to come no nearer than twenty feet from the roof or any grounded object over which it must pass, such as barns, trees (especially in the summer, when the foliage is heavy), tin roofs, etc. If moving the antenna to one side or the other a slight amount will avoid the necessity of having it pass over some object, it is desirable to do so. There is a theoretical difference in its performance, but it will be so much better than the ordinary type of antenna that you will never miss the slight loss which the change will produce.

An antenna of this variety is quite directional. The directional properties of such a system has confused a number of old timers who have it fairly well rooted in their minds that an inverted L antenna will receive best in the direction opposite the free end. They cannot understand, if that is true—and it is—why the use of the doublet should bring in signals best in the direction at right angles to the flat-top portion of the antenna. But a doublet of this variety, whether it is a tuned or untuned, will receive best in just that manner. *In other words, if you want to receive from stations in Australia and in Europe, consulting a mercatorial map or looking at a globe will indicate that the direction from almost any portion of the United States will put Australia to the southwest and Europe to the northeast.* The best direction for the running of the antenna is, therefore, southeast and northwest, or at right angles to a line drawn on a globe from Australia to Europe.

Unilateral Directional Antenna

Where it is desirable to receive from a single direction, we can generally rely upon the unilateral directional properties of the inverted L type antenna, but the modern version is provided with a suitable transposed transmission-line lead. The lead is, of course, taken *from the end of the flat-top from which we wish to receive.* For instance, if we wish to receive from Europe, our flat-top should run in a general northeast and southwesterly direction, with the transposed transmission line lead taken from the northeasterly end. In general, the same precautions regarding the insulation and the isolation of the antenna itself should be followed as have been outlined as a guide in the erection of the directional doublet.

Some confusion exists concerning the method of applying the transposed transmission line lead to the ordinary inverted L type of antenna. It is easy enough to understand the connections when such a symmetrical system as the horizontal doublet is used, but the method of using the two wires with a single wire in the flat-top part of the system could cause mystification. As shown in Fig. 1, the antenna end of the second wire in the transposed transmission line lead goes nowhere—that is, it goes nowhere electrically. Physically, it is terminated at the opposite end of the antenna insulator, which is also the terminal for the lead-in end of the flat-top. Of course, another insulator is used to break the path from the second lead to the supporting element.

It is but natural that a rather long flat-top and its down lead, is balanced by nothing but the down lead itself. The system is partially unbalanced, but the greater part of the effect of this unsymmetrical condition is reduced by the simple process of placing a suitable resistance in each of the base positions of the two wires which go to make up the transposed transmission line lead-in, as shown in Fig. 1. In this connection, it will be found that the value of the resistance for optimum results on given frequencies will vary. It is a simple matter to incorporate a suitable resistor mount in each lead and make the necessary changes by having a suitable supply of fixed resistors on hand. Precision wire-wound resistors are not required for this purpose, and the range of resistance required is from two hundred to about one thousand ohms. Steps of one hundred ohms are usually sufficiently accurate for all practical purposes.

In many instances it will be found that there will be plenty of signal, especially if the length and the height of the flat-top portion of the antenna system are great, so that adjustment of the resistance in series with the coupling coil is unnecessary. This is particularly true when it is possible to adjust the coupling between the transposed transmission line lead-in and the tuned circuit of the receiver to which it is coupled. In such cases, the value of the resistors which seem to function satisfactorily is in the neighborhood of 400 ohms. A very simple method of coupling a transposed lead to any sort of receiver, other than those in which the antenna coil is in a shielded can, has been treated in this series previously.

Many modern receivers are so thoroughly shielded that the use of any special coupling device is out of the question. While it is impossible to say what degree of satisfaction is to be derived from using receivers of this nature, it may be said with certainty that, while one such receiver may work better than another under identical operating conditions, it is positive that even with the poorest performer there will be a noticeable improvement in the ratio of desired signal to background noise if the following precautions are taken. It is possible, however, in some few instances, in territories which are particularly free from the noises which are produced by man-made static, and where the ground is especially good, that the advantages gained by the systems we are considering are less evident.

In any event, the changes necessary for trying the system are very simple.

The third fundamental type of antenna is one which is recommended for use in areas where the space available will not admit of the use of the horizontal doublet and where reception from all directions is desired. The mechanical details for such a system are given in the drawing, Fig. 2. The length of a flat-top of this nature does not need to be as great as the length of a single wire for picking up the the same signal voltage, but, for all practical purposes, especially where it is desirable to receive a fairly dependable signal from given stations at almost any hour, the flat tops for any of the three systems described should not be less than thirty-five feet in length.

Conclusions

1—Noise-free reception on short waves is possible and economical.
2—Transmission lines for broadcast and short waves are simple and inexpensive, but differ in form.
3—There are three general types of antennas best suited for short waves.
4—Stranded, insulated copper wire is better for antennas and transmission lines than solid copper or stranded alloys, such as phosphor bronze.

Graphite Anode Transmitting Tubes

(*Continued from page 7*)

reinforced against excessive warpage. A minimum of supporting metal is highly desirable from the standpoint of less occluded gases to be cleaned up during bombardment and exhaust.

Since the graphite anode has been previously purified, it gives off little or no foreign matter during bombardment. The mass is heated to incandescence or hotter than it will ever get in actual use, assuring the expulsion of occluded gases and water vapor residing in its pores. The volatilization point of pure graphite is too high to be attained in production bombardment, so that there is no sputtering or spattering of conducting particles about the tube, as is frequently the case with metal. When cooled, the graphite mass acts as a getter, having great affinity for whatever gases may still remain in the evacuated tube.

Mechanically, the graphite anode is stronger than the usual metal plates. It is rigidly mounted and supported in place by means of screws, nuts and rods. With the roughest handling, the glass and metal parts will break before the graphite anode. The contact resistance between this one-piece anode and adjacent metal is practically zero, because of the low contact resistance of pure graphite.

In operation, the advantages of the graphite anode immediately become obvious. The outstanding feature is, of course, the realization of that perfect black body as a heat radiator. The graphite anode offers 50 per cent greater heat dissipation than the usual metal plate. The glass bulb may run hotter, because the heat is radiated by the anode to the surrounding glass envelope; but the latter can withstand the heat since its function is to impart that heat to the surrounding air. The graphite anode never attains the incandescent state, as contrasted with glowing molybdenum plates even under normal operating conditions.

Due to the exceptional heat dissipation, graphite anode tubes are capable of handling higher outputs for a given rating. If desired, the tubes may be made smaller and provided with more compact glass envelopes. If operated at the indicated rating, the tubes are under comparatively little strain and can function satisfactorily for long periods. Long life is anticipated for these tubes, because (1) the tubes can be processed and aged more critically than is common practice with metallic plate tubes; (2) the tubes can be made "harder," or more highly evacuated, because of the getter action of the graphite; and (3) with harder tubes the positive ion bombardment of the filament is reduced to a minimum, which means that the thorium in thoriated filaments is consumed at a far slower rate, resulting in longer filament life.

The operation of the graphite anode at a lower temperature than is the case in tubes heretofore available prevents primary and secondary emission from the grid, because this element is not heated excessively.

The non-warping characteristic of the graphite anode is of considerable interest to the short-wave enthusiast, engineer, and operator. With the precisely controlled frequencies in present-day short-wave amateur and commercial communications, the matter of precisely stabilized tube characteristics is of prime importance. The precision is even more marked in the ultra-short-wave band, for which the graphite anode tube appears particularly well adapted.

Reports from the field indicate the realization of the several outstanding advantages anticipated for the graphite anode tube, not only in theoretical speculation, but also in laboratory tests on our experimental tubes. Indeed, the results are sufficiently encouraging to encourage us to essay other elements of graphite in transmitting tubes, replacing still more metal. It is difficult to predict just what may be the further gain by introducing more graphite components, but it is safe to state emphatically that the graphite anode at least is here to stay.

High Gain A. F. Amplifier

(*Continued from page 6*)

TABLE II

Tube Type	Grid-Bias Volts	Screen Volts	Peak-Output Volts†	Distortion Per Cent
37	—22.5	.	275	0.7
56	—16.5	..	255	1.1
57	— 3.5	75	300	1.0
57	— 3.5	75	350*	2.5*
77	— 3.5	70	293	1.5

† The peak-output voltage is that measured between plates.

* For the 350-volt output condition in the above table, the input to the 57 tubes is sufficient to cause some grid current.

In cases where the grid leak of the power tubes is limited to 100,000 ohms, the maximum output of two 57's in push-pull with plate load of 250,000 ohms is 315 volts peak with distortion of 1.8 per cent. Screen voltage of 75 volts is used. The input signal is that which will just start grid current.

Thus, if it is desired to operate two 845's in push-pull with a plate voltage of 1000 volts and grid voltage of 155 volts to provide approximately 45 watts of power, very satisfactory results would be obtained by using a pre-amplifier stage of two 57's in push-pull with a plate-supply voltage of 500 volts and a control-grid voltage of 3.5 volts. Where an amplifier is to be used in conjunction with low voltage inputs, the high gain of the 57 is a distinct advantage.—*RCA Radiotron Co.*

Problems in S. W. Super Design

(*Continued from page* 17)

than the r.f. coils, or the oscillator tuning condenser may have a smaller capacity than the other condensers. In any case, the point is that the difference frequency is 456 k.c., which is so far beyond audibility that a beat cannot be heard. To obtain the beat therefore, connect a small external condenser across the oscillator tuning condenser and adjust it until a beat *is* heard. The only reason we want a beat is to be sure that the oscillator is oscillating. We could tell, of course, by means of a wavemeter; but not all experimenters are gifted with such equipment.

If we find that a beat is heard, then remove any of the auxiliary equipment used in the oscillator circuit and proceed; but, on the other hand, if you find that you cannot get a beat, then reverse the connections of the plate or grid coil in the oscillator circuit; check the coupling system between the oscillator and first detector; check all voltages and currents; be sure that there are no shorted turns on the oscillator coil; and, finally, watch those high-resistance joints. Oscillator circuits are fairly well understood, so that no trouble should be experienced on that score.

With the r.f., first-detector, and oscillator functioning normally, our next job is to line up the i.f.'s. It is well to point out at the outset that it is absolutely necessary that an oscillator be used here; you can't get by successfully without one. To adjust the i.f. stages, remove the r.f. and oscillator tubes from their sockets, and insert the two i.f. and the second detector tubes in their sockets. Change the connection of the phones from the plate circuit of the first detector to the plate circuit of the second detector.

The external oscillator should, of course, be capable of generating a reasonably strong signal at 456 k.c., our intermediate frequency. One side of the oscillator output should be grounded and the other side connected to the control grid of the first-detector tube. Set the oscillator to 456 k.c. and listen. Adjust the trimmers of the i.f. transformers until the oscillator is fairly strong, and then disconnect the lead from the oscillator to the control grid. The signal should disappear entirely. If the signal does not disappear, then the i.f. stages are picking up the oscillator externally. The remedy is to completely shield the oscillator proper and its "hot" lead going to the control grid of the first detector. Ground the shield. After the signal can be made to disappear entirely, reconnect the hot lead to the grid and tune the i.f. trimmers very carefully for maximum response.

It's a good idea to connect a milliammeter in the plate circuit of the second detector in series with the phones; watch the meter as well as listen. If the second detector is of the power type, the meter reading will *increase* with signal strength; in this case a 0—10 ma. meter will do the trick. If the second detector is of the grid-leak — grid-condenser type, then use a 0—1 ma. meter; in this case, the meter reading will *decrease* with increasing signal strength. The advantage of using a meter is that its indications of variations are more accurate than those of the human ear, and a better adjustment is possible. The phones are desirable because the usual experimenter feels better when he's listening.

After the i.f.'s are lined up, we must go back to the oscillator again; for we haven't adjusted its tuning condenser so that the difference frequency is 456 kc. We know that the i.f. stages are all right, and we know that the r.f. stages are tuned properly; but we know nothing about the oscillator, except that it is oscillating.

Insert the r.f., first detector, and oscillator tubes in their respective sockets and, keeping the phones and the meter—if one is used—in the second-detector plate circuit, tune in the signal. Of course, if the oscillator tuning condenser is too far off, you will not hear it; but by carefully adjusting the trimmer, tuning the set after each small adjustment until maximum response is again obtained, you can tune in a signal. Remember, whether the plate milliammeter in the second-detector circuit increases or decreases depends upon the type of circuit used, as discussed previously.

When these adjustments are completed, the entire procedure should be gone over once again to insure accuracy, as sometimes a change in one circuit may affect the adjustment of another, allied circuit.

Perhaps it would be best to summarize the procedure outlined above for convenience.

(1) Line up the r.f. and first-detector tuning circuits;
(2) Be sure that the oscillator is working. Test by the beat method;
(3) Line up the i.f. stages using an external oscillator;
(4) Adjust the oscillator tuning condenser for maximum output response.

We will not discuss the audio end of the set, as audio amplifiers are so well understood that any brief discussion could only be a repetition of already published material.

When the adjustments are completed, there should be no squeals, howls or other internal disturbances to mar reception. But what if there are squeals and howls? What to do then?

The answer to that question is simple. With squeals and howls present, you could not adjust the set to maximum sensitivity. Each individual squeal and howl must be eliminated one at a time; and the proper time is when making individual adjustments of the set. For instance, when adjusting the i.f. stages, be sure that when peak sensitivity is reached, none of the i.f. amplifiers is oscillating. Many men, when reaching maximum response, find a persistent oscillation. They serenely "put salt on the bird's tail" by detuning one of the transformers. Why throw away sensitivity? Eliminate the oscillation by reversing either the primary or secondary, or both, leads of one of the transformers; place i.f. filters in the plate circuit of each i.f. stage; shield the transformers or leads or tubes; or do all of these things. But don't leave the i.f. stages without eliminating the oscillation.

Another thing. Nearly all s.w. supers are equipped with a second oscillator for c.w. reception. Of course, this same oscillator may also be used to locate carriers of phone stations. The important thing about this oscillator is that it must not disturb the adjustment of the set when turned on or off. For this reason, this oscillator is so connected that its output feeds into the i.f. stages, preferably the second. This oscillator should be thoroughly shielded, and only a small voltage removed and fed to the amplifier. In this manner, the effect of the oscillator will be nil.

Bear in mind that 456 kc. is small compared to 20,000 kc. (corresponding to 15 meters). We all know the trouble in getting broadcast supers to work, so imagine the trouble getting a super to work at 20,000 kc.

The usual precautions for s.w. work holds: shield all parts; make the leads as short as humanly possible; take your time when adjusting it; and last but not least, keep your shirt on when tuning it.

Quartz Crystals in S. W. Supers

BECAUSE of the publicity that has been given certain superheterodynes using quartz crystal filters in their intermediate-frequency amplifier circuits, many short-wave broadcast listeners have obtained an erroneous idea as to the purpose of this novel arrangement. Let us get this business straightened out and prevent further confusion.

Idea Is Old

The idea of using a quartz crystal to sharpen the selectivity of a tuning circuit was suggested more than 10 years ago, but because of the high cost of satisfactory crystals and the fact that simpler circuit combinations were quite satisfactory for current conditions, the scheme never achieved any widespread use. Credit for the present application of the idea must be given to James J. Lamb, technical editor of QST. The congestion in the amateur transmitting channels was becoming so great that super-selective receivers were becoming a necessity. Mr. Lamb designed a remarkable short-wave superheterodyne, using a crystal filter, which possesses such enormous selectivity (expressed in cycles rather than in kilocycles), that it became known popularly as the "single signal" receiver. This set clearly separates amateur telegraph signals that in ordinary receivers are merely a hopeless jumble of noise. In some of the superheterodynes using the single signal principle, the selectivity is hundreds of times greater than in the best previous types of short-wave receivers.

The very needlepoint selectivity that makes these single signal supers so valuable for amateur telegraph reception is just what makes them undesirable for broadcast reception. The exceedingly sharp cut-off effect on an ordinary voice or music signal removes most of the side-bands and renders the transmission wholly unintelligible. The selectivity effect may be broadened out to a point that will permit intelligible reception of at least voice, the frequency range of which is less extended than that of music, but interference on the short-wave broadcast channels has by no means reached the same point that it has on the crowded amateur bands and extreme selectivity of this kind is neither desirable nor necessary, at least at the present time.

To sum things up, it can be said that the single signal receiver is primarily an amateur communication receiver. The listener who is interested mostly in foreign short-wave broadcast reception need not concern himself about its complex technicalities.

Used in Stenode

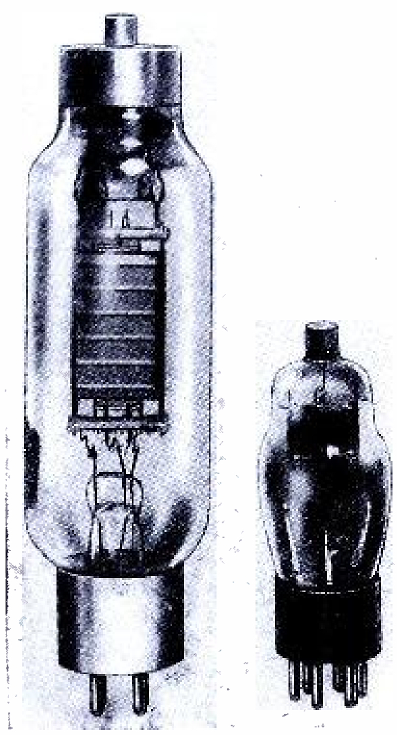
As a matter of fact, the late lamented Stenode receiver, which was given considerable attention in American radio publications about three years ago, was a superheterodyne using a crystal filter in much the same manner that the present amateur single signal outfits do. Of course, the great selectivity provided by the crystal filter in the i.f. amplifier lopped off a good deal of the high-frequency portion of the received signal. To compensate for this loss, the set employed a special audio amplifier which emphasized the high frequencies and which thus tended to restore a natural balance to the final music as reproduced by the loud speaker. Most American radio engineers who heard the set in operation were not greatly impressed by the tone quality, although admittedly the r.f. selectivity was of a very high order.

New Raytheon RK-18 Transmitting Tube

The new Raytheon RK18 is an oscillator-amplifier tube designed particularly for use in the amateur high-frequency bands. It is intended for use in Class B modulator service also.

The RK-18 provides r.f. power output and Class B modulator performance which cannot be secured from the 210, although it requires only 750 volts for normal operation. Having capacities lower than the 210, it is more suitable for use on the ten- and five-meter bands.

The plate connection is made at the top of the bulb and the grid and filament connections through the usual prongs on a standard four-prong Isolantite base. The maximum diameter is 2 1/16" and maximum overall length 8½".



The new RK-18 (left), compared with a 58.

Operating Data and Characteristics

Filament Voltage		7.5 volts
Filament Current		1.40 amperes
Class "A" Service		
Plate Voltage	750 nominal	1.000 maximum
Grid Bias Volt.	−30	−40 volts
Amplification Factor	18	18
Plate Resistance	6,300	6,000 ohms
Mutual Conductance	2,850	3,000 ohms
Plate Current	34	36 ma.
Load Resistance	9,300	13,500 ohms
Undistorted Pr. Output	5.4	8.5 watts
Class "B" Service		
Plate Voltage	750 nominal	1.000 maximum
Grid Bias Volt.	−40	−50 volts
Load Resist.*	2,500	3,000 ohms
Power Output (2 tubes)	55	70 watts
Plate Dissipation per tube	25	35 watts
Max. Plate Current (peak)	210	220 ma.
Max. Eg. AC	64 RMS	70 rms.
*For two tubes, multiply by four.		
Class "C" Service		
Plate Voltage	750 max. mod.	900 unmod.
Grid Bias Volt.	−150	−150 volts
DC Plate Current	85	85 ma.
Grid Leak Resistor	15,000	15,000 ohms
RF Grid Current	5 max.	5 amps. (max.)
Plate Dissipation (per tube)	35	40 watts
Watts Output	30	35 watts

Replacing Obsolete Modulated Oscillators

(*Continued from page* 25)

even the 20 attained in a really good short-wave receiver r.f. stage, but it is adequate for the job. And if the 24 runs at 250 volts on the plate, we are o.k.; 180 volts is frequently enough, and to spare.

The oscillator condenser, like that of the old 1929 model shown in Part I, is solidly grounded on the front panel, via its mounting bushing. It should not be grounded elsewhere, other supports being of an insulating nature. The mechanical arrangement may be as shown in Part I, or this may be modified in various ways, one of which is suggested in Figure 5. The main idea is always to provide quite short paths and to avoid loops which look as if they might tune to five meters and/or be coupled to the tuned coil, or rather loop. As an illustration of what is meant, an oscillator arranged as shown in Figure 6 showed a bad "jump" at five meters when tuned back and fourth. The fault was found to lie in the loop consisting of the bus B, the filament bypasses C1 and C2, and portions of the tube and the tuning condenser. When the loop was turned down horizontally to decrease coupling with the tuned coil, the "jump" almost stopped. Rebuilt as in Figure 5, it worked quite well.

Again—the C and B feed leads have little r.f. voltage on them inherently; but what is to prevent their picking up voltage by induction? They run near the tuned coil, and cannot be shielded without inducing bad losses in the shielding. If they could be led off at right angles to the plane of the tuned coil, the coupling would be small. The usual test of touching the B lead and watching the plate meter for a jump is good if—and only if—we are not being deluded by having an accidental high-loss capacity between the B plus lead and chassis acting as a bypass. This will prevent the appearance of r.f. voltages (so will a bypass in the plate supply filter), but the performance is poor none the less.

Getting Started

Start by placing a good r.f. choke in the B plus lead quite close to the stopping condenser in the tuned coil and bend it around until you find the "least coupling" location. During this stage of the proceedings, use a B plus lead that does not lie on the chassis and that is from 10 to 20 inches long before reaching a bypass to chassis. Now, any r.f. at the "back" end of the choke will be shown up very nicely by a jump of the plate-supply meter when the supposedly cold end of the choke is touched. (Look out for the d.c. and don't touch the chassis with the other hand.) Having, by means of neon lamps, finger-touch, and plate-meter tests established the fact that the oscillator oscillates well across the five-meter band, and a comfortable distance to both sides, we are ready to advance from 1924 to 1934 by adding the buffer-stage.

This stage is coupled to the oscillator in the manner made manifest by the type-diagram, Fig 7, noting that not all of the coupling gadgets shown there are well used in all cases. The proper combinations for various tube arrays will be shown in later paragraphs. Whereas the oscillator circuit was an extreme example of the so-called "high C" type of circuit, we should use a very low-C circuit in the buffer tank if this were possible. The tuning capacity should be, perhaps, a micromike. This is not very practical, for one must waste too much time in clipping sixteenths of an inch from the coil and every change in the tube or in the position of a coupling clip would then demand another coil rebuilding. Thus, we throw the ideals clean overboard and use a 25 micromike midget tuning condenser across a single 1¾" or 2" turn of a fairly heavy wire or small copper tubing, taking care of the tuning-spread in the dial by using another "velvet" microdrive dial.

Adjusting the Set

The adjustment is simple to the last degree. The input clip is put on the "plate" side of the coil near the B plus end, the 24 operated at 90 volts screen and 180 to 250 volts plate, then the tank condenser is turned slowly while plate meter and neon lamp are watched. If nothing happens move the input clip a little closer to the "plate" end of the coil and it will shortly happen. The tuning is very sharp. Do not expect much output; it isn't needed or wanted. The amplification in the buffer is between four, as a maximum, and less than one, as a minimum. The latter should not happen, but in most tube combinations some de-amplification in this stage is harmless as there is ample "push" to start with and a de-amplifier is a perfectly splendid buffer since the coupling from input to output is obviously low.

The excitation of the final stage is a repetition of the above with the minor difference that we must adjust for a particular plate current. For plate modulation this is done by using ample grid r.f. input and changing the plate-to-load coupling until the required plate current appears. For grid modulation the coupling to the load is made rather close, and the r.f. input is carefully adjusted until the plate current has the specified value.

When it comes to modulation by

the plate method, the procedure is familiar, with the difference that for once there isn't any antenna or tank meter to lie about the percentage—one must watch the d.c. plate meter and modulate until it just moves a very little on loud sounds. This is the right method on ordinary waves, too.

For grid modulation we plug the milliammeter into the grid of the final r.f. tube just discussed, and modulate by such an amount as will occasionally cause a faint movement of the meter, *i.e.*, a twinge of grid current.

The only thing about the whole business that is the least unusual is that the set happens to be working at five meters, and is of low power.

So far we have intentionally gone light on structural details. In the next part of this story the construction of a specific set will be described.

"Supers" in Favor

IT took the short-wave fraternity a long time to accept the superheterodyne circuit, in spite of its admitted superiority over straight regenerative circuits on the general points of sensitivity and selectivity. An enormous amount of signal amplification can be squeezed out of a regenerative tube, but the comparatively poor selectivity of single tuning circuits apparently is what finally forced short-wave fans into the complexities of the super. Now that they have been using supers for a while, they admit, rather begrudgingly, that they are really good sets after all. With short-wave stations crowding the air in increasing numbers, it certainly is desirable, if not necessary, to employ three or four tuned circuits, as the super does, in order to separate powerful stations on nearby channels.

One of the factors contributing greatly toward the increasing popularity of the super is the general improvement that has been made in the circuit itself. Instability, the curse of early short-wave supers, has been eliminated almost entirely by the design of electron-coupled oscillators and quartz crystal resonators, the latter being responsible for the "single signal" type of "ham" set.

Incidentally, the popular acceptance of the short-wave superheterodyne has also brought coil-switching arrangements back into favor. The flimsy, unreliable switches that were perpetrated two or three years ago have given way to sturdy, absolutely dependable devices that isolate the individual coils and make wave changing really easier than using plug-in coils. For certain purposes, of course, plug-in coils are still preferable, either in t.r.f. or superheterodyne sets. In some of the more advanced supers, however, the switches are so well made that no operator need ever worry about their getting out of order.

Station X1G

(*Continued from page* 19)

This can also be used as a monitor for checking purposes. Next in line is a Hammerlund Comet "Pro" receiver. This is mostly used for the reception of short-wave broadcasting stations from the U. S. A. For all amateur reception, a Hendricks and Harvey Single Signal Super is used and it sure does pull them in. Next to the S.S. receiver is a four stage a.c. operated speech amplifier that consists of a 57 impedance coupled to a push-pull stage of 27's, followed by another stage of push-pull 27's followed by a pair of 50's in push-pull. A 500-ohm line couples this unit to the Class B modulators for 20 and 75 meters and to the Class A modulators for 160-meter operation. A Western Electric moving coil microphone is normally used.

The power supply unit for the 20- and 75-meter transmitters is located on the opposite side of the room from the operating desk and is remotely controlled by means of push buttons which actuate time delayed relays. It consists of a sturdily built rack made of one-inch channel iron divided into three shelves. The top shelf contains the power supply for the crystal oscillator and buffer stages and voltages from 300 to 900 volts are obtained. The four relays which control the various plate and filament voltages are mounted in the rear of this shelf. The 2000-volt supply for the 852's is mounted on the center shelf and consists of a pair of 872 mercury vapor tubes in a full-wave circuit. The bottom shelf contains the 1000-volt supply for the class B modulators. This whole unit is switched from the 20-meter set to the 75-meter set by means of the two multi-poled double throw switches on the front panel. An auto transformer in the primary circuit enables the operator to regulate the line voltage to compensate for the changes that are quite severe in Mexico.

A cathode ray oscillograph is mounted on the mantle above the fireplace and is used for checking up the frequency response of all the transmitters and amplifiers. An Esco motor generator unit supplies the 1200 volts for the 160-meter set and is located in an adjoining room.

With this arrangement, a complete coverage of all bands may be had and changing from one band to another can be accomplished almost instantaneously. All the above transmitting equipment was built and installed by Morton B. Kahn, who owns and operates W2KR in New York City. The frequencies of the various transmitters are 1995 kc., 3896 kc. and 14140 kc. Phone is used exclusively and as the handling of messages is prohibited by the Mexican Government the main enjoyment derived by the operation of this station is rag chewing.

The Hg-7

(Continued from page 11)

on the bottom of the copper can in its usual fashion. The prongs of the coil, therefore, protrude through the wafer socket-top and shield can and slide into regular sockets mounted on the chassis. The top of the can should be removable for inspection whenever necessary. Four such cans are required, one for each wave band.

All that is necessary, then, to change wave bands is to remove the entire can and substitute another one. Another feature of this arrangement is that the front panel is not cluttered up with coil knobs, which may be used, perhaps, once or twice an evening. Also, we believe the cost of this method of construction is lower than any other equally successful coil-changing method.

The procedure used to line up the superheterodyne is not different from that of any other super. Obtain an oscillator and adjust the i.fs. to 465 kc. Since the three-gang tuning condenser has no trimmers on it, there is no necessity for making any other adjustments. Individual antenna adjustments or individual antenna compensations are made by means of C1. The oscillator coil should have several turns removed from its secondary on the two longest wave coils. This information is given in the coil data. Although the photographs show condenser C4, the oscillator-compensator, mounted directly on the front panel, it should be pointed out that a better location, and one that has been used in the final model, is directly underneath the three-gang tuning condenser. The mechanical drawing of the chassis takes care of this. Any insulated type of bracket may be used for this purpose. A scheme used by the writer is shown in the same sketch as for the coil shield.

The proportions and directions given here should enable anyone with a working knowledge of radio to build this receiver in a few nights and have it work "right off the bat."

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912,

Of SHORT WAVE RADIO, published monthly at Chicago, Illinois, for October 1, 1933.

State of New York }
County of New York } ss.

Before me, a Notary Public in and for the State and county aforesaid, personally appeared Louis Martin, who, having been duly sworn according to law, deposes and says that he is the business manager of the SHORT WAVE RADIO and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 411, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business manager are: Publisher, Standard Publications, Inc., 4600 Diversey Ave., Chicago, Ill.; Editor, Robert Hertzberg, 1123 Broadway, New York, N. Y.; Managing Editor, Louis Martin, 1123 Broadway, New York, N. Y.; Business Manager, Louis Martin, 1123 Broadway, New York, N. Y.

2. That the owner is: (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding one per cent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a firm, company, or other unincorporated concern, its name and address, as well as those of each individual member, must be given.) Standard Publications, Inc., 4600 Diversey Ave., Chicago, Ill.; Louis Martin, 1123 Broadway, New York, N. Y.; Robert Hertzberg, 1123 Broadway, New York, N. Y.; Irene Levine, 1123 Broadway, New York, N. Y.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state.) None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

LOUIS MARTIN.

Sworn to and subscribed before me this 5th day of October, 1933.

MAURICE COYNE, Notary Public.

(My commission expires March 30, 1934.)