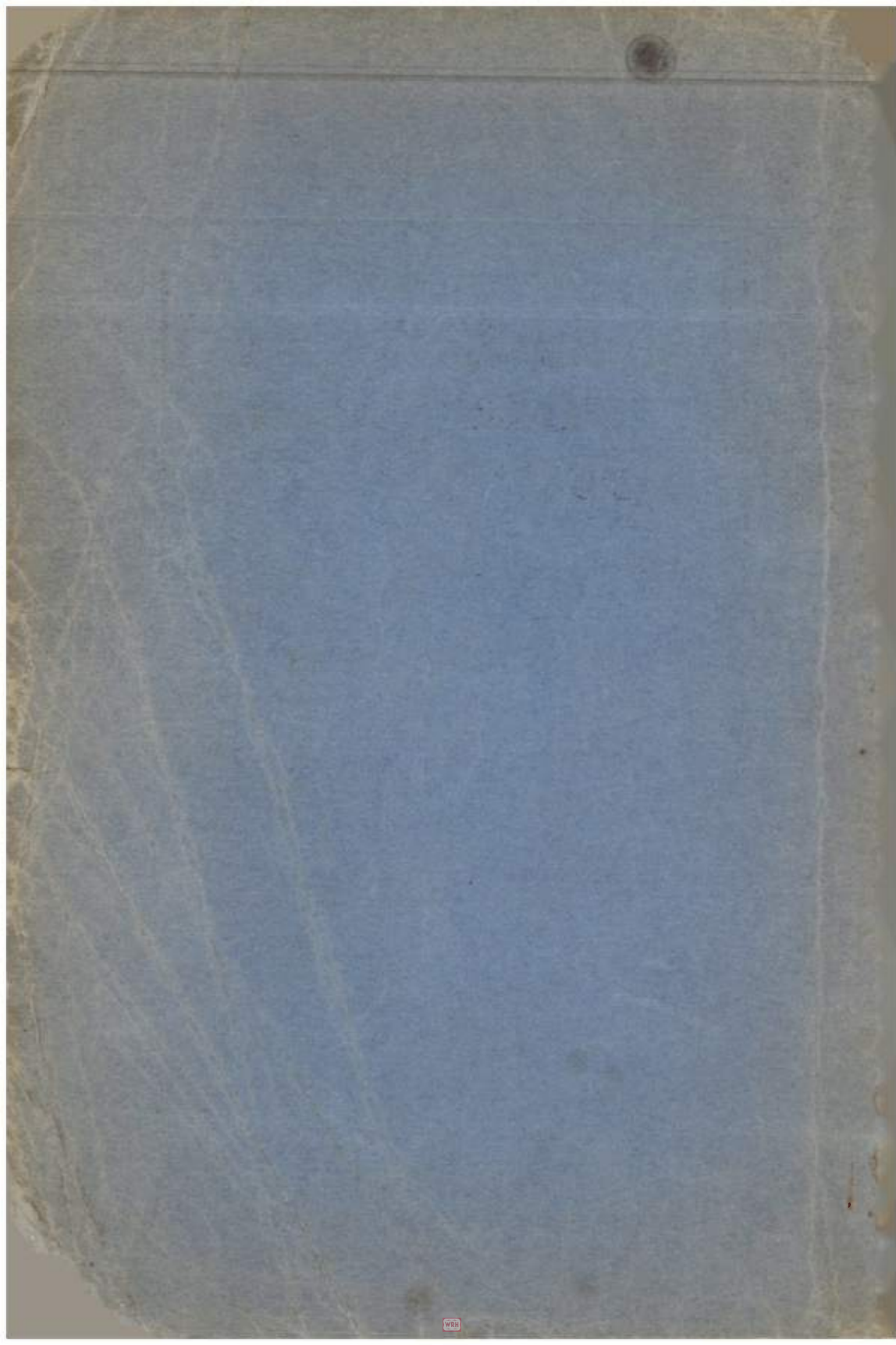


All-Wave Radio
**PRACTICAL
RADIO MANUAL**



Joe Manson

All-Wave Radio
**PRACTICAL
RADIO MANUAL**



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16 East 43rd Street - New York

All-Wave Radio

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Dear Reader,

To Mr. G. S. Granger was allotted the difficult task of preparing to the order of many of our readers a different, "personalized" course of instruction in Amateur Radio. Mr. Granger, already well known to followers of ALL-WAVE RADIO for his interesting feature articles, and to the Radio Field in general for his booklets on Radio Receiver Design, immediately enlisted the aid of two real "Embryo Hams," Barbara and Ernest Rowland. His series of letters to them, signed "Gerald," covering the ground of both theory and practice and answering their normal questions is justly famous.

Now, for the first time, this unusual series, supplemented by carefully selected material of value, is made available complete in bound form. As readable as a novel, as authoritative and complete as many a text book, this volume gives a fascinating insight into what "makes the wheels go 'round'" - as well as aiding the more serious student in qualifying for his own license. If you find this volume of interest, you will like ALL-WAVE RADIO Magazine in which all of this material originally appeared.

This little volume is dedicated to you in the hope it will prove of real help and value. Best of luck and may you soon have your own "ticket"!

Sincerely yours,



E. W. Lederman
Publisher, ALL-WAVE RADIO

EWL:SHR



PROLOGUE

Mr. and Mrs. Ernest Rowland, of 384 William Street, East Orange, New Jersey, are two "youngsters" who have been so taken with amateur radio that they have decided to "plug" for all they are worth so that they may get on the air with their own amateur transmitter.

Neither "Ernest" nor "Barbara" had the slightest idea as to how they should go about becoming amateurs, nor did they know if their chances of obtaining radio amateur licenses were at all favorable. They asked Mr. Granger, whom they have known for some time.

What Granger told them was simply this: "If you are sincere in this, and if both of you are willing to devote a bit of time each day to a study of the code and the fundamentals of amateur radio, there is no reason why you shouldn't pass your examinations for Class B licenses."

When Granger commenced outlining

preliminaries, it was Ernest who remarked that there must be thousands of other short-wave listeners who desire to become radio amateurs, but have been scared off by a lack of knowledge as to how to proceed.

Since Granger had agreed to "see them through" to the bitter end, it was immediately planned to publish each month the correspondence between instructor and students, with the idea in mind that short-wave listeners who wish to become radio amateurs will have the opportunity of "following through" with Ernest and Barbara.

Be that as it may, we are sure our readers will find it immensely interesting to follow the progress made by these two enthusiasts. The entire staff of ALL-WAVE RADIO has taken a fatherly interest in "Ernest" and "Barb," and wish them lots of luck.—THE EDITOR.

CONTENTS



Ernest & Barbara Radio Amateur Series	5
Amateur Radio Districts (Map)	52
Frequency Conversion Chart (Meters-KC)	60
Question and Answer Series	83
Ham Lingo (Conventionals, etc .)	89
C. W. Kit Transmitter	95
Traffic Rig for 40 and 80 C. W.	99
The DX4UCW Xtal Xmtr on 10-20-40-80	105
Siple AC-DC Code-Practice Set	112
Portable or QRR Self-Powered Xmtr-Receiver ..	113
A 5 and 10 Superhet	119
DX With the Backyard Antenna	127

The Embryo Radio Hams

Barbara & Ernest Learn the Code

LESSON 1

Dear Ernest and Barb:

You certainly make an odd pair of students. Ernest, you seem to have all the confidence necessary, but Barb seems fearful of that which is ahead of her.

But I can understand that; a man has a mechanical turn of mind, whereas a woman has not. Nevertheless, a woman is quite often more receptive of mind than a man is, and for that reason I believe the two of you are going to run nose-to-nose in this.

But it would help immeasurably if Barb could work up a bit more confidence. I wish you would go to the Library and get her a copy of Anne Morrow Lindbergh's book, "North to the Orient." and force her—which will be easy in this case—to read the first few chapters in which Mrs. Lindbergh speaks of her apprehensions concerning the possibilities of her ever learning anything about radio. Barb is sharing the identical apprehensions, and it may be that she will feel better after reading of the progress Mrs. Lindbergh made; much, I believe, to her surprise.

All things are deep and difficult until one understands them; afterwards one smiles at their simplicity. You will find this to be so with the Continental Code you are about to study, and you will find it so with the fundamentals of radio, beyond which you need not go unless you care to. It will all be very simple—afterwards. In the meantime, never mind the little fears . . . just study, and the "afterwards" will arrive more rapidly than you would expect.

I am attempting to make things as easy for you as possible. I phoned Bob Hertzberg, of Wholesale Radio Service, Inc., and he was so interested in your

joint venture that he very kindly donated a key (which you can use with your transmitter later on) a buzzer and a pair of headphones for the two of you to get started with. More than likely you have received these by this time and I think it would be a good idea to get them hooked up right away so that both you and Barb can get the "feel" of a key before you actually get into code practice.

Buzzer Hookup

Here is a sketch (Fig. 1) that shows how to wire up the key, the buzzer and the two No. 6 dry cells. Mount the key and the buzzer on a board, or better yet, mount them on an old table if you happen to have one around. After you have the outfit working, adjust the little screw on the vibrator contact for a good, steady tone. If you can't steady the tone, you might add another No. 6 dry cell in series with the two shown in the sketch.

After you have the buzzer working properly, connect up the headphones for Barb. The connections are shown in dotted lines in the sketch.

Since the two of you are going to work together on this, it would be a good idea if you were to send to Barb a while, then switch the pair of headphones and have her send to you for a while.

The first thing the two of you will have to do is to learn how to send properly. If you cannot form the characters in the right way, Barb certainly won't be able to make out what the letters are. And vice versa, Barb! But, sending slowly, as both of you will do for a while, is not a difficult feat, providing you keep in mind that the dots and dashes which make up the letters *will make up other letters if the spacing is incorrect*. I shall get around to that shortly.

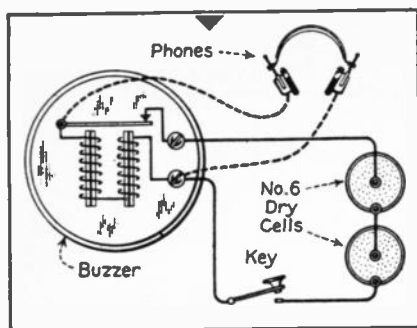


Fig. 1. Connections for a typical code-practice setup.

Candler to Help

First of all, I want to tell you that Mr. Walter H. Candler, of the Candler System Co., Asheville, North Carolina, who has been so successful in training people in the radio code, has shown the same keen interest in the two of you as have numerous other people with whom I have talked. Possibly it is because it is unusual to run into husband and wife both intent on becoming hams. In any event, Mr. Chandler has offered to enroll the two of you in his complete course in Scientific Code Instruction, free of charge, which is a break for you! This includes all the necessary training in code and radio fundamentals for you and Barb to obtain your amateur licenses. Mr. Candler is a past master in code training and there isn't much I could tell you that he won't tell you later on. But, until you receive the first lesson from him, I would like to cover a few of the major points regarding the code.

Fundamentals of Code

I have worked up the complete Continental Code on the attached sheet (Fig. 2). This includes everything but the special punctuation marks which you may never use. Anyhow, I don't want you to get all tied up into a knot over them at this stage of the game, as they are relatively unimportant.

Now, please note that all letters, numbers and punctuation marks are made up of combinations of dots and dashes *without spacing*. In the Morse

code, where dots predominate, certain letters are composed of dots that are spaced. This is not so in the Radio Code.

Now if you two will run down the alphabet you will observe that some letters are composed wholly of dots, others wholly of dashes, and others composed of a combination of the two. Thus, *e*, *i*, *s*, *h* are composed of one, two, three and four dots respectively, while *t*, *m* and *o* are composed of one, two and three dashes respectively. Then there are letters like *a* which are composed of some dot-and-dash combination, and other letters which are just the reverse. Thus, *a* is dot-dash, while *n* is just the reverse, or dash-dot. Going further, there are letters, such as *f*, that are made up of larger combinations which, if separated in one way or another, will make up two other letters. Thus, *f* is dot-dot-dash-dot, but if it were to be broken up, it could be *in*, for instance, for *in* is dot-dot dash-dot.

You will see from this that the matter of spacing is highly important if the person at the other end is to know what you are talking about. I have drawn a little sketch of the characters making up the letter *c*. (Fig. 3). This is an extra-special letter since it is a part of that very famous "CQ" used by radio operators and almost done to death by many amateurs. And you would be surprised how often an amateur sends something other than CQ without even realizing it.

Observe from my sketch that the letter *c* is dash-dot-dash-dot. If it is keyed as it normally sounds it will be dah-dit-dah-dit. But, if the operator is careless and either spaces these four characters or gives them the incorrect rhythm, they will be either dah-dit, dah-dit, which is *nn*, or dah-dit-dah, dit, which is *ke*.

Rhythm of Code

I am bringing this up now because you are going to do the sending for Barb and she is going to do the sending for you. It is important, therefore, that both of you appreciate that the dots and dashes making up the letters of the alphabet will form a very definite rhythm that cannot possibly be mistaken for any

other rhythm in the code, if keyed properly. I'm not good at remembering the titles of songs, but you will know both the title and the melody of "Carry Me Back to Old Virginny." If, instead of humming it, you will give it the old "da-de-da-da-" method of fill-in one uses when he doesn't remember the words, you will find that it will be something very close to this: dah-dah, dit-dah, dit-dah-dah, dah-dah, which is *mawm* in radio code. The same thing won't work out very well with "The Music Goes Down an' 'Round," but the "Carry Me Back to Old Virginny" is a good example of the rhythmic content of the radio code.

You will appreciate, then, that both of you should learn to key or send with rhythm and that eventually you must learn to copy by the rhythmic sound of each letter. The letter *c*, for instance, cannot be clipped so that it sounds like two fast *n*'s. The dah-dit-dah-dit must be blended together so that it has continuity. It must be treated in exactly the same way you would treat an *h*, which is dit-dit-dit-dit. If it is broken thus: dit-dit, dit-dit, it is a double *i*; if it is sent dit, dit-dit-dit, it is *es*; if it is sent dit-dit-dit, dit, it is obviously *se*, and not by the wildest stretch of the imagination an *h*.

Holding the Key

It is hard to send if you don't hold the key properly. The key should be far enough back so that you can rest your arm on the table. The first two fingers of the right hand (unless one happens to be a southpaw!) should be placed on top of the key knob and the thumb along the left edge of the knob. The key should not be tapped; sending should be accomplished by flexing the wrist which will increase the pressure of the fingers on the key knob. If too much pressure is required to make the key close for the dots and dashes, then the spring tension on the key should be adjusted until you find the key easy to operate.

Now, one last point about keying . . . don't try to send the letters fast. The time interval of a dot is about what anyone would expect it to be—short enough to be a dot and long enough to be rec-

The Radio Code

Letters

A	●
B	●●●●
C	●●●●●
D	●●●
E	●
F	●●●●
G	●●●●●
H	●●●●
I	●●
J	●●●●●●
K	●●●●●
L	●●●●●
M	●●●●●
N	●●
O	●●●●●●
P	●●●●●●●
Q	●●●●●●●
R	●●●●●●
S	●●●●
T	●●●
U	●●●●●
V	●●●●●●
W	●●●●●●
X	●●●●●●●
Y	●●●●●●●
Z	●●●●●●●

Numerals

1	●●●●●●
2	●●●●●●
3	●●●●●●
4	●●●●●●
5	●●●●●●
6	●●●●●●
7	●●●●●●
8	●●●●●●
9	●●●●●●
10	●●●●●●

Punctuations

Period	●●●●●●
Comma	●●●●●●
Interrogation	●●●●●●
Exclamation	●●●●●●

Fig. 2.. The Continental Code, as used in radio communication.

ognizable. A dash should equal three dots in time interval. The spacing between each character making up a letter should be equal to one dot. If the spacing is greater than this, you will have split one letter into two. This spacing need not worry you too much at first providing you send but one letter at a time, which is a good idea anyhow.

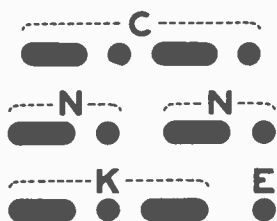


Fig. 3. The letter "c" will turn out to be "nn" or "ke" if the characters are not spaced properly, as shown.

Learning to Copy

In learning to copy, take the easy letters first, such as *t*, *m*, and *o*, which are all composed of dashes, and *e*, *i*, *s*, and *h*, which are all composed of dots. Then work on the simple combinations such as *a*, *n*, *u*, *g*, etc. Try at the very beginning to differentiate between letters by their rhythm or sound, for the sooner you are able to do this, the sooner you will be able to pick up a bit of speed. A speed of even 5 words a minute is out of the question if one has to think first what a certain character combination is. It is necessary to learn to recognize a letter by its sound in exactly the same manner that you recognize and understand a spoken word by its sound only.

After you have done a fair job of learning the letters, turn to the numbers. You will find that the characters representing these are made up of larger combinations of dots and dashes. Unlike the letters, however, the sequence is unbroken. Thus, the numeral 1 is *dit-dah-dah-dah-dah* and the numeral 2 *dit-dit-dah-dah-dah*, so that the numerals from 1 to 5 are readily distinguished by the number of dots. Beginning with the numeral 6 the combination is reversed. Thus, 6 *dah-dit-dit-dit-dit*;

7 is *dah-dah-dit-dit-dit*, and so on, through to 0 which is five dashes, just the reverse of the numeral 5, which is five dots.

Just as long as the characters making up a numeral are keyed properly so that there is no break in continuity, there is no chance of confusing a numeral for a group of letters. There is but one exception to this, and that is the number 6 which can very readily be taken for *th*. A good operator, of course, can make the dash hang on to the four dots so well that there would be no chance of a mistake. A good operator can send *6th* so well that you would never question it. It would sound like this: *dahditditdit-dit, dah ditditditdit*. Simple enough after you have gained proficiency in keying.

Punctuation Marks

Now take a look at the punctuation marks. At first glance it looks as though they might be confused with groups of letters, but this is not the case. A period is triple *i*, thus, *dit-dit dit-dit dit-dit*, but there is no word in the English language containing three *i*'s in succession, so there can be no possible chance of a mistake. A comma, you will observe is essentially a triple *a*. This might be confused with the Government's AAA, but certainly nothing else in the English language. The interrogation mark is *imi* run together, and the exclamation point is *mim* run together, both so distinctive in sound as never to be confused with anything else. As a matter of fact, the question mark has what one might term a very high degree of readability. In sound, it stands out like a sore thumb.

Discouraging at First

Well, that's about all on code, for the present at least. Mr. Candler will give you far better instruction than I possibly could. I want to add, though, that both of you will be very much discouraged for a while. I have yet to meet a person who didn't feel in the beginning that developing speed was simply out of the question for him. I went through the same sort of experience myself many years ago. I knew every letter and number by heart. You could ask me for anything in code and I could give you

the answer in less than the shake of a lamb's tail. But I couldn't repeat them rapidly by their sound.

The queer thing about it is that the whole business comes over you all of a sudden. You slave away day after day and presume you are making no headway at all. Then one day you are surprised to learn that all the plugging has been etching sounds on the subconscious. Before you realize what has happened, the subconscious has opened up, and there you sit, really copying stuff by its sound. It's just like the sun breaking through a cloud bank.

Unquestionably you will experience the same thing—everyone does. So, don't lose confidence. Absorb as much of the code as you possibly can. When you aren't practicing together, tune to some of the short-wave commercial radio telegraph stations and drink in their constant repetition of *v's* followed by *de* and their call letters. You will find some who send quite slowly. I'm going to spot a few for you and include them in my next letter. In the meantime, you might hunt for a couple yourselves.

List of Books

Since the two of you won't be practicing code all the time, I think you ought to start in absorbing a bit of information about amateur radio in general. I am sending you some inexpensive books which you will eventually find indispensable. The first one is, "How To Become a Radio Amateur," published by the American Radio Relay League. This little book is elementary and will give you a good idea as to what amateur radio is all about—not that I won't tell you myself!

The second little book is, "The Radio Amateur's License Manual." This tells you how to apply for an amateur license, what grade of license you can obtain as a beginner, and what amateur bands such a license will permit you to operate in. The book also includes 198 typical questions and answers as are asked in the government examinations. When the time rolls around, you will be asked ten of these questions, picked at random from a standard group of about 200. Since you can't do the picking, and since you

won't know which ten questions will be placed before you, it is important that you know the answers to all of those in the book listed under the heading "Examination For Classes B and C." Don't make the mistake of even *looking* at the questions for the Class A Examination. You can't obtain a Class A license until you have been on the air for a year. Besides, the questions asked in this examination will scare the life out of both of you. Later on they won't seem so tough. *But, leave them alone for the present.*

Though there are 198 questions in the little book, you will note that many of them are practically duplications—the same questions asked in a different manner. So, really, you don't have to learn the answers to 198 *different* questions.

I would suggest that for the time being you and Barb confine yourselves to the questions dealing with the Federal Communications Commission Laws and Regulations. We will get around to the "Theory" and "Practice" questions later on.

The third book I am sending you is, "The Radio Amateur's Handbook." This is a big fellow. I am also sending you a copy of "The Radio Handbook for Amateurs and Experimenters." This is another big fellow.

These last two books cover much the same ground, and either one alone would fill the bill. They are being provided for reference purposes only. You couldn't possibly absorb everything in them, but you will find them very handy when you want to get the low-down on some particular subject that has you guessing.

I would suggest that you browse through both of them. No doubt you will get some ideas of your own as to what sort of transmitter you want when the two of you have obtained your licenses. You'll find everything from soup to nuts in these books.

Well, that's about all for now. But don't forget that you are to send me duplicates of your reports to Mr. Candler. He is going to be of great assistance to you in radio theory and practice, as well as code instruction, so you will not have to count on me as much as you thought. However, I am the

fellow you should throw your questions at, so start shooting. You and Barb get together and write down all the brow wrinklers and send them to me. Never mind how silly they may sound to you—send them along anyway. You'll get the answers pronto.

Sincerely.

GERALD.

*'Tis said that lending money to a friend
costs both friend and kale
Sometimes. But giving radio advice is
never known to fail!*

*A hint as to what set to buy, in light and
friendly tone*

*Can do more harm to friendship than a
thousand-dollar loan.*

*No matter what the cost, how good the
set, you'll service it for years,*

*And bear the brunt of open kicks and
sundry, subtle sneers.*

*Static, whistles, weather, tubes—your
reputation takes the raps,*

*Dwindling day by day—until the frazzled
cord of friendship snaps!*

*Oh lend him money, steal his wife, tell
him he's no judge of Scotch,*

*But never on fair friendship's blazon
smear that one unfading blotch.*

*Let him rave with pleading tongue, or
in white anger lash—*

*But lending money to a friend, and los-
ing both the friend and cash*

*Is just a nice clean job compared with
telling him what set to buy.*

*Someone else can help him. Don't you
be the guy!*

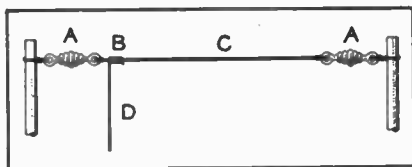
Zeh Bouck

What About Aerials?

Take the aerial, for instance. When did you last examine it? Ten to one any soldered connections (if they are soldered) have become corroded. If they aren't soldered, and you haven't bothered with them, the chances are a hundred to one that the connections are oxidized. If you've ignored the aerial completely, it's at least an even chance that all the insulators are coated with a film of carbon, or other substances, left there by wind and rain and snow and sleet and smoke and what have you.

A terminal of a storage battery in a car can become so thoroughly corroded that no current can pass. When that happens, your car is completely out of commission—but usually you don't let it happen. But, there are many radio listeners who will disregard corrosion and oxidation in the aerial system because it has never occurred to them that corrosion and oxidation are particularly harmful, to say nothing of insulator film. Yet the aerial is called upon to pass electrical currents so infinitesimal as to be almost negligible. When these minute currents reach a corroded terminal, they're up against a veritable stone wall.

The trouble is, of course, that the listener still receives signals—and possibly fairly good ones at that—and assumes that the old aerial is still what she should be when she isn't at all. If the aerial is of the single lead-in L or T type, the lead-in may be doing all the real pick-up work, in which case the receiver is called upon to operate at greater sensitivity. The result is increased noise back-



Danger points. A, insulator film; B, corrosion or oxidation; C, oxidation. If point B is corroded, signal pickup may be in lead-in D only.

ground. Some aerials are probably so bad that they provide no real signal pick-up at all and the listener would be just as well off using a piece of bell wire thrown on the floor.

Ten Meters

THE TEN-METER amateur band is beginning to show signs of life. Foreign stations are commencing to break through in good fashion. It may be that the band will be wide open by the time you read this. In any event, if you have ignored ten, it will be well worth your while to watch it from now on. Try it during daylight hours.

Wave Lengths & Harmonics

They Learn to Transmit

PROGRESS

Dear Gerald:

Both Barb and I want to thank you very much for your letter giving us the details of how to start the procedure necessary to get ourselves a Ham license. We received the equipment from Mr. Hertzberg, of Wholesale Radio Service Co., Inc., and also the start of the course from Mr. Candler, and we have been working on the code constantly ever since.

As you say in your letter, it is extremely difficult, but we are gradually emerging from the darkness and can now distinguish a few sounds when we listen to the "commercials" calling. We know what "V" sounds like and we recognize "de", and we have gotten so that on account of the constant repetition that we can recognize a few letters by their rhythm.

Rhythm of "C"

Naturally there are plenty of questions that have come up, and we would like to get some answers if it is possible to explain them in writing. First is the matter of rhythm. Most of the letters seem to be comparatively easy, but the one that is used the most in amateur work is the letter "C", and both Barb and I find it very difficult to get a proper rhythm with the "*dah-dit-dah-dit*." Is there any easy method of overcoming this trouble except practice?

In transmitting between ourselves, of course, neither one of us is by any manner of means expert, and we would like to know whether it is better in the beginning to write each letter down as it comes over, or should we wait to make a word? You suggested in your letter that we should listen in to some of the code messages that are being transmitted.

Naturally they go too fast for us to do anything but pick up a letter now and then. Would you recommend this method of distinguishing letters, or would you advise us to wait until we are faster in picking up code?

We wonder in your next letter if you will provide us with the frequencies of some stations that send slowly so that we can tune in on these and better get the sound of the letters over the radio rather than through the buzzer and ear-phones, as there is a distinct difference in the sound. We would also like to know whether it is better first to transmit just words, going over them two or three times, or making complete sentences? Also, as a matter of curiosity, why do these commercial stations use the letter "V" instead of "CQ" and why do they continue the call so long? We have heard some of them on at least ten minutes and it would certainly seem that this would be too long to do any good.

What Are Harmonics?

Now for a few general questions, as we haven't gone very far in our various books which you so kindly provided us. We are interested in knowing what harmonics actually are, and what causes them. Are they always the same distance apart? How is it possible for Hams to change the frequency of their transmitters? We wonder whether you would explain to us just why meter designations were used originally in preference to kilocycles? We realize, of course, that "meters" refer to the length of a wave, but don't understand why it was used.

We understand that the code examination is given to us over a tape. Would you recommend renting a tape machine before the examination so that we would

be accustomed to the sound of it? In our reading of the book, we get the impression that it is necessary to wait 60 days after obtaining the license before one's own station can be operated. Is this true?

We are now using a Philco 16-V All-Wave Receiver and find that the band spread is so small that there is a great deal of crowding. Could you suggest another receiver, or possibly a converter that would operate with the Philco set? While this Philco is an excellent receiver, it was not designed for amateur reception. We believe that there is a considerable amount of slow sending on 40 and 160 meters, but we cannot get it on account of the crowding.

There are plenty more questions that we will ask you as we get along in our studies, but these should be enough for a start.

Ernest.

P. S. I hope no one else as old as we are tries learning the code, because as you get older you are either very dumb, or slow to catch new sounds. However, you might be interested in knowing that Barb is now convinced that she will get it, and her original skepticism is gone. She is getting more interested in it daily.

ANSWER

Dear Barb and Ernest:

I am pleased to know that you got off with a good start. No Ham or commercial operator would expect the two of you to knock off the code in a couple of weeks. It's the one thing that takes time, and plenty of it. From what you say, and from your report to Mr. Cand-

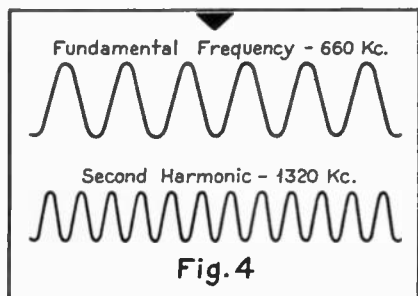
ler, I should say that you are progressing very nicely.

So you're having a tough time with the letter "C". It has rhythm all right, and you'll pick it up soon enough. If sent properly, it sounds like "ke" tied closely together. The dashes are accented, or appear to be accented, so that it sounds like *DAH-de-DAH-dit*. I would follow the advice Mr. Candler gave, and practice with words containing the letter "C"—and, of course, listen for it on the air.

In alternately transmitting to each other, I certainly wouldn't suggest that you copy down words at a time until you have picked up a bit of speed. After all, in the beginning, the idea is to pick up the rhythm of the letters so that in time you will be able to recognize them instantaneously upon hearing them. The principle, if you would call it that, is exactly the same as the principle applied in learning to operate a typewriter or play a piano—one practices until the time arrives when the manipulation of the keys, and the process of the fingers in automatically finding and hitting the right keys, becomes a subconscious action.

Reaction to Sounds

What you are doing in your practices, is storing up definite rhythmic sounds in the subconscious mind. Once the subconscious has knowledge of the rhythm for each and every letter, number and punctuation mark, you will find that it will instantaneously impart the information to the conscious mind. You will find, for example, that when you have reached this stage, the sound *di-dah* will *instantaneously* react in your mind as the letter "A", with no thought about it on your part. As you continue practicing, these "paths of knowledge" between the subconscious and conscious mind will become more clearly defined, until the point is reached when you will be able to read whole words at a time in much the same way. From then on, the speed of copying you will attain will depend entirely upon how fast your brain is capable of reacting to the stimulus of the sounds on the subconscious. This speed varies with individuals, as indicated by the fact that thousands of people are able to copy at the rate of 30 words per minute



The second harmonic of a radio wave is double the fundamental frequency, the third harmonic triple the fundamental frequency, and so on.

(based on five letters to a word), but few are able to reach the almost unbelievable speed of 56.5 words a minute that T. R. McElroy, the World's Champion, can take on a "mill." Nor are there a great number of operators who can "copy behind," which is a way some operators have of letting the transmitted material get a number of words ahead of them before they commence taking it down.

But, unless Barb or yourself have a yen to match McElroy, you can forget about such things—15 words a minute is going to be *plenty* for both of you insofar as the exams are concerned. You can worry about higher speeds afterwards, if you want.

And you don't have to wait 60 days before going on the air. You can start the day you get your license.

Code Practice Schedules

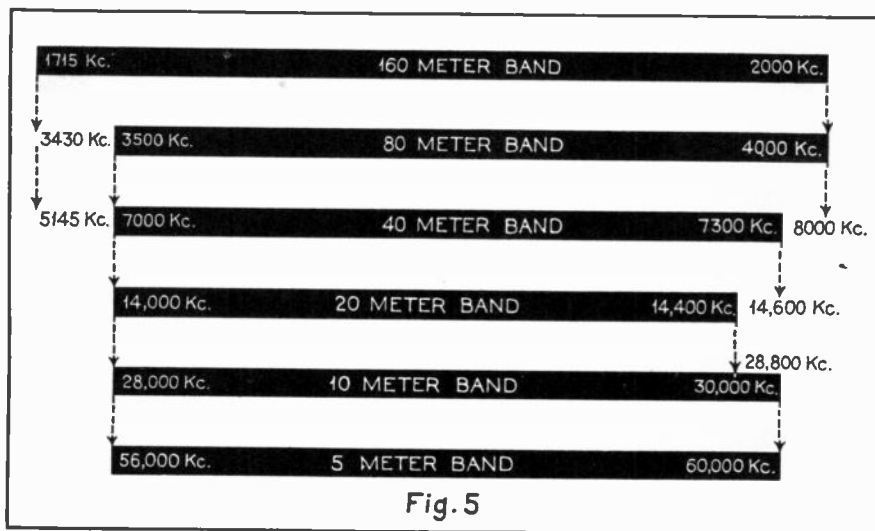
You ask if it is advisable to listen to the commercial code stations. I think so. Of course you can't expect to copy much of what they send—if you could, we wouldn't be chinning about code—but I think it is very good practice to listen to these signals and pick out letters where you can. It will assist you in getting the rhythm and in developing speed. However, you might prefer to listen to

the code practice transmissions sponsored by the American Radio Relay League. Certain key amateur stations operate on regular schedules and at various frequencies. Since these schedules are altered from time to time, I am not going to give them here, but offer the suggestion that you communicate with the Communications Department, American Radio Relay League, West Hartford, Conn., and request that they send you the latest list of Code Practice Schedules.

Why do the commercial stations send the "V" instead of "CQ"?—because they are not calling. The V's, the de's and the station call letters give the automatic sender something to do between actual transmissions of traffic. "Cold" transmitters shift frequency or wavelength, so it is the custom to leave them "on the air," warmed up for instant use. There is also a point about regulations as applied to active channels that I will skip, as it is beside the point.

Harmonics

What is a harmonic? In music harmonics are overtones which bear an arithmetical relationship to the fundamental tones. In radio harmonics are really the same things, but the frequencies involved are much higher.



Illustrating the harmonic relationship of the amateur bands. With but few exceptions, second harmonics produced in one band will fall within the limits of the next higher frequency band. A few exceptions are shown. Third harmonics fall into commercial bands, and therefore cannot be tolerated.

A fundamental frequency has numerous harmonics; they are referred to as the 1st, 2nd, 3rd and 4th harmonic, and so on. Thus, WEAf operates on a frequency of 660 kilocycles. This is the first, or fundamental frequency. The 2nd harmonic is just twice this frequency, or 1320 kilocycles; the 3rd harmonic is three times the fundamental frequency, or 1980 kilocycles, etc. (see Fig. 4). Each succeeding harmonic is weaker than the preceding one, so there is a limit to the number that can be heard. In radio work, it is not uncommon to hear the second harmonic of a fundamental frequency, and in some cases even the third harmonic can be heard. Thus, if WEAf radiated the second harmonic of its fundamental frequency of 660 kilocycles, which it does not, you could hear the program from WEAf not only at 660 kc, but also at twice the frequency, or 1320 kc, merely by tuning your receiver to the latter frequency. You could hear the program again at 1980 kc if the third harmonic was radiated.

These are means of preventing the radiation of harmonics, but I'll let them ride for the present as I will wish to take this up later in conjunction with some technical explanations of station operations. But this is a good time to point out that all the amateur bands are harmonically related to each other, so that if an amateur station radiates a second harmonic, it will not, in most instances, interfere with a commercial station. If you will look over the attached sketch (Fig. 5) you will see how this works out. For instance, if you had a Ham transmitter working in the 160-meter band, and the frequency in this band upon which you operated your transmitter was 2000 kilocycles, the second harmonic would be 4000 kilocycles, which falls in the tail end of the 80-meter amateur band. The third harmonic would fall in the 6-mc short-wave broadcast band, which wouldn't be so hot, but there is no excuse for a third harmonic, and little for a second. Now, if your transmitter was operated in the 80-meter band instead of 160, and the fundamental frequency was, say, 3500 kilocycles, the second harmonic would fall in the 40-meter amateur band, at 7000 kilocycles. And so it is right down

the line from 160, through 80, 40, 20, 10 and 5 meters—that no matter which band you work in the second harmonic of the fundamental frequency will, in most cases, fall right in another amateur band. Such interference is not nice for the amateurs, of course, but this convenient arrangement saves wear and tear on the commercial services, and at the same time puts it up to the amateur to keep his own channels clean. But note from the sketch that third harmonics fall *outside* the amateur bands.

You have asked what causes harmonics, and if they are always the same distance apart. Harmonics are caused by a natural phenomenon, and it may be said that they are arithmetic divisions of the power of the fundamental frequency. Numerically, they are always the same distance apart, as I have outlined in the previous paragraphs. There are such things as even and odd harmonics—the second, fourth, etc., being even, and the third, fifth, etc., being odd harmonics. More on this later.

Changing Transmitter Frequency

How does a Ham change the frequency of his transmitter? He tunes it, just the way you alter the frequency of your receiver when you tune it from one station to another. The difference is that the Ham usually changes the coils in the transmitter when he wishes to shift from one band to another. If the transmitter is tuned to operate in the 160-meter band, and the Ham wishes to shift to the 80-meter band, he takes out the 160-meter coils and replaces them with coils having the correct number of turns (correct inductance) to tune or resonate at some frequency within the 80-meter band. After the 80-meter coils are inserted, they are tuned by means of the same variable condensers used to tune the 160-meter coils. You perform a similar operation when you switch your all-wave receiver from one wave band range to another . . . when you turn the switch from one point to another, you automatically disconnect one set of coils and connect in another set. Each set is wound with just the right number of turns of wire to cover a given frequency range with the

same variable gang tuning condenser.

Just why were meter designations used originally in preference to kilocycles? There is no good reason for this. The field got off to a wrong start when it selected the length of a radio wave rather than its frequency, as the means of measurement. It would have been better for everyone if the length of a radio wave had never been aired in public.

In radio work, we deal with oscillating currents. What we wish to know is the frequency of oscillation in a given circuit, not the length of the wave it will produce or the wavelength it will respond to. Certain factors are not easily translated into wavelength in meters, and for another thing, knowing the wavelength at which a circuit will resonate is not sufficient data by which to draw conclusions regarding the functioning of the parts of the circuit. We must know the frequency in any event, and since the wavelength in meters contributes little in itself, it is best dispensed with. Practically all calculations are based on frequency, so the use of the term has become universal.

Frequency refers to the number of cycles produced per second. Since the frequencies of radio waves are very high with respect to sound waves, they are expressed in kilocycles and megacycles. A kilocycle is 1000 cycles, a megacycle 1000 kilocycles. Thus the frequency of WEAf is 660,000 cycles, or 660 kilocycles, or 0.66 megacycle. The term megacycle comes in handy when the kilocycle figures become bulky; thus 30,000 kilocycles is more easily expressed as 30 megacycles.

More than likely you could obtain fairly good c-w reception on your Philco receiver if you employed a beat-frequency oscillator to make the signals audible. The code signals you hear are those beating with a 'phone station carrier, and are difficult to copy at best. They disappear when the 'phone carrier is taken off the air. There is a beat-frequency oscillator on the market that can be easily attached to any type of *superheterodyne* receiver for the reception of c-w signals.

Automatic Tape Transmitter

Yes, the code examination is given over a tape. It is nice, clean stuff and much easier to copy than a straight fist, but I agree with you that a bit of experience with one of these machines prior to the exam would be a good thing. These machines are excellent for learning the code once the rhythm of the letters have been mastered, and since I note from your recent report to Mr. Candler, and his reply to the effect that you are progressing in fine shape, I think it is about time you commenced using one of these machines. It will be of great assistance to both Barb and yourself in not only speeding up your copying, but also in improving your transmission.

As it happens, Mr. Miller, of the Teleplex Company, the manufacturer of the automatic tape transmitter, has also taken a keen interest in the efforts of Barb and yourself to become full-fledged Hams, and has kindly offered to contribute a machine towards the good cause. Make good use of it and you will master the "15 or 20 w.p.m." sooner than you expect.

You will find that the Teleplex machine uses tape rolls in which the dots and dashes are punched. The tape is run through the machine, at any desired speed, and the automatic key transmits the letter groups and words on the tape. You can use one tape over and over again, and as your speed picks up, you can correspondingly increase the speed of the tape which increases the transmission. Since the Teleplex incorporates an audio oscillator, the "copy" that comes off the tape will sound like the copy from a commercial code transmitter. Thus, once you have this machine, you need not worry about picking up code transmissions on your Philco.

There are a series of tape rolls, each roll being a lesson in itself. Moreover, the Teleplex has a key, so that you can practice sending as well as receiving. The idea is to run a bit of the tape through the machine, listen to the letter formations, stop the tape, and then transmit the same letters yourself with the hand key and see how near you can come to duplicating the swing and the rhythm

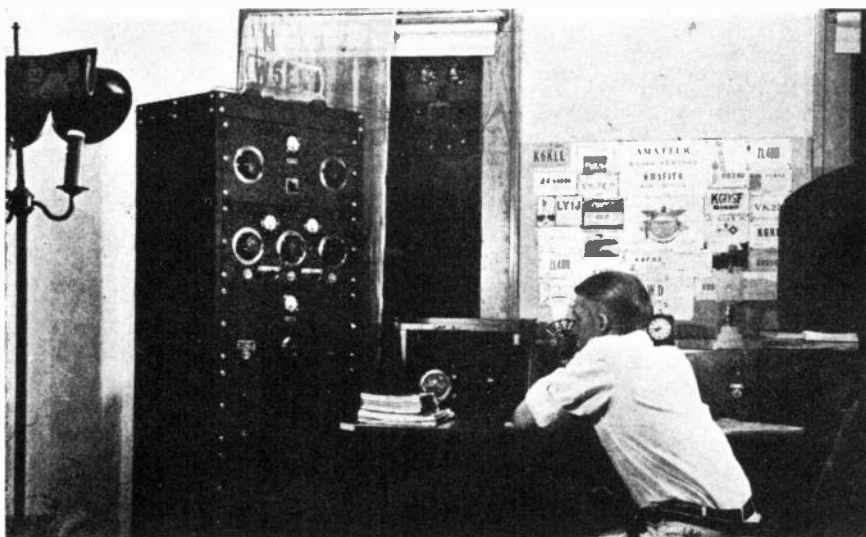
of the letters as reproduced in code by the tape. This is an excellent way of checking up on your own fist and eliminating faults in sending. Try it.

That's all for the present. With my next letter I'll start you off on some radio fundamentals. But, in the meantime, shoot along what questions you have, and I'll tackle them, too.

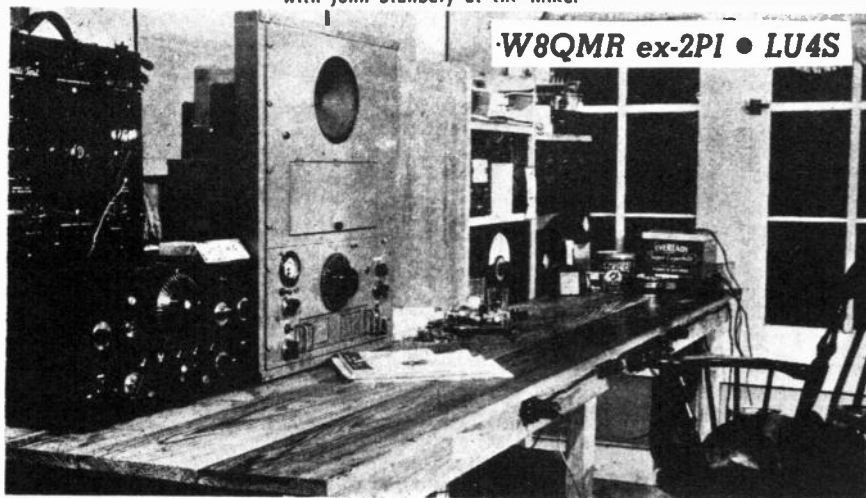
Gerald

THEY ALL loose their minds sooner or later. W8NCV kept hearing c.w. signals after he turned off his receiver. In vain he tried to copy the poor sending until suddenly the canary stopped for another breath. Yep, It actually happened!

Typical Amateur Stations



W5FIY—"the powerful little 60-watter of Okemah, Oklahoma," with John Stanbery at the mike.



Candid shot of the shack at W8QMR. Note burned out tubes under the table.

What is Electricity?

Electrical Fundamentals as Applied to Radio

From Ernest

Dear Gerald,

Thanks for your latest letter giving us further advice on how to become successful hams. The Boss and I have been devoting the major part of our spare time to perfecting ourselves in code and for a couple of old folks we're doing pretty well, if we do say so ourselves. We're up now to a point where we're taking perilously close to 10 words per minute, which isn't so bad.

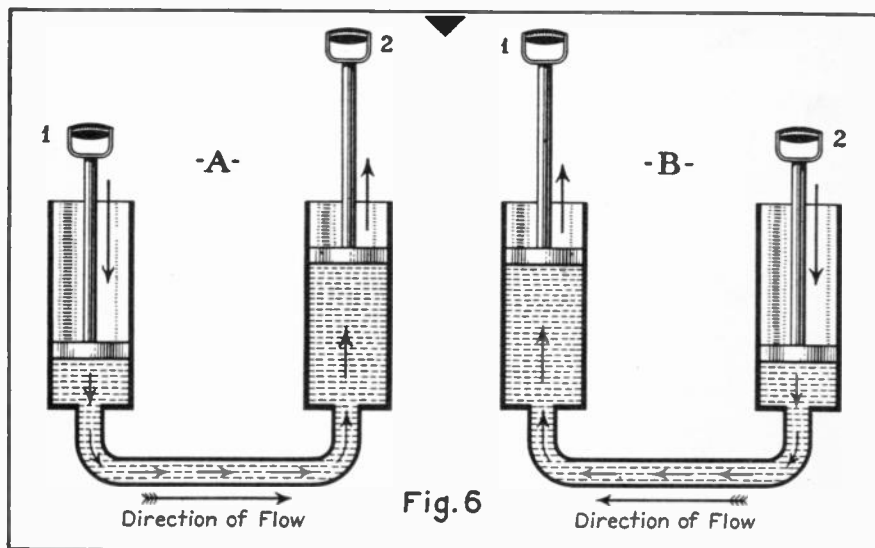
Mr. Candler's course helped us in this very materially, but with Mr. Miller's Teleplex we were able to distinguish the correct sound of the letters, something we seemed unable to do by ourselves. I've even gotten so that I can transmit that old debbil "C" properly in line with the way you advised it in your last letter. I have one trouble which Barb doesn't

seem to experience and darned if I know how to correct it. Maybe you can tell me.

I preconceive words as I am receiving. Barb will shoot a few letters at me and I think it's going to be a certain word. Then a wrong letter (to me) comes through and I'm up in the air ten feet. By the time I come down I've missed about four or five letters and the word is gone for all time. How do I correct that?

We believe it's about time now that we start studying up for the written examination and I have a few questions to ask on that, so I can get started out on the right foot.

The Radio's Amateur's License Manual put out by the A.R.R.L. has a list of some 161 questions, which they say, if we know the answers to, will be all that we need to know to pass the examination. Have we, for example, any surety that this statement is so? I'd hate



Interconnected hand pumps employed as illustration of the manner in which an alternating electric current travels in a wire circuit.

to think that we'd put a lot of work on these questions and find that the government may have changed its mind at the last minute and pulled a fast one on us. I imagine the A.R.R.L. must know what they are talking about.

Mr. Candler recommends that the student should join the A.R.R.L. before getting a license. I had intended joining this organization if successful, but am wondering whether it would do me any good to join before that.

To get back to the original subject, on the matter of questions; you have told us to study only the part covering the F.C.C. Regulations first. It would appear to me that anyone with ordinary intelligence could study these easily and as I see them they require practically no explanation.

But the first part covering the technical side of radio; boy—their's the stickers. Even I, who have had a technical education, am slightly nonplussed as to some of them, but Barb, who doesn't know a watt from a filament is going to have a swell time mastering this bunch. If you can teach her even the fundamentals of this side, you're a better man than I, Gunga Din. I've tried for fourteen years to give her some slight knowledge of things electrical, and as an explainer apparently I'm not so hot.

The boss has a lot of questions she wants to ask you, so if you don't mind I'll let her do her own asking.

Will you convey my greatest thanks to both Mr. Candler and Mr. Miller for their kindness to us.

Ernest

From Barb

My dear Gerald,

Ernest tells me that I am really doing very well with my code, and, I admit myself that I can see a great deal of improvement, but I am still a bit worried about my ability to attain any degree of speed. At times I find myself going along like the G.O.P. Convention, turning on all cylinders and all of a sudden I go blotto and can't tell an "L" from an "F". Is this a normal complaint or is it due to senility? Frankly, and confidentially. I think I transmit better than Ernest does—which by the way he loudly disputes,

as his transmission is inclined to be jerky—my transmission, if I do say so, is pretty good. My only trouble—and I do wish you could help me in it—is that my arm becomes very tired. I have tried to follow Mr. Candler's instructions as far as I can. Trying to keep a loose wrist with the proper grip of the key, but somehow after a half-hour's work I'm tired.

I find Mr. Candler's course very helpful indeed. Its steps are very gradual and most explicit. The Teleplex has been a wonderful help to me, for had I only Ernest's species of transmission as an example I'm afraid I'd fail to recognize professional transmission entirely. It's been a great help in the matter of rhythm and the fact that the speed can be regulated with no undue pauses.

I would like to know why it is that I can take a tape at a fair speed and yet fail to recognize even slow transmission over the radio.

I feel that with practice and patience I can work my speed in code, but when I think of an examination involving any technical questions I collapse like a balloon. Can that part of the examination be learned in poll-parrot fashion or must grey matter and reasoning be used?

I suppose, like all of my species, I've been a long-winded pest, still I'll be very grateful for any help you can give me regarding my problems.

Yours in trepidation,
Barb

The Answer

Dear Barb and Ernest:

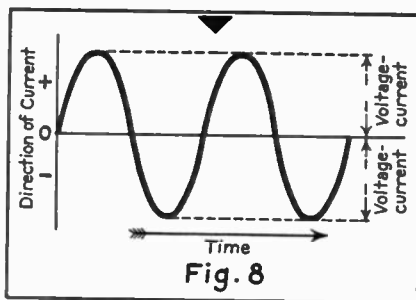
I'm really very pleased to hear that you two are "perilously close to 10 words per minute," and that you feel sufficiently well advanced in code to start giving thought to a bit of technical instruction. You'll get that, anyway, but I think it is time for the three of us to stage a preliminary code exam. So, you may expect a visit from the old maestro, who will put you through your paces.

As to you, Ernest, your preconception of words is a good sign rather than a bad one. It is an indication of mental agility in code reception, even if it does trip you up occasionally. It is a stage all

operators pass through, and many never really break themselves of the habit of attempting to anticipate words. However, try breaking yourself of the habit by copying only that which you hear rather than attempting to reconstruct words in advance. As good a method as any, I believe, is to have Barb send you groups of letters with no meaning rather than actual words. Something like "ecftha qbgwt," etc., containing all the letters of the alphabet, and with a number thrown in here and there for good measure. Be sure Barb copies down the word and number groups beforehand so you can check back afterwards.

Well, Barb, I'm glad to hear that you have a better "fist" than Ernest, even though you may still be a bit worried about code speed. As to the latter, it is quite natural to go through periods of mental "wipe-outs" when certain letters simply fail to register. In your own case it might well be due to mental fatigue caused by too much code practice at one time. In any event, it is no cause for worry.

I am at a loss to know why you are able to take fair speed on the tape and yet fail to recognize even slow transmission over the radio. I have a suspicion, though, that the difficulty is not with you, but rather with the transmissions you intercept. Your radio is not equipped with a beat-frequency oscillator and is, therefore, not properly equipped for the reception of code signals. More than likely the majority of signals you pick up are far from being clear. However, we'll check on this when we get together for the preliminary code exam—real soon.

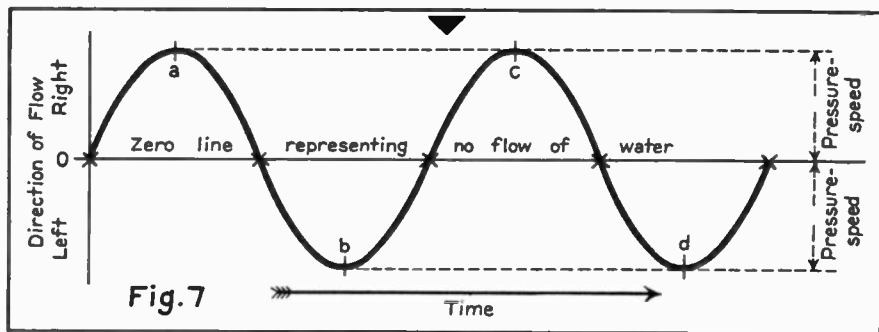


Illustrating the flow of an alternating electric current in a wire circuit.

Tired Fist

I'm not at all surprised that your arm becomes tired after a half-hour's work with the key. As your arm becomes used to this new type of work, and as you develop better form, the aching will disappear, and you will find it possible to send for protracted periods without suffering muscular fatigue. Above all, follow Mr. Chandler's instructions to the letter, even though it may be difficult at the outset. You had to learn how to hold golf clubs, didn't you? And, if you have ever played tennis, you will know that the body muscles have a way of complaining until they are well used to the exercise.

So, you're both frightened to death at the thought of the technical questions? Seems to me you were two frightened puppies not so long ago, whenever you so much as contemplated the code. Now that the code is a friend and an inspiration and no longer the big, bad wolf, you have to transfer your fears to the technical phase of the game! Well, as the dentist might say, let's do a little prob-



How the water flows in the "pump circuit" shown in Fig. 6.

ing and find out just how painful it is. (If I'm as good as I think I am, it won't hurt you at all!).

But, first, joining the A.R.R.L. now or later is for you to decide. If you're superstitious, possibly you'd rather wait.

And, as to the F.C.C. questions, as listed in the License Manual, if you can reason them out, you will have nothing to fear when exam-time rolls around. But I wouldn't care to vouch for your chances were you to learn the answers by heart without as well learning the why's and wherefore's. Of course, it's up to me to give you the fundamentals in simple form so that you can reason for yourselves. And I'll see to it that you will be able to explain all the questions listed.

Bare Fundamentals

But, before we get into fundamentals, we must have an understanding as to what I intend to do and what I intend *not* to do. I intend to provide you only with such information as you will require to pass the exam, and little more. I do not intend to follow every subject to the bitter end, as is done in most courses, because I am not trying to make technicians out of you two. You can get clever as hell later on, if you wish.

So, we will dispense with the "fuller explanation departments" and stick to broad essentials. We won't get all involved in the precise operation of radio tubes, or go into long explanations of grave engineering functions. Rather than this, we will "develop a series of photographs" of the surface appearance of radio and not worry too much about what's "behind the photo."

One of the odd things about radio is that it is possible to *almost* explain all its phases by analogy, but yet not *fully* explain them. That's where the average instructor commences to become conscience-stricken, for fear that one of his students is going to come back at him some day and say, "Why, you taught me thus and so and it is only half the truth. The analogy you employed doesn't fully cover the function." Which in most cases is the truth. But, take it from me, analogy is good enough for the beginner,

and though it is a generalized short-cut, "it sufficeth."

An analogy is just what I am going to use. You're warned!

Now, where should we begin? Certainly not with the names and functions of the various components employed in radio transmitters and receivers, nor with the terms designating the properties of the components. For, all of these things will be meaningless until you first have a clear understanding of electricity in its various forms. A radio receiver or transmitter, or any unit of one or the other, is a lifeless thing so long as it is not energized by electricity in one or more of its various forms. So, let us talk first of the "invisible fluid" that is the life blood of radio.

Electricity

There is nothing overly mysterious in the manner in which electricity passes through a wire circuit. It is much like the flow of water through a pipe. And, just like the water in a pipe, the electricity has a definite pressure and a definite rate of flow. The pressure of electricity in a circuit is referred to as its "voltage," and is measured in "volts." The flow of electricity in a wire circuit is referred to as "current" (as the current of a river), and is measured in "amperes."

Actually there is but one type of electricity, but it is made to take various forms by the manner in which it is produced. The electricity produced chemically by a storage battery or a dry cell is of the purest form and is referred to as "pure direct current," because the flow is continuous, with no interruptions, in one direction only. The electricity produced by a dynamo is also a direct current, but contains a ripple, much like the ripple of a brook flowing over stones. But the ripple in the current from a dynamo is caused by actual interruptions in collecting the electricity, so that the current is fed to the wire circuit in broken sequence, like a series of dots. However, due to electrical inertia, the spurts of current join so that the result is somewhat similar to the jerky flow of water from a hand pump.

The electricity produced by an alternator (alternating-current generator)

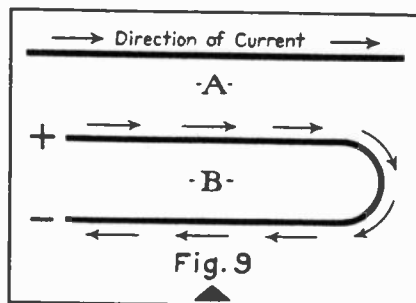
is something quite different. Electricity in this form does not flow continuously in the same direction. Instead, it is made to change its direction of flow in the wire circuit a certain number of times a second. In other words, the electrical current oscillates back and forth.

Alternating Current

You could accomplish much the same thing with water if you had a gadget like the one shown in the attached sketch (Fig. 6). It is composed of two cylinders, each with a hand piston, connected together with a pipe. The cylinders and pipe contain water. Case A shows that if you were to push down on piston No. 1 the water would flow through the pipe in the direction indicated and force up piston No. 2. Then, if you were to immediately reverse the process and push down on piston No. 2, as shown at B, the water would flow in the opposite direction and force up piston No. 1. If you were to grab both piston handles and work them up and down as fast as the inertia of the water flow would permit, you could reverse the direction of flow of the water in the pipe a considerable number of times per minute. Possibly you could do this 30 times per minute, in which case the water would pass through 30 complete alternations, or 15 complete cycles of change in flow.

An alternating electrical current flows the same way in an electrical circuit. In our analogy the two pumps represent the alternating-current generator and the connecting pipe, through which the water flows, the electrical or wire circuit. If the electrical current itself were visible in the wire, it would be seen to change its direction of flow a number of times per second (faster than you could pump!). If it were found to change direction 120 times per second, then it could be said that there were 120 alternations of current flow, or 60 complete cycles. And 60 cycles is the frequency of the average home electric-light line.

Now let's return to the pump analogy so that we may better explain what happens to an alternating electrical current in a wire circuit. In operating this silly pump, you would find that the water



"Positive" (plus) and "negative" (minus) indicate direction of flow of an electric current.

would not always flow at the same rate. During the down stroke of either piston it would go through the pipe like the devil, but when the down stroke of one piston was completed, the water would come to a standstill in the pipe before you could get the other piston going on its downstroke. And, furthermore, it would take a bit of time, and a bit of extra pushing to overcome the inertia of the still water, before you could get the other piston going at a good rate. Consequently, during one piston stroke, the water would begin flowing slowly from a complete standstill, and increase its rate of flow as you got your wind up, and would cease flowing again when the piston you were pushing came to the end of its stroke.

Pressure, Flow and Direction

I have attached a sketch illustrating all the antics through which the water must go in passing back and forth from one cylinder of the silly pump to the other (See Fig. 7). This is a handy sketch as it shows a whole lot of things at one time. First of all, there is a horizontal arrow at the bottom representing time, which might be half a minute in our case. Above this is another horizontal line which represents zero or no flow of water. To the left of this line, and drawn perpendicular to it, is another line indicating the direction of the flow of water in the pipe. Then, drawn over the horizontal "zero flow" line is a continuous wavy line which shows just what the water does.

This wavy line is marked with an "x" wherever it crosses the "zero flow" line, and these are the points indicating the times when the water in the pipe



is at a standstill. If we start with the first "x" and follow through on the wavy line, we see that first of all the water commences flowing through the pipe in the right-hand direction, since the line curves upwards into the "right-hand territory" above the zero line. We also see that the water flows faster and faster as time passes, until it reaches point "a," at which time piston No. 1 is nearing the end of its stroke. From this point on, the water flow decreases in speed until it again comes to a standstill (at the point of the second "x") because piston No. 1 has now reached the end of its stroke. Then piston No. 2 comes into operation and the water slowly commences to flow in the opposite direction—to the left, or below the line of zero flow in Fig. 7—and gains speed until it reaches maximum, of point "b". From then on its rate of flow decreases because piston No. 2 is nearing the end of its stroke, and the water finally comes to rest in the pipe again when piston No. 2 reaches the end of its stroke. This brings us to the third "x". The two following alternations "c" and "d" are merely repetitions of what has just been explained. But it is well to note that this sketch represents four alternations or two cycles of water flow.

Positive and Negative

Now glance at the third sketch I have enclosed (Fig. 8). This is identical to the one shown in Fig. 7, except that it has different designations. It represents an alternating electrical current, but direction of flow is indicated not by left and right, but rather by "positive" and "negative" which are the electrical terms used for designating direction of flow. The terms are purely relative, and hark from the old days when it was customary to refer to the terminal of a battery or dynamo from which the current emerged as the "positive" terminal, and the terminal to which the current returned as the "negative" terminal. However, it should not be inferred from this that a "negative" electrical current is a "minus quantity" to the extent of having no power. The term "negative" is used only to indicate a difference in the direction of current flow, just as "left" and "right" were applied

to the pump analogy to express opposite directions of water flow. For an illustration of the fact that the terms "positive" and "negative" as applied to electrical current are merely relative, glance at the sketch of Fig. 9. "A" shows a wire with an electrical current flowing through it. "B" shows a similar wire that has been bent back on itself—nothing more. In case "B" the current flowing through the lower section of the single piece of wire is, relatively, "negative" with respect to the current flowing through the upper section. This may seem odd since there is but a single piece of wire with the current flowing through it in only one direction. Nevertheless, it is obvious that with the wire bent as shown, the *relative* currents in the two sections are opposite. I will go into this more fully later on as it has a bearing on certain elements of radio design.

Voltage and Current

Now back to the sketch of Fig. 8. Aside from indicating time, and the direction of current flow, the illustration also indicates the pressure and the speed of the electricity, except that these factors are referred to as "voltage" and "current," the electrical designations. Thus, this sketch, as well as the sketch of Fig. 7, would indicate that pressure or voltage, and speed or current, increase and decrease in unison, since both are represented by one wavy line. Under ideal conditions this holds true, but I don't know enough about water pumping to know if it could be true in that case. Let's refer to Fig. 6 again and see what happens.

Suppose the water is at a standstill in the pump circuit and that the water level is the same in both pumps. Then, if you were to push down on either piston handle, you would immediately create pressure on the water in that particular cylinder. But, because of the inertia of the water, and the friction present, it would take a bit of time before the water actually started to flow. It is obvious, then, that the pressure comes first, or to put it another way, the pressure leads the flow.

The same thing can and does happen in an electrical circuit carrying alter-

nating current; the voltage leads the current. But, we have means for making the two coincide or, if desired, of making the current lead the voltage. How this is accomplished will be explained when we have reached the point where you can make use of the information.

So, more anon. In the meantime, your questions. If I have not made all points clear, let me know.

GERALD.



MRS. ROWLAND AT CODE PRACTICE



MR. ROWLAND AT DOT DASH DITTO

HAMS and the FLOOD



Radio Station AB, at Columbus. The operators from left to right are: Second Lieutenant Dane O. Sprinkle, W8CKG; First Class Private Theodore Drake, W8JBI; and Corporal Bert Hayhurst, W8IZK. (Photo by H. Maxwell, W8VE.)

AGAIN raging waters have brought tremendous loss and deep misery to the peoples of cities, towns and villages within reach of the mighty Ohio and Mississippi rivers. And again the Radio Amateur has rolled up his sleeves and taken over the huge task of establishing an emergency communications network. He has braved danger, gone without sleep and stuck it out all along the line because of an ideal. He has had as a motivating force that has seen him through many a tough spot the bright knowledge that he was upholding a fine and courageous tradition that is a gold thread woven through the history of Amateur Radio.

The thread of gold is unbroken. The Radio Amateur has played his part efficiently, effectively and heroically.

The work of W8YX's net was a credit to Amateur Radio. In one instance the Deputy Sheriff at Carrollton, Kentucky, placed a message with W9NKD at 3:22 P.M. At 3:32 the message, which read: "Have ambulance to

meet baby at Madison being brought by speedboat from Carrollton. Be there in thirty minutes. Be ready for appendicitis operation," was relayed to W8YX; at 3:35 it was relayed to LC9X, at Indianapolis, who had a direct wire to most points in Indiana, including Madison. At 3:38—sixteen minutes after the message was written—the ambulance was on its way to meet the speedboat, and the hospital at Madison was preparing for an emergency appendicitis operation.

Graphic Messages

Samples of urgent messages handled by W8YX and the network give a graphic illustration of the exemplary work done by Amateur Radio:

"To U. S. Public Health Service, Washington. Send enough typhoid vaccine for eight thousand people to Maysville at once."

"Airplane with serum ready to leave Philadelphia for Louisville. Advise over WHAS where plane should land."

Radio & Audio Frequency

Barb & Ernest Study Code and Radio Theory

Says Ernest

Dear Gerald:

We got your past letter, the boss and I, and I appreciate your explanation of the analyses of electricity for the boss's sake. It was, of course, rather fundamental to me, having passed my alternating current in technical school a good many years ago with pretty high marks. When it comes to 60-cycle stuff I claims to know it pretty well, as I'm messing around with it daily. But brother, when you get talking about high frequencies and their actions, then I'm over my head plenty.

Take, for example, the reading of the Handbook, which you suggested. The first two chapters were swell, and repeated what you and Mr. Candler and Mr. Miller have been saying right along. But Chapter 3 on Fundamental Electrical Principles busts right out with a picture (Fig. 302) showing "Conduction by Thermionic Emission of Electrons in a Vacuum Tube." So right away I'm stopped. When it comes to a wire circuit I'm not so dumb, but electrons mean very little to this man's son.

So then I turn to the questions and answers in the A.R.R.L. License Manual. I've gone over the first 17 questions in this book rather carefully, and I don't question that I'd be able to pass an examination on these all right, though I must admit that I don't know how a filter is made, and I think I should know it if I'm going to be able to pass an examination.

However, I'd hate right now to have to take an examination on frequency measurements, or transmitter theory and practice. The terms used are way over my head, and as far as I can see the Manual doesn't define terms so that an absolute "amateur" like myself can un-

derstand them. If I were going to school where I had more time to study these terms it would be easy, but I have to do my studying at odd times at night and I don't get very far. And poor Barb, who knows absolutely nothing about electricity is going to have a swell time when it comes to "High Q", "Impedance" and a lot of terms that won't mean a thing to her. Take, for example, the simple term "Push-pull". I've read this for years and it still means nothing to me.

As to code, we're getting along as well as can be expected. Mr. Miller paid us a visit, and we are very much encouraged by his remarks on our code-copying ability.

I'm going to let Barb tell you her tale of woe now. I wish you could hear her remarks as she tries to wade through the technical end. It would be swell reading, but I'm afraid the government would take your book off the stands!

Ernest

Says Barb

Dear Gerald:

Ernest has just told me that I should write you and tell you what I know about the technical end of radio. That's easy. I know that I don't know anything and I wonder if I ever will know anything.

I'm doing pretty well at the code, if I do say so myself. Mr. Miller thinks so, too. I'm not so hot taking it off the tape but when Ernest transmits I get it pretty fast. But I can't get it on the radio. Ernest tells me that that is due to the small band spread on our set, which causes interference, or should I say QRM?

But to get back to the technical end.

Honest to goodness, Gerald, I'm just so dumb that I don't suppose I'll ever learn. Your explanation of the difference between a.c. and d.c. helped a whole lot, and I think I get what it's all about, but if I must tell you the honest truth I still don't know what makes the wheels go round.

I went over a few questions in the first part of the examination for Class B and C licenses, and while I could memorize them, right now I still don't know even the barest terms. After your explanation I know the difference between a.c. and d.c. but the terms which they use have me stumped.

Take question number one alone. I'm just going to give you a list of what I don't know even after I read it. 1. Plate Power Supply. 2. Filtered Direct Current. 3. Frequency Modulation. (Hurray, I know what "Broad Signals" means). 4. Oscillator.

I think maybe I could understand question 2 after a while. Question 3 doesn't seem so hard. Question 4, I give up entirely. What is a filter? I guess I haven't got sense enough to find it in the Handbook. Question 5 the same. I know about ripples in a stream of water, but these ripples are different.

Have I asked enough to show my absolute ignorance or shall I go further? I'm afraid I'm going to be forever dumb but you've told me you could help me learn, so I lay the job at your doorstep in a big way. I envy the OM's technical knowledge. Maybe I'd better take the code examination and let him take the technical side!

I'm hoping you'll be able to help me, but I doubt it. We just got a letter from Mr. Candler who says he's sending us a copy of *The Beginner's Story of Radio*, and maybe this will help me. Both Mr. Candler and Mr. Miller have been more than kind to us, and they certainly help us a great deal.

Barb

Says Gerald

Dear Barb and Ernest:

You two are like a young medical student slowly going mad trying to memorize the Latin terms used to cloak

human ailments in a veil of mystery. Well, be mystified if you want, but don't let the terms used in radio get you down. They're not as tough as you might suppose, and many of them, such as *resistance* and *impedance*, carry the same definitions when applied to radio as they do in their more common applications.

Now that you are spending more time with the technical aspects of radio, you will naturally run into many words entirely new to you—words that you will become well acquainted with as time passes—but do not make the mistake of assuming that such words as *resistance* and *impedance* have different meanings when applied to radio.

And another thing—Question No. 1 in the License Manual is not necessarily an easy one because it is the first. The ability to answer any or all of the questions in this book is predicated upon a complete understanding of radio fundamentals. Therefore it is quite useless to attempt to comprehend the questions before you have become well grounded in radio fundamentals, as you have in the code. By the same token, there is no reason why you should know what an oscillator or a filter is before you have run into them in your studies.

What's a Filter?

And, by the way, Barb, the filter that has you worried does just what the word implies, and the ripples it filters out are quite similar to the ripples, in, say, a brook. Though this is getting ahead of the game somewhat, suppose you were handed the problem of smoothing out the ripples in a brook because their noise disturbed a hypochondriac living nearby. One way you could do this would be by feeding the water of the brook into a large tank, where it would be stilled, and then feeding it out the bottom of the tank minus the ripples.

The voltage from the power line in a house has ripples in it, and if we don't smooth out these ripples they will impress themselves on the radio wave and become audible at the receiving end. So, we filter them out. And, to do this we use, well, of course, a filter, which is composed of one or more "chokes" and "condensers." Both chokes and con-

densers have the ability of momentarily storing up electrical energy, and at certain intervals releasing this energy. So, in this respect, they play much the same role as the hypothetical tank you supposedly built into the brook to still the water ripples. Or did you?

That, as you may guess, is only a part of the story, but it is enough to give you at least a partial idea as to what an electrical filter is and what it does. There are other types of filters, too—selective filters that will pass currents of only certain frequencies. We'll be around to these things soon.

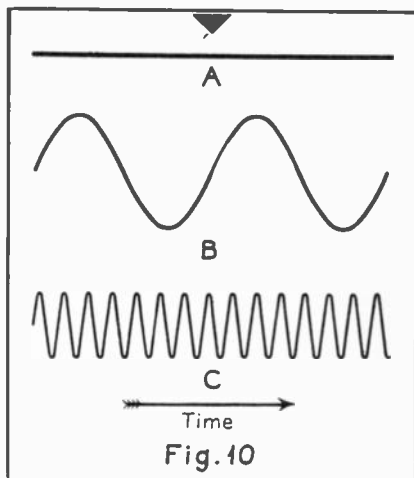
I had intended covering radio frequencies in this letter, but since the days are so hot, and the two of you are off for a vacation, I'm not going to get too deep into this subject. Just the groundwork . . . so, here goes—

Frequency, Radio and Audio

In my last letter I explained the difference between a direct and an alternating current, and pointed out that the former is a current flowing continuously in one direction only, whereas the latter reverses its flow periodically. I am sure you have found it obvious that there is quite a difference between the two. However, the difference between the common variety of 60-cycle alternating current used in most homes, and a radio-frequency current, is but a matter of degree.

Let's review the whole matter by drawing pictures. In Fig. 10 I have shown a pure direct current at A and an alternating current at B. At C, I have shown what may well be a radio-frequency current—I am asking you to believe that it is—and you will note that the only difference between this and the alternating current, B, is that there are more wiggly lines or cycles compressed in the same amount of space. In other words, there are more cycles per second to a radio-frequency current than there are to a good, old household alternating current. One is a low-frequency and the other a high-frequency current.

There have to be distinguishing features between these currents so that there will be no mixup when one attempts to pass a technical *mot juste* over



A, direct current; B, low-frequency oscillation; C, high-frequency oscillation.

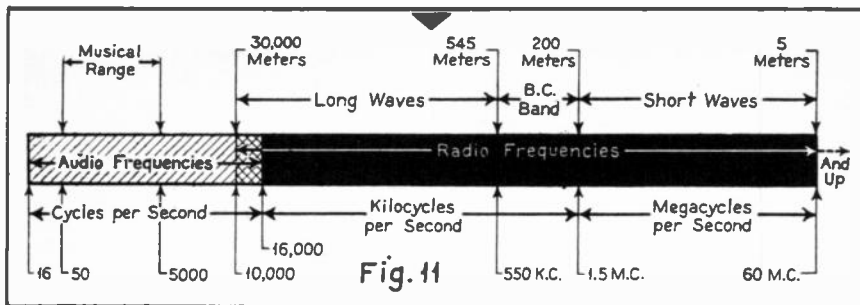
on a fellow enthusiast — so a dividing line has been created so that the other fellow will know what sort of a current you are talking about. You'll get the idea from Fig. 11.

The first group are those currents, such as the 60-cycle house supply or the currents that actuate the loudspeaker of a receiver, whose frequencies are within the range of audibility. These are known as *audio frequencies*. The second group are those currents whose frequencies are beyond the average range of audibility. These are known as *radio frequencies*, and are used for broadcast and communication purposes.

From Fig. 11 it will be seen that the audible frequencies extend from 16 to 16,000 cycles, although the range of audible frequencies broadcast is usually from about 30 to 5000 cycles. The lowest radio frequency employed is seen to be 10,000 cycles, or 10 kilocycles, which corresponds to a wavelength of 30,000 meters. Radio frequencies beyond 60,000,000 cycles, or 60 megacycles, which corresponds to a wavelength of 5 meters, are used but are not shown as their use is uncommon.

Oscillations

Now the audio- and radio-frequency currents that are employed in radio work are "oscillating" audio or radio cur-



The frequency spectrum employed in radio communication.

rents, that is, they oscillate to and fro in an electrical circuit much in the same manner as the pendulum of a clock oscillates back and forth in space. There, Barb, is your word "oscillate," and, as you have suspected by this time, an "oscillator" is a device that creates or generates an oscillating power. In radio, the power is electrical, and the device we use to generate the oscillations is the well-known vacuum tube. An "audio oscillator" is a generator of audio frequencies (such as the vacuum-tube audio oscillator in your Teleplex machine). A "radio oscillator" or "radio-frequency oscillator" is a generator of radio frequencies.

Frequency

This word "frequency" we have been using is employed to express the number of times an electrical current oscillates, or, to put it more specifically, the number of cycles of reversal a current passes through *per second* (we measure these things in seconds in radio—never in minutes.) Thus, the alternating house current "oscillates at a frequency of 60 cycles" which is much less "frequent" than a radio-frequency current which, even at a wavelength of 300 meters, oscillates at the tremendous rate or frequency of 1,000,000 cycles per second. At a wavelength of 5 meters, the lowest wavelength commonly used by amateurs, the rate of oscillation is 60,000,000 cycles per second.

Such figures as 1,000,000 cycles and 60,000,000 cycles are a nuisance to use, so we go in for a bit of abbreviation. For a figure the size of 1,000,000 we add "kilo"—denoting 1000—to the word

cycles, and thus shave down the expression to "1000 kilocycles." Then, of course, the figure 60,000,000 cycles could be expressed as "56,000 kilocycles," but human nature being what it is, it is easier to use the term denoting 1,000,000 in place of "kilo," and so we express such an immense figure as "56 megacycles."

You will observe the more you study that at any time an engineer is forced to revert to a decimal or a comma, he will use the terms "cycle," "kilocycle," or "megacycle," as the instance dictates. He will write "1 kilocycle" before he will write 1,000 cycles, and he will write, as likely as not, "1 megacycle" before he will refer to it as 1,000 kilocycles—and if for no other reason than to avert a possible error, he will write "600 kilocycles" before he will write ".6 megacycle." And for an abbreviation of kilocycles he will use K.C., k.c., KC or kc, and for megacycles, M.C., m.c., MC or mc. Take your choice. They all appear to be in vogue.

Behavior of Oscillations

Now the next step would be an explanation of the behavior of oscillating currents in a radio circuit, and particularly radio-frequency currents. But, as I promised, I shall leave that for my next letter. Just let me say, though, that alternating or oscillating currents have the knack of transporting themselves through space with the greatest of ease, whether the space be the distance between a transmitter and a receiver, or merely the space between two coils or the plates of a condenser. Nothing, you might say, can stay these couriers in

their appointed tasks. The job we have is keeping them from running all over the lot.

The above should lead you to the conclusion that audio-frequency and radio-frequency currents behave alike, which is true. Both are generated and controlled in the same manner, but the higher or radio-frequency currents are more difficult to keep in hand. But we manage to make both do our biddings through the use of vacuum tubes, coils of wire, condensers and resistors, and little else.

More when you return from your vacation. Have a good time.

Gerald.

W2IRM HEARD BY A "D"



W8EA's conception of the five-meter band—when it boils over into virgin territory . . . signals like bolts from the blue.

WAVELENGTH-FREQUENCY TABLE

IT'S NOT THE MOST convenient thing in the world to translate wavelength in meters to frequency in kilocycles—or vice versa—by mathematical computation. Realizing this, the Bureau of Standards, in Washington, D. C., prepared a table some years ago, from which it is possible to determine at a glance either the frequency in kilocycles for a given wavelength, or the wavelength in meters for a given frequency in kilocycles. This table is printed on the opposite page.

The odd and even columns in this table are related to each other; that is, the first column is related to the second, the third column to the fourth, and so on. Fundamentally, the numbers in the odd columns—the first, third, etc.—refer to wavelength in meters. These columns are continuous numerically from 10 meters to 10,000 meters. The numbers in the even columns—the second, fourth, etc.—refer to frequency in kilocycles. These columns are continuous from 29,982 kilocycles to 29.98 kilocycles.

It is obvious from the above, then, that 10 meters is equivalent to a frequency of 29,982 kilocycles, and that 10,000 meters

is equivalent to 29.98 kilocycles. Or, that 300 meters is equal to a frequency of 999.4 kilocycles.

The table is also reversible. Thus, the number 10 at the top of the first column may be read in kilocycles, in which case the number opposite it in the second column represents the wavelength, or 29,982 meters. Likewise, if 300 is read as the frequency in kilocycles, then the wavelength is 999.4 meters. This same relation exists throughout the entire table. It is for this reason that the designations for frequency (f) and wavelength (λ) are placed at the top of each column, since any two related columns may be read either way.

From this table it is also possible to determine frequencies and wavelengths above or below the values included. Thus the frequency corresponding to 5 meters may be determined by selecting the number 50 in the first column and reading it as 5.0. The answer is 59960 kilocycles, or 59.96 megacycles. For 2.5 meters, one would select the number 250 in the first column and read it as 2.5. The answer in this case is 119900 kilocycles, or 119.9 megacycles. It is merely a matter of shifting decimal points.

See next page for details.

[illegible]

4 DLH

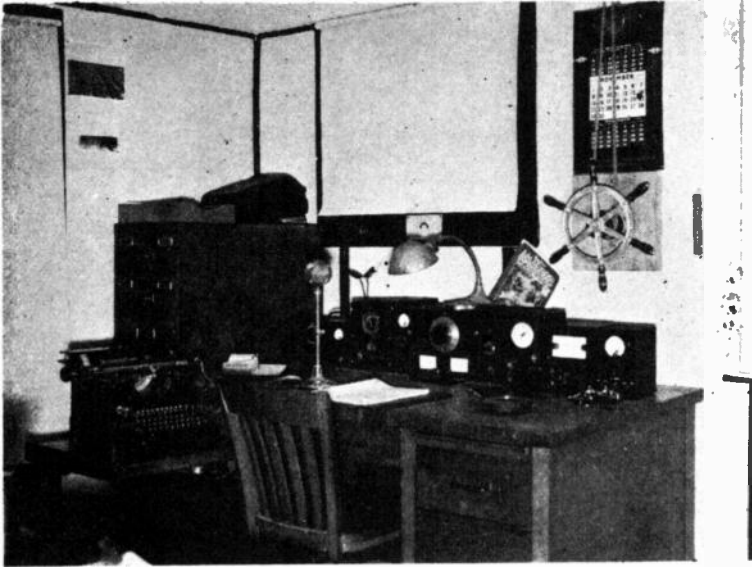


Fig. 1. Operating position at W4DLH, Goulds, Florida. Note pilot wheel on wall for rotating the "Signal Squirrel."

4DLH, operated by William Burkhardt has a record of consistent DX operation. Figure 1 shows the "office," with Astatic mike, field strength meter, Peak pre-selector, National HRO receiver, Peak linear detection radiophone monitor, re-

mote control cabinet and a Triplett combination carrier frequency level indicator, modulation meter and monitor. The boat steering wheel is the helm that controls the rotary beam antenna illustrated in Fig. 2.

— And Rotary Beam

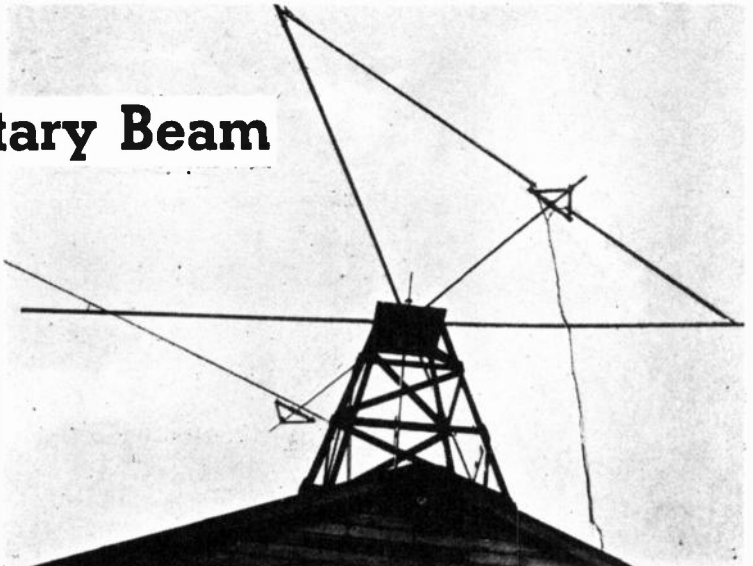


Fig. 2. The rotary beam (Signal Squirrel) antenna at W4DLH which is operated from the shock where a pointer on the ceiling indicates direction.

Radio Coils — Their Properties

How Coils Make Possible Radio Reception

From Ernest

Dear Gerald:

We haven't very much to write to you about this time, because we've been away on a vacation and in addition it's been pretty hot weather, so we haven't done as much as we should have. However, we're still up to about 13 wpm and I should say that in a month or so we would be ready to take the code examination and pass.

You might be interested in knowing that the lady of the house is a little better on code than the man of the house, but I'm sure the man of the house will pass just as well as she will.

We've started studying the book that Mr. Candler sent us, "The Beginner's Story of Radio," and we find it is going to help us a lot in learning the various terms that are used in Radio, but I'm afraid I'm a very poor teacher, because I just can't seem to make any impression on Barbara and think it's a good deal of a mental hazard with her. She thinks that she can't get it, so she can't. But I guess she'd better tell you that herself.

I've been wondering whether it might help both Barb and me if, in your next letter you'd give us a few simple diagrams and show us what happens to the good old juice when it rambles around in the set and where it goes when it comes out. The circuits shown in the handbooks are very pretty but not very descriptive. A little help on this line will be greatly appreciated.

I wonder whether it would be possible in the next month or so if we could have a little time with you personally. I think we're at a point now when a little concentrated study will teach us more than all we might learn from handbooks.

Ernest.

From Barb

Dear Gerald:

I've just read over Ernest's letter to you and he tells all in no uncertain terms. I am afflicted with the definite assurance that I'll never learn the technical part of this radio thing.

I'm not so bad on code, and I'm very sure that I'll pass the examination with no trouble at all with about a month's practice, but the other part is just too much.

Ernest, bless his heart, does his best to explain the book to me, but after his explanation the whole thing's just as clear as mud. Maybe the best way would be to open up my skull just before the examination and pour it in to my brain with a funnel. It would have to be just before the examination, because I'm afraid it would leak out very quickly.

You said, when you spoke about studying in the first place, that you could teach me the fundamentals and I'm still waiting to learn. Your two letters have helped a little, but that's all. I guess as Ernest said, we'd better have some conversation with you direct. You know the old story, that a husband can't teach a wife anything. I guess it's right.

I'll be looking forward to your next letter with interest.

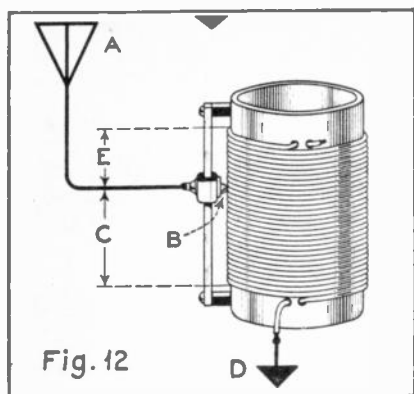
Barb.

To Barb and Ernest

Dear Barb and Ernest:

It's queer the way things work out; at the outset Barb was sure she would never learn the code, whereas your confidence was supreme—and now it comes out that the "boss of the house" is the real wizz. Yet I hear that you are running a close second.

But, keep up the code practice. Polish



One of many ways to tune a coil . . . the aerial is connected to a sliding contact.

up the rough spots and try attaining greater speed. After all, there's nothing like a margin of safety.

I've already told you that the FCC has jacked up the code speed requirements from 10 to 13 words per minute. (Receiving and sending). I know it isn't going to bother Barb and yourself, but it's a tough break for the fellow who started in with the idea that a receiving speed of 10 words per minute would be sufficient. Oh, well, what's three extra words per minute to a feller who is intent on becoming a ham? Once you hit a good ten per, an extra three comes rather easily.

Anyway, it looks as though you two have the code licked, so it's time to commence worrying about radio fundamentals, which seem to be what Barb has been worrying about ever since she got rid of her fears of the code. If Barb runs to form, she may also turn out to be a technical wizzard, which would be a laugh on you, Ernest.

We'll get around to a bit of personal instruction right soon. In the meantime, I've arranged to have the two of you visit a ham station where you will get a good idea as to what the various dinguses are, what they look like, and what makes them do what they do.

I'd be glad to start unravelling the mysteries of the circuit diagram if I thought it were the right time, which I don't. I'd be much happier if you first knew something about the components used in radio circuits. Otherwise I'm

afraid you'll get all tangled up mentally. So, suppose we cover that subject first.

There are three things a radio circuit is just overflowing with—coils, condensers and resistors. As a matter of fact, if you ignore the vacuum tubes, coils, condensers and resistors in one form or another are about all there is to a radio.

"Let's Take Coils"

Let's take coils. They're just a bunch of wire wound 'round and 'round on some sort of form such as a tubing made of insulating material, or on an iron core. It all depends what sort of a coil it is and what it is supposed to do.

Now, maybe you'd never believe it, but a coil of wire wound in circular fashion like a spring develops some amazing properties, the most interesting one being the property of the coil to resonate electrically at some particular frequency or wavelength, depending on the number of turns. This isn't difficult to understand if you'll just stop to consider the different size pipes in an organ. Each pipe resonates at some particular tone or audible frequency with the result that when you push air through it you get that sound. If the air space inside the pipe is made smaller, the tone will be higher in pitch; if the air space is made larger, the tone will be lower in pitch.

It's much the same with a coil. If the amount of wire or the number of turns is made small, the coil will resonate at a high frequency; if the number of turns is made large, the coil will resonate at a low frequency. About the only difference is that in the first case we are dealing with mechanical resonance while in the second case we are dealing with electrical resonance.

Tuning The Coil

Now carry this a step further and consider ye olde trombone. It's got a sliding dingus which the player moves back and forth to produce tones of different pitch or frequency. Thus, by making it possible to vary the air space in the trombone, a wide range of tones can be

produced. Likewise, if we had a coil with an arrangement by which we could vary the number of turns, one coil could be made to cover a wide range of frequencies or wavelengths. This can be done very easily by using a coil with a slider arrangement that can make contact with one turn of the coil at a time, as shown in Fig. 12. Since an electrical current always takes the path of least resistance, (or the shortest, most direct path to ground, which is much the same thing) the current produced by the radio wave will flow from the aerial, A, through the sliding contact, B, thence through the coil turns, C, and finally to the ground connection, D. The unused turns, E, are not in this circuit and are therefore not effective. In all cases, then, the number of *effective* turns is dependent upon the position of the sliding contact on the coil.

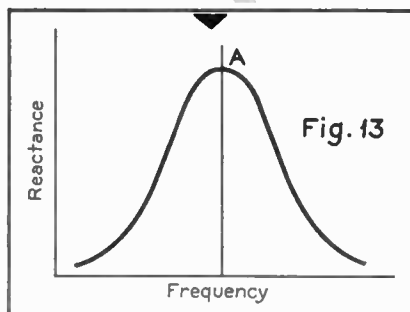
Thus, by varying the number of *effective* turns on the coil by means of the sliding contact, we can "tune" the coil to just one of a number of different wavelengths or frequencies, just as we can "tune" a trombone to a certain frequency or tone. The coil is therefore *selective* in that it can be made to respond to the wavelength of the station it is desired to receive.

This crude form of tuning is no longer used. There are more appropriate methods of tuning coils which we shall cover later.

Resistance and Reactance

Now let's get on with the properties of a coil by first considering a straight length of copper wire. Such a piece of wire will exert a certain amount of resistance to the flow of an electrical current, irrespective of whether the current is direct or alternating. The longer the wire, of course, the greater the resistance, but in any event, if the wire is copper, the resistance will be fairly small.

But, watch what happens when the length of wire is made into a coil . . . the inherent resistance of the wire to the flow of either a direct or an alternating current remains the same, but a different type of resistance presents itself to the

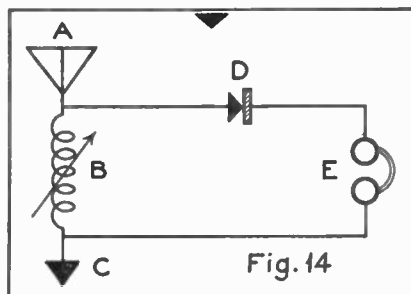


The resonance curve of a hypothetical coil, showing that its reactance is maximum at a critical frequency.

flow of an alternating current that is *not* presented to the flow of a direct current. It is called *reactance* to differentiate it from pure resistance.

Whereas the resistance of a coil to the flow of a direct current might be only a matter of a fraction of an ohm, the reactance of the same coil to the flow of an alternating current might be hundreds of thousands of ohms, or the value might approach infinity, in which case the coil would block the flow of alternating current but still have little effect on the flow of a direct current.

It is obvious from the foregoing that a direct current has but one retarding force to contend with when flowing through a coil, and that is pure resistance, whereas an alternating current has *two* retarding forces with which to deal—pure resistance *and* reactance. Both resistance and reactance are measured in ohms, and since the ohm is the unit of measure of the retarding force in an electrical circuit, 100 ohms would indicate a retarding force much greater than 1 ohm.



A simple receiver circuit with a tuned coil, B.

Impedance

Now let's assume that the pure resistance of a given coil of wire is 1 ohm. That would mean that the coil had a retarding force inherent in the wire alone of 1 ohm to the flow of either a direct or an alternating current. Let's assume further that the same coil has a reactance of 100 ohms. This value does not apply to the flow of a direct current, but only to that of an alternating current. The sum total retarding force of the coil to a direct current is then only 1 ohm, but the sum total retarding force to an alternating current is the resistance plus the reactance, or 101 ohms. Since both retarding forces are always present to the flow of an alternating current through a coil, a third term is used to express this total. The term is *impedance*. And the impedance of a coil is always the pure resistance in ohms plus the reactance in ohms, so that in our case the impedance of the coil to a flow of alternating current is 101 ohms.

Now let's get back to the odd retarding force a coil presents to an alternating current, namely, reactance. The current in one turn of the coil tends to oppose the current in the adjacent turn, due to the creation of opposing electrical fields surrounding the wire. The degree of opposition or retardation is dependent on two factors; the inductance of the coil or the number of turns, and the frequency of the current. A coil of a given number of turns or given value of inductance will have a greater reactance or retarding force to a high-frequency current than to a low-frequency current. Or, conversely, a coil having a high value of inductance or a large number of turns will have a greater reactance to the flow of a current of given frequency than will a coil with a low value of inductance or a small number of turns.



We learn from this that a coil with but a few turns of wire would severely retard the flow of a high-frequency current, if not check flow altogether, while its reactance to an audio-frequency current would be negligible.

Critical Frequency

There is one more point—and an important one—to consider in this respect, and that is, a coil of given inductance has a critical resonance point where its reactance is maximum to the flow of an alternating current. This is illustrated in Fig. 13, and shows that the reactance of the coil is maximum at the frequency to which the coil naturally responds, and drops off rapidly at frequencies above or below the point of resonance. It is by means of this property that we are able to tune circuits containing coils in such a manner that the circuits will select a signal on one wavelength to the exclusion of signals on other wavelengths.

The principle may be followed through by reference to the simple receiver circuit of Fig. 14, where A is the aerial, B is the coil and C is the ground connection. The arrow drawn through the coil indicates that it is variable, or in other words, that its value of inductance may be altered, such as by means of a sliding contact. Connected across the coil is the detector, D, whose principle of operation you need not worry about now, and the headphones, E.

Consider the aerial first. It is not a selective agent, and it feeds minute radio-frequency currents not from one, but many, radio signals into the simple receiver circuit. Consequently, if there were no means of selecting one signal from the many, the sounds in the headphones would be a mixture of all the signals.

Selective Circuit

It is the coil with variable inductance that does the trick. If we assume as an example that the inductance of the coil is such that its natural resonance point is at 1000 kilocycles, then we know that it will offer maximum reactance to a signal of that frequency and much less reactance or retarding force to signals of differing frequency, as indicated by the "resonance curve" shown in Fig. 13. The result is that the reactance of the coil is so high to a radio-frequency current of 1000 kilocycles that the current cannot readily flow through the coil to ground. The path of least resistance

is then through the detector, D, the headphones, E, and thence to ground. The headphones are actuated by the current flow and therefore signals are heard. On the other hand, the reactance of the coil to signals of frequencies other than 1000 kilocycles is so low that these signal currents are able to reach ground through the coil and therefore do not flow in the headphone circuit. By the same means, if the inductance of the coil is varied so that its reactance is maximum at 1500 kilocycles, a signal of that frequency will be heard in the headphones, and signals of all other frequencies will readily pass to ground

through the coil. Thus, in each instance, the inductance of the coil is so adjusted that the reactance of the coil to the desired signal will be maximum, and so long as this condition holds, the desired signal will be shunted through the circuit containing the headphones, and signals of differing frequency will be shunted to ground through the coil.

So much for that. Do you find it clear? If not, let me know what points you do not understand and I'll go over them in my next letter at which time we'll get around to other types of coils, and to condensers and resistors.

Gerald.

QRR —

HEADQUARTERS
CINCINNATI FLOOD AREA
33 West Ninth St.
Cincinnati, Ohio

February 5th, 1937.

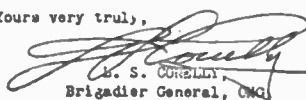
Mr. George E. Hart
6738 Belkenton Place,
Silverton, Ohio

Dear Mr. Hart:

Now that the flood crisis is safely past, and the National Guard is withdrawing from this area, I desire to express through you, my appreciation of the splendid service rendered by the radio amateurs who are members of our National Guard communication units.

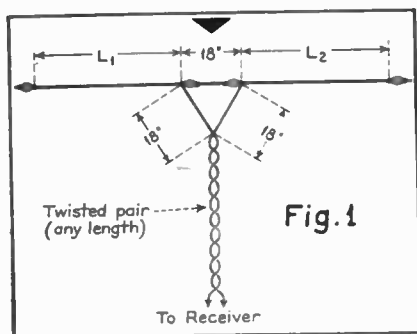
For a period of many hours, the most satisfactory communication which was maintained along the Ohio River, was that which was due to the efforts of the radio amateurs in the various National Guard organizations.

Yours very truly,


L. S. CONNELLY
Brigadier General, OAG

Commanding.

This letter from Brigadier General L. S. Connelly, Ohio National Guard, to Mr. Hart, speaks for itself. It is a fine tribute to Amateur Radio.



Illustrating the principles of antenna design for best results over a given frequency band.

ANTENNA DESIGN

Question No. 39:

The following is a composite question from a good many readers of *AWR*: While I have experimented with various makes of commercial all-wave antennas, and have had good results, I should like to know how to design a noise-reduction antenna system which would give me *peak efficiency on a given band*. In other words, I should like to know the principles of such design and how to put them into practice.

Answer:

There are four principles involved in designing an aerial to give the best results over a narrow band of frequencies—for instance the 20-meter band. These are: 1—The antenna must be the correct length. 2—The lead-in should not pick up noise. 3—The impedance of the lead-in should match that of the antenna at the place where it connects. 4—The impedance of the lead-in must be matched to the impedance of the input of the receiver.

The doublet antenna shown in Fig. 1 can be made to answer the first three requirements. The total length, L_1 plus L_2 , should be one-half wavelength long on the wire. As the wave travels more slowly along the wire than in space, the wave length will be shorter on the wire—about 5% shorter on frequencies between 30 and 3 megacycles. Thus a 20-meter antenna, cut to correct length (half wave) would be 95% of 20/2 or

9.5 meters long. The following formula takes into consideration the 95% factor:

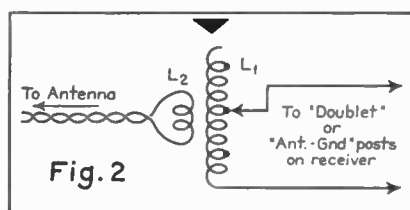
$$L = 468,000/F$$

— where L is the length of a half wave on the wire in feet and F is the frequency in kilocycles—usually chosen for the exact frequency or the frequency in the middle of the band.

Pontoise, at 15243 kc., is just about in the center of the 20-meter band. Taking this frequency for F , the total length of L_1 plus L_2 will be 33 feet, 6 inches.

The ordinary twisted pair—or better yet a twisted pair designed for radio transmission line purposes—makes an excellent noise reduction lead-in, and its impedance, about 75 ohms (length has nothing to do with this, and the twisted pair can be any length) matches that of the center of a half-wave doublet—particularly if “fanned” slightly at the antenna end as suggested in Fig. 1.

The chances are the low impedance of this line will not match the input impedance of the receiver. Connect accordingly to whatever directions accompanied the receiver. Try it across doublet posts, if any, with ground connected—and across antenna and ground posts with ground disconnected. If excellent results are not secured, try link coupling as shown in Fig. 2. Coil L_1 is wound on a standard 1½-inch coil form with 21 turns, close wound, of any convenient wire tapped every third turn. L_2 consists of 3 turns wound over L_1 . When L_1 is connected to the antenna and ground posts of a receiver, try it both with and without ground.



Link coupling to the receiver when the receiver input does not match the impedance of the twisted transmission line.

All questions of a technical nature should be forwarded to Queries Editor, *ALL-WAVE RADIO*, 16 East 43rd Street, New York, N. Y.

Transformers and Condensers

Barb & Ernst Enjoy Visiting a Ham Station

The First CQ

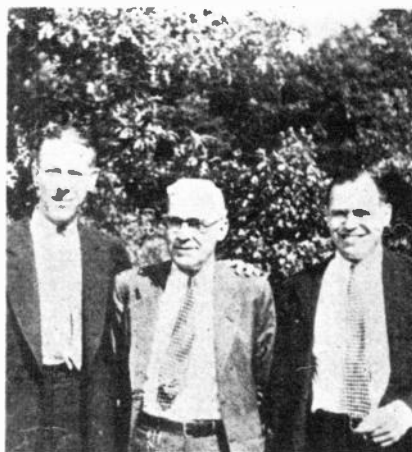
Dear Gerald:

From my standpoint your last letter cleared up a lot of points that I frankly had never paid any attention to before. The fact that by changing the number of turns in a coil you would change the resonant frequency was something that I had not realized before, but your very clear analogy with the slide trombone brought the whole thing home to me much more clearly.

I'm afraid I can't say the same for the boss. She sees the wheels but doesn't know what makes them go 'round. How's chances of chartering your time for a while, so as to pound a little of it into her noodle?

Of course, if I'd had the intelligence I was born with I would have realized that the coil is more or less of a choke, because I've used modifications of this a lot in my work. In signal practice it is customary to use coils to cut back a.c. and let d.c. through, which of course is exactly the same principle that you've described in your letter.

I want to tell you that the boss and I had one swell time last Sunday afternoon at Mr. Appel's station W2FDA, where we saw the wheels go 'round. I suppose I should feel very proud to know that I got an answer to my very first CQ, but to tell the Gospel truth, I was plumb scared to death. If I remember correctly W9FMU who was spending the afternoon with W9UHA in Chicago answered it, and I can assure you that, while I felt like a first-class jackass talking, I got the biggest thrill of my life out of it. Unfortunately, I got very badly bitten with the bug, and I am in deeper now than ever before.



Muhleman—Rowland—Appel. Photo taken by "W2ICU, under the span of his Johnson Q." Muhleman says he looks like Tilden in the photo—Appel says nuts. Which about covers it.

Which reminds me, you haven't told me yet what receiver circuit I should build. We're getting to a point now with the code where we should be able to pass the test very shortly, and I'd like to have a c-w receiver if I should pass. I have an idea, too, that if Barb could help me build a receiver she might get a little more out of this technical stuff.

That's all this time. I'll leave the question to Barb. Please thank Mr. Appel for me for his kindness to both Barb and myself.

Ernest

Scared But Game

Dear Gerald:

I guess it's a good thing you took us to see Mr. Appel's station for frankly I had begun to lose interest in radio, due to

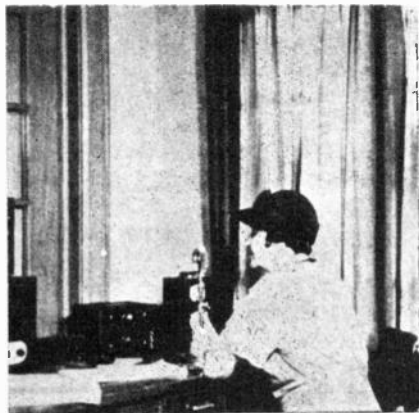
sheer fright over ever mastering the technical side of it. I got such a thrill out of seeing the real operation of a station that I guess it will have to be a case of "To Paris or bust." I suppose to your technical mind my absolute ignorance must seem impossible, but really, while enjoying your trombone illustration, it still leaves me much in the dark as to what's what in radio. Ernest insists that I must ask you technical questions as he has given me up as a bad job, but really I haven't enough sense to think of any. I'm like the man who was being chased by a mad bull and when told to say something to the bull could only say "morning, cow."

However, I could write on indefinitely about our visit to W2FDA. If all radio contacts would be as pleasant, I'm sure it would be well worth the effort involved to make the grade. If we ever do own a station, I shall always remember our first QSO.

I'm going away tomorrow for a week and am going to make another desperate effort to conquer the "darn thing"—my code is still lots better than Ernest's!

Please have patience.

Barb



Barb practicing up at the mike at Appel's shack, preparatory to forming an XYL's knitting bee. Photo by Granger, the sap.

Gerald "Right Back"

Dear Barb and Ernest:

We all had a swell time that Sunday. I'll never forget Geo. working his lungs

over-time trying to raise a station for your "edification" and getting nary a peep out of anyone—and then you sitting yourself down in front of the mike and raising W9UHA on your first CQ. Boy, have you a compelling voice! Maybe you were scared at that, but you certainly didn't sound it. Nor did Barb. I think both of you are going to take to the mike or the key like a duck takes to water.



Ernest trying to slice a sideband with Appel's ACR-175. (It's a posed photo, folks—the signal is emerging from the HRO!)

By rights you shouldn't have rated an answer to your CQ. As I recall it, you said CQ just three times and then left the air, whereas the average Ham yells CQ until his breath gives out. Maybe you'll teach the gang something when you get on the air. If you've got a system for raising a station through bad QRM with only three little come-hither's, the Hams are going to beat a path to your door (and beat the life out of you for copping the DX).

Speaking of receivers—what you really want, and need, is a set with a beat-frequency oscillator with which you can properly receive code signals, and a set with sufficient band spread to make tuning easy in the crowded ham bands. I am designing a not-too-complicated set of this type right now, and you will have the pleasure (?) of building it. When you get through with the job, you'll

know a lot more about radio than you do now! You're going to grab a lion by its tail and not be able to let go—but you'll end up by twisting said tail and making the lion behave. But you may sweat a bit first. In the end, the thing will work, and you'll be wiser for the experience.

I'm sorry, Barb, that you've had such a miserable time with the explanations of technical functions. However, I am sure you will be able to grasp the fundamentals more thoroughly after I have had the opportunity of completing the picture I set out to form. So far I have dealt with only fragments of the whole,

and I don't wonder that you can't piece together the picture when many of the parts are missing. Just stick with it a while.

Now we had best get back to coils. So far nothing has been said about modern tuning circuits for the reason that tuning today is done with condensers, and as yet condensers have not been covered. We'll finish with the coils first.

Enter the Transformer

No doubt you've read or heard about transformers and wondered just what they are. Fundamentally a transformer is two or more coils placed in proximity to each other but not connected together by a wire conductor. They are used for various purposes, but the transformer action in most cases is principally the same.

A transformer is an interesting unit because the electrical energy flowing in one of the coils is made to appear in the other coil without any direct wire circuit between the two. Ordinarily the coil through which the current flows is referred to as the *primary coil* and the coil into which the current is induced is referred to as the *secondary coil*.

A transformer will not function on a direct current; therefore it may be considered as an alternating current device. It can be used only when the current flowing in the primary coil alters in value, or when the flow of the current is interrupted.

Why? Let's look at Fig. 14. "A" shows a single coil through which is flowing an alternating current. This current develops sort of an electrical halo, *M*, around the coil, as shown by the dotted lines. We call it a *magnetic field*. As the alternating current increases and decreases its rate of flow through the coil, the magnetic field "breathes." As the current in the coil rises, the field expands; as the current falls, the field contracts, and, as the current alters its direction of flow the magnetic field changes its direction of movement through the center or core of the coil.

The magnetic field is actually electrical energy extending out into the space around the coil. If another coil is placed close to the first coil, as shown at "B," it will pick up energy from the magnetic field even though there is no direct connection between the two coils.

The transfer of energy from the primary coil, *P*, to the secondary coil, *S*, Fig. 15, takes place by *induction*. As the magnetic field, *M*, is spreading out from the primary coil as the current flow increases, it envelops or "cuts" the turns of wire of the secondary coil, as shown at "C" and thereby induces a current in them. As the magnetic field contracts, it again cuts the turns of the secondary coil, as shown at "D," and again imparts some of its energy. In other words, as long as the magnetic field is in motion, it will induce a current in the secondary coil, just as wind in motion will blow your hat off!

Now, why won't the transformer shown in Fig. 15 operate on a direct current? Observe, please, that were a direct current to be passed through the primary coil, the magnetic field would expand and then *stay put*, because a direct current does not vary. Consequently the field would cut the turns of the secondary coil only once and thereafter remain motionless. A momentary current would be induced in the secondary during this period of the field expansion, but no further transfer of energy from primary to secondary coil would take place. It's simple when you consider that motionless air won't blow your hat off, but if the air is in motion your hat will

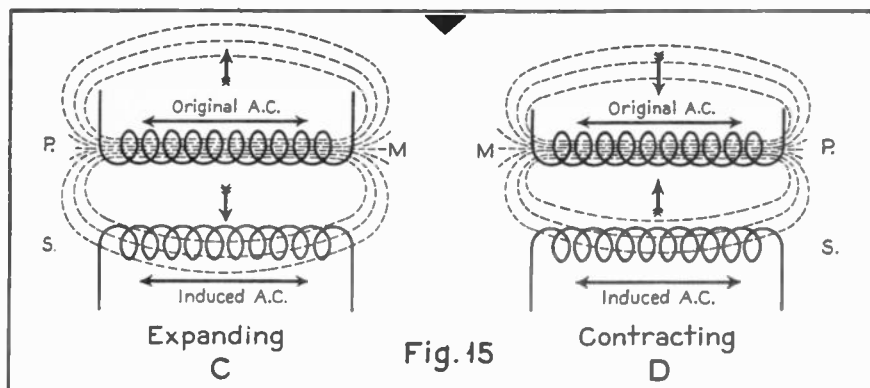


Fig. 15

Illustrating the manner in which the magnetic field expands and contracts, and in so doing induces a current in the secondary coil.

be "gone with the wind." Or isn't it simple?

Uses for Transformers

Transformers are used in radio receivers and transmitters to couple one circuit with another, and to build up or reduce voltages. Those used in high-frequency circuits are known as *radio-frequency transformers*, and usually consist of two separate coils of wire wound one above the other on an insulating tube, as shown at "A" in Fig. 16. Since such a transformer is surrounded by air, it is said to have an *air core*.

Transformers used in low-frequency circuits are known as *audio-frequency*

transformers. These also consist of two coils of wire wound close together, but in this case the coils are wound on an iron core which serves to provide greater coil inductance and a far better "conductor" for the magnetic field than plain air, as shown as "B" in Fig. 16.

Transformers used to supply energy to a transmitter or receiver are known as *power transformers*. These units also have iron cores. One type is used to step down the voltage from the house line to light the filaments of the vacuum tubes, and the other type is used to step up the voltage from the same source to supply plate power for the tubes.

The action of a step-up or step-down transformer is not difficult to understand. It's merely a matter of arithmetic. If there are twice as many turns of wire in the secondary winding as there are in the primary, the voltage induced in the secondary by the magnetic field will be twice the voltage in the primary. Conversely, if there are only one-half the number of turns in the secondary coil as in the primary coil, the voltage developed in the secondary will be only one-half that of the primary. For instance, if a given step-up transformer has a secondary winding with three times the number of turns as the primary, and the primary is connected to a 110-volt a-c line, the secondary voltage will be 660. If the secondary had but one-third the number of turns as the primary, the voltage would be approximately 36.5 volts.

The type of power transformer used

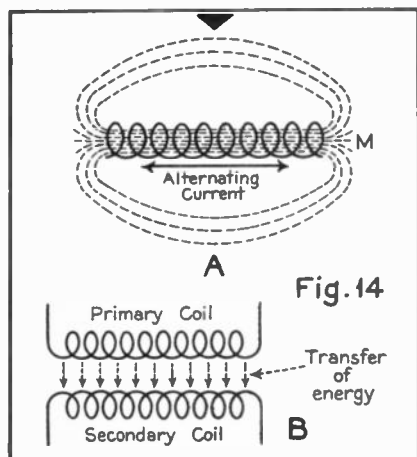
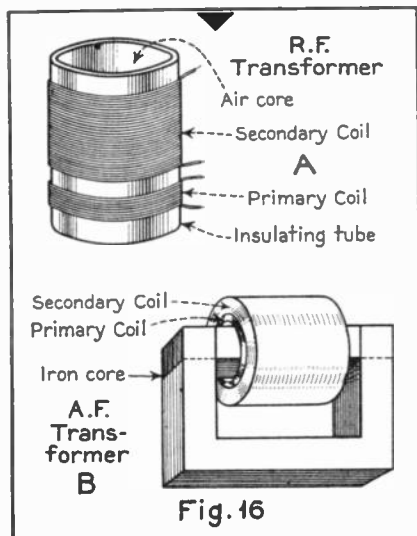


Fig. 14

The magnetic field around an energized coil, and illustrating the transfer of energy from primary to secondary coil of a transformer.

in a radio receiver has a single primary coil which connects to the 110-volt line, and as many as three secondary coils, each having a different number of turns. The single primary winding energizes all three of the secondary windings. One secondary has a large number of turns of wire and supplies 300 volts or so to



Physical appearance of a typical radio-frequency transformer and an audio-frequency transformer.

the high-voltage rectifier tube. Another secondary winding has a small number of turns and supplies 5 volts or so to the filament of the high-voltage rectifier tube. The third secondary winding also has a small number of turns and supplies 2.5 or 6.3 volts to the filaments of the receiver vacuum tubes, depending upon which type of tube is used.

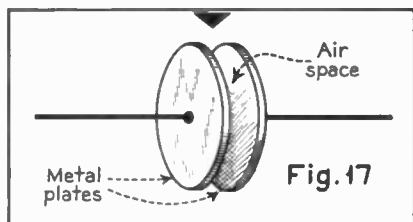
The type of power transformer used in a radio transmitter is similar to the type used in a receiver, except higher voltages are developed and the filament windings which energize the tube filaments are usually separate units.

That will hold us on coils for the time being. Now let's take a look at condensers.

The Condenser

A condenser is fundamentally a storage tank, and every condenser has a definite storage capacity. In this respect it is like a water tank which has a valve that

opens when the tank is completely full and permits all the water to flow out through a pipe. The difference is that a condenser, like a coil, is fundamentally an alternating-current operated device,



A simple condenser, composed of two metal plates separated by an air space.

and therefore, since an alternating current reverses direction periodically, the condenser is first charged to full capacity and thence discharged in one direction, and then charged and discharged in the opposite direction.

A simple condenser is composed of two metal plates separated by some form of insulation, such as paper, mica or just plain air, as shown in Fig. 17. Like the primary and secondary coils of a transformer, there is no direct connection between the plates. And, just as a direct current flowing in the primary winding of a transformer cannot be induced into the secondary winding, neither can a direct current impressed on one plate of a condenser be transferred to the other plate. To put it plainly, a direct current cannot flow through a condenser.

But an alternating current can. The ease with which such a current can pass through a condenser is dependent upon the frequency of the current and the capacity of the condenser.

Let's follow the action of a condenser. We will suppose first that the condenser is not connected in a radio circuit. If we attach it momentarily to a source of d-c voltage such as the battery shown at "A" in Fig. 18, one plate of the condenser will become positively charged and the other plate will become negatively charged, as shown at "B." If the condenser is then disconnected from the source of voltage it will contain a charge of electricity equal to its storage capacity—and in this respect will be like a tank holding water. If the two plates of the condenser are then connected together

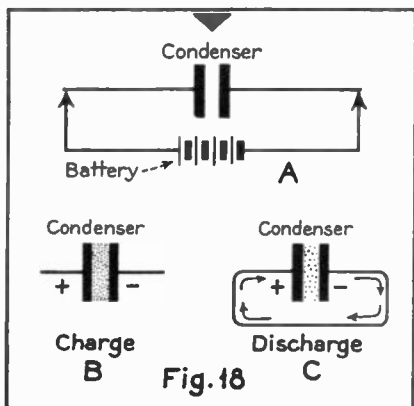


Fig. 18

Illustrating the manner in which a condenser is charged and discharged.

by a conductor the condenser will discharge and there will be a flow of current in the connecting wire, as shown at "C."

Since a direct current is a steady source of power, it is evident that the condenser can be charged but once, since the voltage remains constant. However, an alternating current voltage swings from a positive peak, through zero, and then to a negative peak, with the result that the condenser in this case would be charged to capacity positively one instant and then charged to capacity negatively. The result, then, is much the same as though the alternating current were actually flowing through the condenser from one plate to the other.

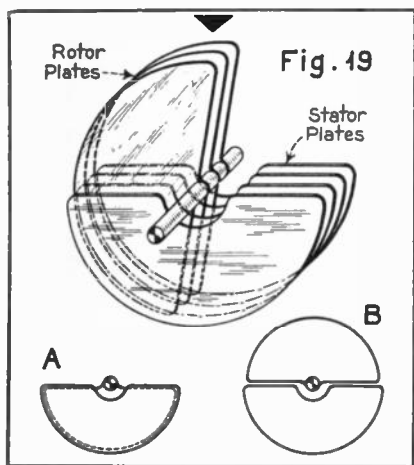
The capacity of a condenser is dependent upon the effective area of the metal plates or conductors, the distance between them, and the nature of the insulation or *dielectric* as it is called.

A condenser composed of two plates separated by air will increase in capacity as the plates are brought closer together and decrease in capacity as the plates are moved further apart. If one plate is made movable, therefore, the capacity of the condenser can be varied.

If the effective area of one plate of a condenser to the other is increased the capacity of the condenser will increase; if the area is decreased the capacity of the condenser will decrease. Therefore, if the two plates are cut in semi-circular form and one of the plates rotated, the effective area and hence the capacity of the condenser can be altered. This is the principle used in variable condensers for radio receivers and transmitters, except that instead of two plates, a series of stationary and rotary plates are used, as shown in Fig. 19. The rotor plates interleave with the stator plates and are separated from the latter by air space. The capacity of such a condenser is maximum when the rotor plates are completely interleaved with the stator plates, as shown at "A," and minimum when the rotor plates are completely unmeshed, as shown at "B."

Fixed condensers are made of sheets of tin or aluminum foil with paper or mica insulation. The so-called *dielectric constant* of paper and mica is considerably greater than that of air and permits the manufacture of condensers of comparatively large capacity that do not occupy much space in a radio set. The use of paper or mica also permits the foil plates of the condenser to be placed very close together which further increases the capacity. The still higher capacity electrolytic condensers have a very thin insulation film between the sheets of foil which is developed chemically.

A condenser, like a coil, has reactance and therefore impedes the flow of an alternating current. The reactance of a coil is referred to as *inductive reactance* and that of a condenser as *capacitive reactance*. The reactance of a condenser is dependent upon the frequency of the



Typical variable tuning condenser. "A" shows position of maximum capacity and "B" minimum capacity.

current and the capacity of the condenser. But, the reactance or impeding force of a condenser *decreases* with an *increase* in frequency whereas the reactance of a coil *increases* with an increase in frequency. It may be said generally, therefore, that a high-frequency current has more difficulty in flow-

ing through a coil than through a condenser. This is an important point, and I'll show you in my next letter how these particular properties applied to a radio circuit permit tuning, and how they make it possible to guide various electrical currents through wire circuits.

Gerald

OHM'S LAW

OHM'S law is concerned with the relation of three factors which are always present in an electrical circuit; the resistance measured in ohms; the electrical potential measured in volts; and the current measured in amperes.

The relation between these factors is expressed by one of the following three formulae:

$$I = \frac{E}{R} \quad \therefore R = \frac{E}{I} \quad \therefore E = I \times R$$

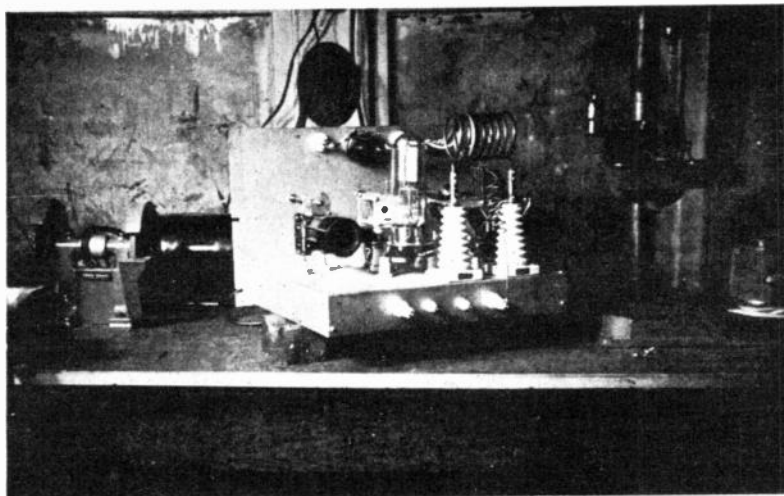
Where I = Current in amperes, E = Potential in volts, and R = Resistance in ohms.

Applying the first formula to a simple problem, for example, to find the resistance value, knowing the circuit voltage to be 6 volts and the current 0.6 amperes:

$$R = \frac{E}{I} = \frac{6}{0.6} = 10 \text{ ohms}$$

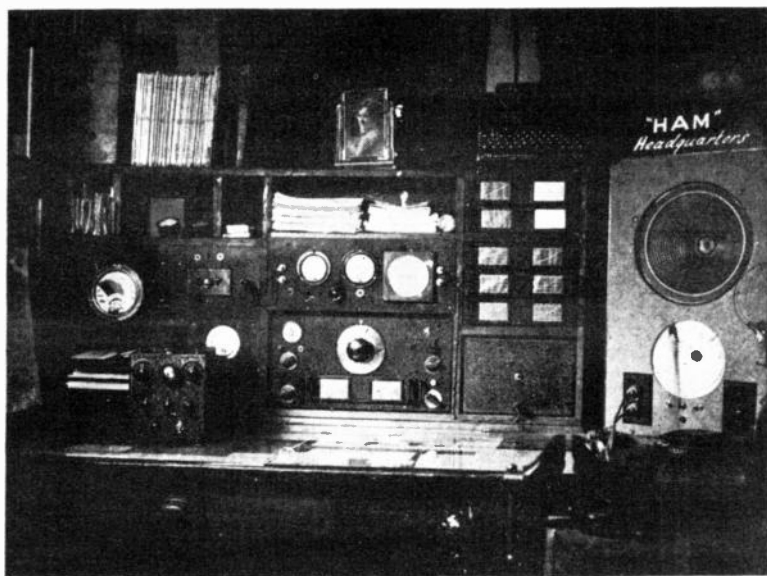
Resistors are rated in current carrying capacity and watts. The basic formula for watts is:

$$\begin{aligned} W &= E \times I \quad \therefore E = \frac{W}{I} \quad \therefore I = \frac{W}{E} \\ \therefore W &= I^2 \times R \quad \therefore I = \sqrt{\frac{W}{R}} \quad \therefore R = \frac{W}{I^2} \\ \therefore W &= \frac{E^2}{R} \quad \therefore R = \frac{E^2}{W} \quad \therefore E = \sqrt{R \times W} \end{aligned}$$



Above: Station WSEMI, owned and operated
by George L. Bird, Pawhuska, Oklahoma.
Below: View of the rig which employs a
W.E. 42A in the final.

Typical Amateur Stations



THEY NOSE INTO TUNED CIRCUITS

Clearing up Some Difficulties on Radio Theory

"Let's Have Circuits"

Dear Gerald:

You'll have to excuse Barb this once for not replying to your last letter. She's been a bit under the weather and just hasn't felt up to digesting the dope you gave us on transformers and condensers—but she'll catch up before your next letter arrives.

As for me, I'm getting along swell. The more you write, the more I realize that you're talking right down my alley, but in terms of radio-frequency currents. Take your dope on transformers, for instance; I play with big fellows that handle plenty power at 60 cycles, but I never stopped to think that these "big berthas" might be sisters to the audio transformers and power transformers used in radio. Now I see that they are, and I feel closer to the situation than I did previously.

But I must admit that I'm still stuck on radio circuits. I think it would help both Barb and me if you would show us how a complete radio circuit works, and what all the trick lines mean. How about it? Won't we get closer to the truth if we understand more than we do about circuits.

I get your explanation of condensers and think I understand how they work, but I'm still in the dark on the type of tuned circuits used in radio sets. I suppose you'll "tell all" in your next letter. I hope so. Until then, 73.

Ernest

"Tuned Circuits Herewith"

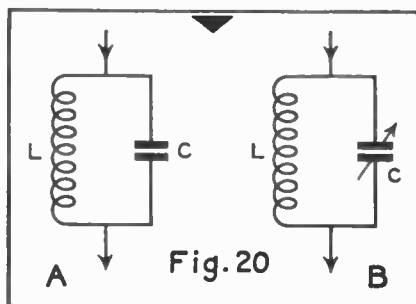
Dear Barb and Ernest:

Sorry Barb is under the weather, but as soon as she feels up to it, ask her to go over my last letter. It hinges on

what I will have to say now, and so it is rather important that she attempt to get the hang of transformers and condensers. We'll have all the pieces in our grasp right soon now, and from then on I believe Barb may find the sailing a bit easier.

For that matter, we have now reached the point where we can tie in condensers and coils, since the general characteristics and functions of both have been covered. Therefore, we can get right down to the type of tuned circuit most commonly used in radio receivers and transmitters, and at the same time cast some light on by-pass, blocking and filter circuits. So, let's commence.

I pointed out in my last letter that coils and condensers are *opposite* in behavior under the influence of radio-frequency currents. The reactance or opposing force of a coil *increases* with an increase in frequency, whereas the reactance or opposing force of a condenser *decreases* under the same condition. Conversely, the reactance of a coil *decreases* with a decrease in frequency while that of the condenser *increases*. Let's see how this works out in the more common type of tuned circuit.

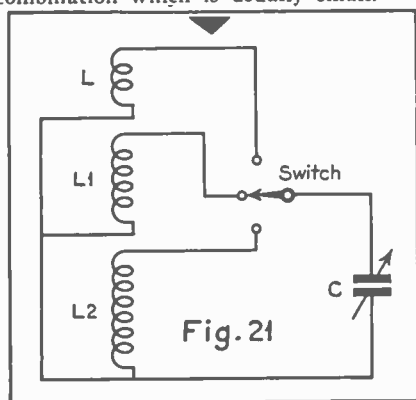


Fixed- and variable-tuned parallel-resonant circuits.

Parallel-Tuned Circuit

Such a circuit is shown at A in Fig. 20. It consists of the coil or inductance L and the condenser or capacity C . The condenser is connected directly across the coil or, in other words, is in parallel with it. The circuit is therefore parallel-tuned. If the frequency of the current fed to this circuit is such that the reactance value of the coil L is high, then the reactance value of the condenser will be low. The current flow through the coil will therefore be less than the current flow through the condenser. On the other hand, if the frequency of the current is such that the reactance of the condenser is high, then the reactance of the coil will be low, in which case the current flow through the condenser will be less than through the coil.

One or the other of these conditions will hold for all frequencies but one. There will always be one frequency at which the reactance of the coil and the condenser are *equal*, and this is known as the *resonant frequency*. Since a coil has *positive reactance*, which tends to make the current lag behind the voltage, and a condenser has *negative reactance*, which tends to make the current lead the voltage, the reactance of one will cancel that of the other. Therefore, at resonant frequency, when the reactances are equal, the total reactance of the parallel-tuned circuit is zero. Under such a condition the only opposition to the flow of the radio-frequency current is the direct-current resistance of the coil-condenser combination which is usually small.



A multi-band tuned circuit, with wave-change switch.

Under the condition of resonance, maximum voltage is developed at the terminals of the circuit, or, more specifically, across the coil. At any frequency other than resonance, when the reactance value of the coil and condenser are not equal, the voltage developed will be small. As a matter of fact, the voltage developed will decrease rather rapidly either above or below the resonant point.

Variable-Tuned Circuit

The circuit of Fig. 20 can resonate at only one frequency, since both the coil and condenser have fixed values. If the condenser is made variable, however, its reactance may be adjusted to equal that of the coil over a wide range of frequencies, in which case the circuit may be made to resonate at any desired point within the frequency or wavelength range of the combination. This type of circuit is shown at B in Fig. 21, and we venture to say that you have seen it before.

Thus we arrive at the parallel-tuned circuit used extensively in radio receivers and transmitters. It is tuned or adjusted to the desired frequency or wavelength by the simple procedure of rotating the plates of a variable condenser similar to the one shown in Fig. 19 of my last letter. The wavelength or frequency range that can be covered by such a combination is dependent upon the inductance of the coil and the minimum-to-maximum capacity of the variable condenser. Since a single coil-condenser combination is not capable of covering all wavelengths or frequencies, a number of coils having increasingly larger inductance values or more turns are used in sequence in conjunction with a single variable condenser. The coils are connected to a multiple-contact switch, as shown in Fig. 21, so that any one of the coils can be connected across the variable condenser at will. In this manner any number of frequency ranges can be covered with a single variable condenser. Thus, with the variable condenser, C , used in conjunction with the coil, L , wavelengths from say 19 to 40 meters could be covered by rotating the plates of the condenser from minimum-to-maximum capacity, and with

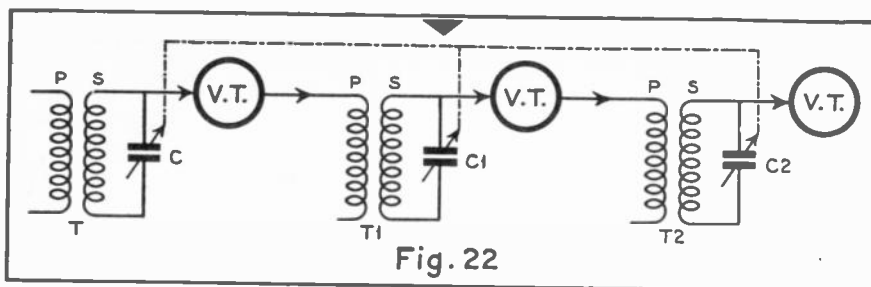


Fig. 22
Circuit of a cascade radio-frequency amplifier with ganged variable condensers.

coil, L-1, wavelengths from 40 to 85 meters could be covered, etc. The switch places the desired coil in circuit with the variable condenser for a given wavelength range, the other coils remaining idle.

This is the type of band-selection system used in modern all-wave receivers, except that the coil-switching mechanisms are more elaborate than the one shown in Fig. 21.

It is not necessary that you remember the exact functioning of a parallel-tuned circuit—you can get by on much less. But keep in mind that modern tuned circuits are composed of fixed coils or inductances and variable condensers. Also remember that maximum signal voltage is developed when such a tuned circuit is in exact resonance with the desired station. Signals above or below the resonant frequency will develop less voltage across the coil, the amount developed being increasingly less the further removed the signal is from the resonant frequency. In other words, the tuned circuit will respond particularly well to the signal to which it is tuned, and less effectively to signals of other frequency.

Cascade Selectivity

Relatively speaking, tuned circuits of the coil-condenser type are not very selective when used singly. They cannot be made "sharp" enough in tuning to eliminate signals close to the resonant frequency. When used singly they are comparatively "broad" in tuning, but when used in cascade the selectivity of the first circuit contributes to that of the second, and so on. This is evident when it is considered that each successive tuned circuit tends to promote the

desired signal and retard undesired "off-frequency" signals, with the result that a second and third tuned circuit have less to contend with than the first tuned circuit.

The modern radio receiver, therefore, has a number of tuned circuits, as shown in Fig. 22. This consists of three radio-frequency transformers, T, T-1 and T-2, which are coupled together by the vacuum tubes, V.T. The primary winding, P, of transformer, T, connects to aerial and ground. The signal in the primary is induced into the secondary, S, which, with the variable condenser, C, forms the first parallel-tuned circuit. The signal voltage developed across the secondary, S, is impressed upon the first vacuum tube, V.T., where it is amplified and thence fed to the second vacuum tube through T-1 by an identical transformer action. The signal is further amplified and then fed to the third vacuum tube by the transformer action of T-2.

The circuits are tuned by means of the variable condensers, C, C-1 and C-2. These condensers are ganged together on a single shaft, as indicated by the dotted lines, so that they can be adjusted to the same frequency simultaneously. In this manner the radio-frequency amplifier shown in the diagram of Fig. 22 can be tuned to any frequency within the range of the coil-condenser combinations by means of a single knob on the condenser shaft.

By-Passing and Blocking

So much for tuned circuits for the present, but while we are on the subject of the reactance of coils and condensers, let us see how these components may be used to direct and/or block currents in radio circuits.

We have learned that a condenser will not pass a direct current but will pass an alternating current. The ease with which it will pass an alternating current is dependent, of course, upon the frequency of the current and the capacity of the condenser. We also know that a coil or inductance will pass a direct current and an alternating current, but here again the ease with which the coil will pass the alternating current is dependent upon the frequency of the current and the inductance of the coil.

Now, let's pose a problem: We have a vacuum tube which has in its output both a direct current and a radio-frequency current. We want to connect this tube to a branch circuit, but in such a manner that *only* the radio-frequency current will pass through one wire and *only* the direct current through the other wire.

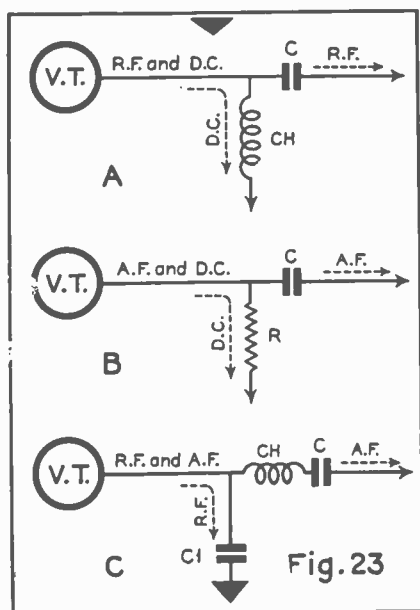
"Routing" Currents

The solution of the problem is shown at A in Fig. 23. The condenser, C, is placed in series with the wire that is to carry only the radio-frequency current (r.f.) and it is given a value of capacity having low reactance to the flow of r.f. current. The r.f. will therefore pass

through the condenser with ease (almost as if the condenser weren't there) but the direct current (d.c.) will be effectively blocked since a direct current cannot flow through a condenser. Now in the other wire, through which we wish the d.c. to flow, we have placed a coil having a large number of turns or high inductance value. This type of coil is known as a "radio-frequency choke" and is marked "CH" in the diagram. This coil or choke will effectively pass the direct current but will present a high impedance (reactance plus resistance) to the flow of a radio-frequency current. Therefore the d.c. flows with ease through the lower wire but the r.f. is blocked or "choked" so that it cannot flow through this circuit. The total result is that the d.c. is forced to flow through one circuit and the r.f. through the other circuit.



Now let's assume the same circumstances but in a case where there is a direct current and an audio-frequency current (a.f.) in the output of the vacuum tube. The solution is shown at B in Fig. 23. Since the reactance of a condenser increases with a decrease in frequency (but likewise decreases with an increase in capacity value) the condenser, C, must be of large capacity to permit ease in passage of the a.f. into the branch circuit. Also since the reactance of a coil decreases with a decrease in frequency, a coil having exceptionally high inductance (one with an iron core) would be required in the lower branch circuit to effectively block the flow of a.f. Such a coil (known as an "audio-frequency choke") could be used for this purpose, but a straight resistance, R, of high value, would be sufficient to permit the flow of direct current and yet effectively retard the flow of a.f. for the simple reason that an electrical current will take the path of least resistance, and in the example shown, the path of least resistance (capacitive reactance) for the a.f. is through the condenser, C. Consequently the a.f. will flow through the upper wire and the d.c. through the lower wire, since the d.c. can't get past the condenser.



Branch circuits using by-pass condensers and r-f chokes.

Division of R.F. and A.F.

Now let us assume that the output of the vacuum tube contains r.f. and a.f. The solution is shown at C in Fig. 23. We know from the previous examples that an a.f. current will have no difficulty flowing through a condenser of high capacity, but neither will an r.f. current. However, an a.f. current will flow readily enough through an r.f. choke, which has comparatively low reactance at this frequency, but an r.f. current will not. Therefore, if we connect an r.f. choke, CH, in series with the high-capacity condenser, C, as shown at C in Fig. 23, the a.f. will flow through the upper circuit but the r.f. will not.

But, the r.f. will flow readily enough through the lower circuit to ground because the condenser, C-1, introduced into this circuit has low capacity (reactance of condenser decreases with increase in frequency). But this condenser has a high reactance at low or audio frequencies and in consequence the a.f. current is effectively blocked from this circuit. The result is that only the a.f. flows through the upper circuit and only the r.f. through the lower circuit.

It should not be inferred from what I have said that blocking action is complete. In example C, for instance, some r.f. will get through into the upper circuit and some a.f. will get through into the lower circuit, but the degree in either case would be small if the values of capacity and inductance were correct to satisfy the conditions.

When a coil or inductance is used to retard the flow of an alternating current of low or high frequency, it is referred to as a "choke." When a condenser is used to retard the flow of a direct current or an alternating current of low frequency, it is referred to as a "blocking condenser." When it is used to pass an alternating current of high or low frequency it is referred to as a "coupling condenser" when applied to a circuit such as A in Fig. 23, or a "by-pass condenser" when applied such as C-1 in the circuit C of Fig. 23.

Well, let me know how this went over. Any points you wish cleared up? I'll take up vacuum tubes in my next letter, and after that we'll get around to complete circuits. We're getting places—or aren't we?

Gerald

Your Aerial and Receiver

IT is as good an idea for the farmer to make hay while the sun shines as it is for the squirrels to store nuts while the gathering is good. And, it is also a good idea for the dyed-in-the-wool radio listener to whip his receiving equipment into shape before the real DX commences to break through from the four corners of the earth.

Whip the receiving equipment into shape? Possibly that's a new idea to some listeners, but there's nothing foolish about it. An aerial system can drop its efficiency as rapidly as can an auto storage battery left to its own devices, and a receiver can commence misfiring as readily as an auto engine if it isn't given the once-over occasionally.

In other words, you can't expect an aerial or a receiver to continue functioning perfectly unless you give them a bit of attention. Neither the aerial nor the receiver are foolproof, and you're mistaken if you think they are.



SOME OF OUR European short-wave transmitters, with a half dozen or so channels, have the annoying habit of dropping a transmission in the middle of a program, and without warning. They shift frequency with no more formality than breaking a treaty.

"THE VALVE OF VALVES"

Sun-Through-The-Clouds

Dear Gerald:

You're getting a joint letter this time because our "reactions are in resonance." Hi! Barb and I think your last letter was a revelation. It certainly clinched a lot of points that were worrying us—so now the sun is shining through the clouds.

The valve idea certainly covers a lot of territory, and it seems to us now that once a person gets it into his head that coils, condensers and chokes have critical acceptance or non-acceptance points of frequency where they go into action, that half of the story is told. I don't see that it's even necessary to know all about reactance, impedance, etc., if you think of the electrical currents as water and the radio parts as valves in the pipe line (circuit to you). If you see things that way, then all you have to remember is what values of capacity and what-not are needed to pass or block a current. It's all very simple!

Remember 'way back when the code had us loco? Now we think nothing of it. That's one worry behind us. Now we've put a couple more bad spells behind us and await with interest and confidence the dope on complete circuits. Make it soon.

Barb and Ernest.

Valves That Are Valves

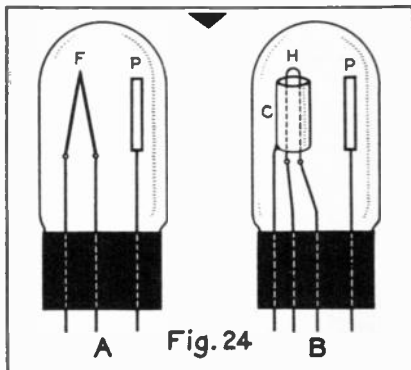
Dear Barb and Ernest:

Swell. In a few more months I'll be expecting you to tell *me* things. I've always wanted the real low-down on what an electrical current is. It's supposed to be electrons in motion, and that's probably the case, but there is still a great deal to be learned about these fundamentals.

And speaking of electrons in motion brings us to the valve of valves—the vacuum tube. The operation of this device is also based on electron motion or flow, but the flow in this case is through *space*—not through a wire. The electrons, which are negatively-charged particles, are made to fly through a vacuum from one conducting element to another and thereby connect an otherwise open circuit. In this manner an electrical current is made to flow through space.

The simplest type of vacuum tube is shown at A in Fig. 24. It consists of a filament, F, and a metal plate, P, enclosed in an evacuated glass or metal envelope. Since there are but two electrodes, the tube is known as a *diode*.

If current from a battery is passed through the filament, intense local heat is developed in the filament wire. This heat increases the motion or vibration of the electrons in the filament wire to such a degree that electrons break away from their mother atoms and fly off into space, in much the same manner that steam is liberated from boiling water. This is known as *electronic emission*.



Simplest type of vacuum tube: A, battery type; B, a-c type. These are diodes.

In many types of modern vacuum tubes the filament is not relied upon to supply the electronic emission. Instead, the filament is merely employed to heat a separate element, called the *cathode*, which in turn provides the electronic emission. The filament, in this case, is often referred to as the *heater* since heating the cathode is its only function. This arrangement is shown at B in Fig. 24, where C is the cathode, H the heater and P the plate. Though this tube actually employs an additional element, it is also referred to as a diode since the filament is put to the sole job of heating the cathode and is no longer an actual part of the electronic circuit. Since the cathode is the emitter of electrons, we can disregard the heater for the time being as it plays no other role in the functioning of the vacuum tube apart from heating the cathode.

Space Charge

Therefore in A of Fig. 25 we have shown only the cathode, C, and the plate, P. Since the cathode is heated, electrons are liberated. Though a few of these electrons may reach plate, P, the majority of them remain close to the cathode, as shown. This cloud of electrons is known as the *space charge*, and it is important to know why such a cloud exists when it would seem more probable that each electron would continue its journey through the evacuated area within the tube envelope.

To begin with, it should be remembered that each and every electron is a negative charge of electricity; no positive electrons (protons) escape from the

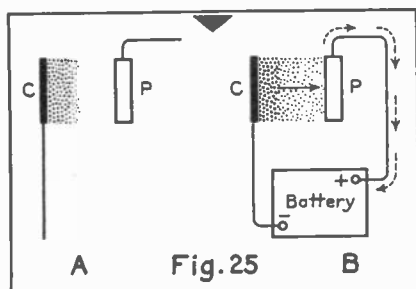
cathode. In all instances, therefore, we are dealing with electrical charges of negative value. Now it so happens that electrical charges of the same character *repel* each other, whereas electrical charges of unlike or opposite character *attract* each other. The only two characters electrical charges can have are *positive* (plus) and *negative* (minus). Therefore, since all electrons are negative, they tend to *repel* each other.

Now let us return to A of Fig. 25; electrons liberated from the cathode travel off into space but with decreasing velocity. They therefore form a negatively-charged area around the cathode that tends to *repel* the outward transit of additional electrons. If the negatively-charged area, or *space charge*, is sufficiently intense, it will force electrons back into the cathode. Under such a condition few if any electrons are able to break through the barrier and reach the plate; instead, they are turned back and either return to the cathode or become a part of the space charge.

But remember that unlike signs (minus and plus) *attract* each other. Therefore, if a positive voltage is impressed on the plate, P, of the tube, by connecting the plate to the positive terminal of a battery or some other source of positive voltage, the plate itself will *attract* the electrons emitted by the cathode. This is shown at B in Fig. 25, where the electrons are seen to be flowing from cathode to plate. This electronic flow constitutes an actual electric current in the space between cathode and plate, almost as if the cathode and plate were connected together by a wire. The current thus developed flows from the cathode to the plate and back to the battery through the plate connection, as shown by the arrows.

"One-Way" Tube

It is obvious that under no conditions can the current flow from the plate to the cathode—in other words, the tube is a one-way proposition or uni-directional. Increasing the positive voltage will, of course, increase the flow of electrons from cathode to plate, and therefore increase the current flow in the plate circuit, but if the plate is made *negative* in-



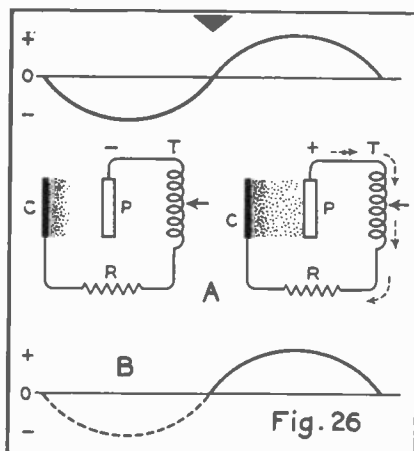
Electrons from the cathode are drawn to the plate when the latter is given a positive potential.

stead of positive it will *repel* the electrons and no current will flow. The diode therefore functions as an electrical valve that will permit current flow in one direction but not in the other.

It is this characteristic of the diode that provides a means of converting or "rectifying" an alternating current into a direct current. The diode is therefore useful as a signal rectifier or "detector" in a radio receiver, and as a power rectifier in the unit employed to change the a.c. house current into a direct current for the operation of a receiver or transmitter.

The rectifying or detection properties of a diode will be better appreciated by reference to the sketches shown in Fig. 26. Here we show two diode circuits that are identical except as to operating conditions. The tube in each case is represented by the cathode, C, and the plate, P. The plate circuit contains the secondary winding of a radio-frequency transformer, T, and a resistor, R. The latter component completes the circuit back to the cathode of the tube. Above these two circuits, and in the proper relation to them, is shown a graphic representation of one complete cycle of a radio signal. The straight line indicates zero voltage while the curved lines represent the excursions of the signal voltage into the negative and positive regions—in other words, a negative and a positive alternation.

Assume this signal voltage to be impressed upon or developed in the secondary coil, T, of the radio-frequency transformer, as indicated by the arrow. During the negative half of the cycle, the plate, P, of the diode is negative, as indicated in the left diagram, and as a result the plate repels the electron flow from the cathode and no current flows. However, during the positive half of the cycle, as indicated in the right diagram, the plate is positive and therefore attracts the electrons from the cathode. The result is that current flows in the plate circuit, as shown by the small arrows. This current flows through the winding, T, and the resistor, R, back to the cathode. If a pair of headphones were connected across the resistor, the signal could be heard.



Illustrating the one-way action of a simple diode rectifier tube.

A graphic representation of what actually takes place is shown at B in Fig. 26. This is also related to the diagrams, and indicates that during the negative half of the cycle no current flows in the output circuit of the diode but that current does flow during the positive half of the signal cycle. It is clear from this that the negative half of the cycle is eliminated or lopped off by the uni-directional behavior of the diode. The resultant signal is therefore composed of a series of "humps" or pulsating uni-directional currents separated from one another by the time durations of the negative halves of the cycles. Since only half of each cycle of the signal is utilized (the negative halves being "killed off") the simple diode is known as a "half-wave rectifier."

Full-Wave Rectifier

If a second plate is added to the diode, full-wave rectification may be obtained, as shown in Fig. 27. In this case we have shown the tube connected to a power transformer, T, the primary of which we will assume to be connected to a 110-volt line. The secondary winding has a center tap. The disposition of the voltage developed in this winding will be such that the center tap will be at zero voltage with respect to terminals 1 and 2, and during the period terminal 1 is positive, terminal 2 will be negative. Therefore plate P1 will draw current

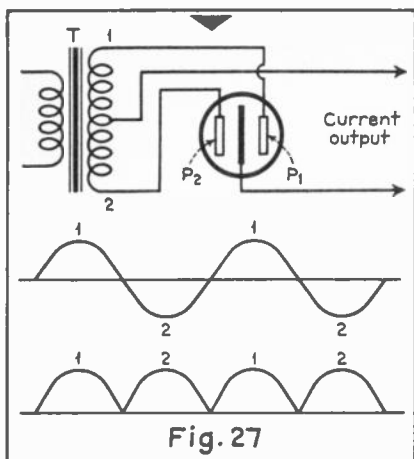


Fig. 27
Illustrating the action of a full-wave rectifier tube.

while plate P₂ is idle, and vice versa. In this manner both the positive and negative halves of the cycles are utilized and the resultant output current is a series of unidirectional pulses with no spacing between them, as shown below the alternating current graph. In other words the negative halves (2) have been made to assume the same direction as the positive halves (1).

Though half-wave and full-wave diodes make excellent rectifiers and detectors, they cannot be employed as amplifiers. This brings us to the three-element vacuum tube, or *triode*, which can be used as an amplifying detector in a radio receiver or as an amplifier of radio or audio-frequency voltages.

The Triode Tube

The elements of the triode are shown in the simple diagram at A of Fig. 28. There is the heater, H, the cathode, C, and the plate, P, just as they are in the diode. The third element, G, is a mesh-like structure of fine wire interposed between the cathode and the plate. It is called the *grid* or, in tubes having more than one type of grid, the *control grid*.

As in the case of the diode, there is the cloud of electrons in the vicinity of the cathode. Forgetting the grid for the moment—we know that this space charge can be at least partially dissipated by placing a positive voltage on the plate of

the tube, and furthermore that the greater the value of the positive plate voltage the more electrons the plate can draw from the cathode. However, a point is finally reached where a further increase in plate voltage does not bring about an increase in electron flow. This is called the *saturation point* of the tube.

Now, for the sake of the example, let us assume that the voltage on the plate of the tube shown in the circuit at A in Fig. 28 is of such a value that the greatest possible number of electrons are being drawn from the cathode. In the circuit under discussion the heater obtains its energy from a battery marked "A." The filament or heater supply is always referred to as the "A" power. The voltage of this supply is much too low for the plate, so an additional battery or other source of power is provided for the plate. This is known as the "B" battery or "B" power supply, and its voltage may be anything from 180 to 250 or 300 volts, depending upon the type of tube and the conditions under which it operates.

Function of Grid

Under these conditions there is maximum electron flow from cathode to plate. Now consider the grid, G. It is of open structure and therefore the electrons pass freely through it. But suppose we place a *negative* voltage on this grid. We know that like signs repel each other, and it is therefore evident that the grid is going to repel the electrons and thereby prevent them from reaching the plate. The grid is therefore much like an electrical control valve. If the negative grid voltage is made high enough a point is reached where the flow of electrons to the plate ceases altogether. The negative grid voltage at which plate current cut-off is reached is known as the *cut-off bias*.

Now suppose that instead of placing a negative voltage on the grid of the triode we gave it a positive voltage, as shown at B in Fig. 28. This looks like a good scheme, as in this instance the grid *attracts* the electrons and thereby increases their speed toward the plate. Moreover, the positive grid tends to dissipate the space charge around the cath-

ode. It appears, therefore, that a positive potential on the grid would be a good thing—but it isn't, except in certain forms of power amplifications that you will learn more about later.

When the grid is positive a number of things happen. In the first place the grid begins to function like a plate with the result that not only is there a flow of plate current but also a flow of grid current. This condition, which you will appreciate more thoroughly as you learn more regarding load conditions and vacuum-tube characteristic curves, will introduce losses into the grid circuit, affect selectivity and sensitivity in a receiver, and cause a form of frequency distortion in both r.f. and a.f. amplifiers. A positive grid will also intensify a condition known as *secondary emission*, which amounts to the bouncing off of high-velocity electrons from the surface of the plate. These electrons tend to reduce the number of cathode electrons reaching the plate, and therefore decrease the amplifying properties of the tube. In most cases, secondary emission is an undesirable condition; it is sought only in special types of tubes not ordinarily employed in radio work.

It may be assumed, then, that the grid of a triode should always be maintained at a negative voltage. This will be understood more readily by reference to the circuit of Fig. 29, illustrating the essentials of a radio-frequency signal amplifier.

Amplifier Action

The first point that should be clearly understood is that the vacuum tube is a *voltage-operated* device; that is, the action of the tube is controlled by the degree of voltage impressed on the plate in the case of a diode, or on the grid in the case of a triode or other more complex types of tubes. The second point that should be clear is that in the case of the diode the plate voltage is the signal voltage itself and therefore there can be no amplification of the signal. But in the case of the triode the plate voltage is obtained from a separate source and this is, to all intents and purposes, "triggered off" by the signal voltage impressed on the grid. The signal output

in the plate circuit is therefore an amplified version of the signal input in the grid circuit. Or, to put the matter in another way, the diode is controlled by the signal voltage whereas the triode is controlled by the grid upon which the signal voltage is impressed.

Now, we wish to maintain the grid at a constant negative potential. This we do by adding to the circuit a "C" battery, with its negative terminal connected to the grid through the coil L. We will assume that the value is 4 volts. This is sufficient to reduce considerably the flow of electrons from cathode to plate, but is not sufficient to produce plate-current cut-off.

We have indicated an incoming signal, S, directly above the coil, L. It is to be assumed that this is the voltage being induced into the coil from a primary winding, as indicated by the arrow. Two complete cycles of the signal are indicated, and they are marked accordingly. We will say that the highest potential attained at the peaks of these cycles is 3 volts, or 1 volt less than the grid bias.

Grid Voltage Variation

Now let's see what happens. As the first cycle of the signal starts its excursion from zero voltage to a positive peak value, the negative bias on the grid will alter from 4 volts to a minimum of 1 volt, as the positive signal voltage will tend to cancel the negative bias voltage by simple subtraction. Then, as the signal starts into a negative excursion, the grid voltage will rise in negative

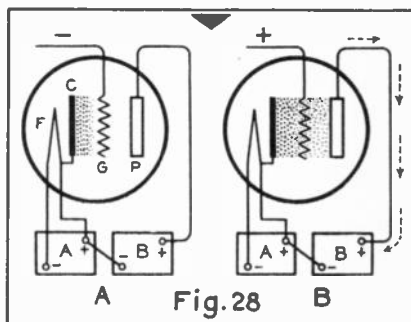
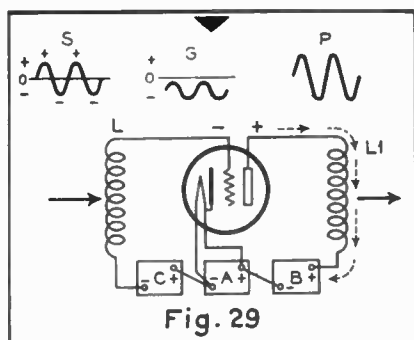


Fig. 28
Illustrating the action of a grid in a three-element vacuum tube.



The functioning of a triode, illustrating how it amplifies a signal.

value and reach a peak of 7 volts, in this case the negative signal and bias voltages being additive.

The result is a variation in grid voltage in conformance with the signal, as indicated by the graph, G, shown directly above the grid. It will be noted from this graph that, though the voltage of the grid varies over fairly wide limits, it never extends over the zero-voltage line into the positive region. Therefore the grid is never driven positive by the signal and in consequence there is no flow of grid current at any time. If the signal had a peak of 5 volts, however, the grid would go 1 volt positive during positive excursions of the signal voltage.

In the meantime the variation in negative grid voltage for each signal cycle has produced a corresponding variation in the flow of electrons from cathode to plate, and therefore a large variation in plate current, as indicated by the graph, P, directly above the plate. So long as proper plate and grid voltages are em-

ployed, the variation in plate current will be a magnified or amplified replica of the original voltage. In any event, the plate current so triggered off flows through the primary coil, L-1, in the plate circuit and returns to the cathode via the "B" battery. This flow of current through L-1 develops magnetic lines of force which in turn induce a voltage in a secondary coil (not shown) connected to the grid of another tube where further amplification takes place in the same manner.

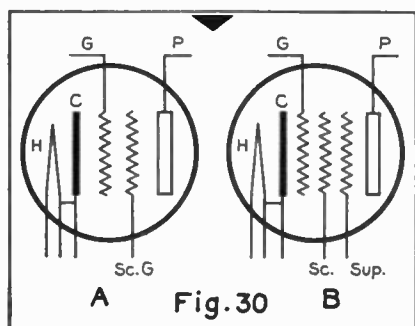
The functioning of a triode in an audio-frequency amplifier is exactly the same, the only difference being the value of the circuit components and the character of the voltage.

The Tetrode

The *amplification factor* of a vacuum tube is dependent upon the control the various elements have over the flow of electrons. Some tubes have an amplification factor of only 6 whereas others have values well over 100. One means of increasing this factor is to dissipate as much as possible the space charge around the cathode. We have shown that this can be accomplished by running the control grid positive, but not without undesirable effects. But it can be accomplished in a desirable way by adding a second grid to the tube, placed between the control grid and the plate as shown at A in Fig. 30. This is known as the *screen grid* and the tube as a *tetrode*.

This second grid has two functions. First, it is placed at a comparatively high positive potential in order to accelerate the flow of electrons from cathode to plate. Second, it acts as a screen between the plate and control grid so that energy from the plate cannot be fed back to the grid by virtue of the capacity existing between these two elements. This permits the tube to be operated at high amplification levels without developing regeneration or oscillation.

Of course, the screen grid draws current, but this is not objectionable since the screen is not a part of the signal circuit. However, it is necessary to maintain the screen voltage at a value



The elements used in, A, a tetrode, and B, a pentode.

that is always lower than the minimum plate voltage; otherwise the screen, being more positive than the plate, will draw the secondary-emission electrons from the plate. This introduces the odd condition of current flowing in the wrong direction and, of course, a decided increase in screen current at the expense of the plate. The result is serious distortion, loss of power and possible oscillation.

The Pentode

This effect has been overcome by the addition of a third grid between the screen and the plate, as shown at B in Fig. 30. This is known as the *suppressor grid* and the tube as a *pentode*.

Most of our present-day voltage amplifiers are of this type.

The purpose of this third grid is to suppress the flow of secondary electrons from plate to screen and turn them back into the plate. By this means the amplification factor of the pentode can be many times that of the triode and tetrode without encountering the operating difficulties previously referred to,

Well, that ought to hold you for the present. In my next letter I'll take up the various types of vacuum tubes and the uses to which they are put. After that we'll get right down to actual circuits—which is what you want.

Gerald

Ham Notes from Zeh Bouck's Column

ONE of the BCL's standing complaints against amateurdom is the content of most ham fone QSOs. It wouldn't be so bad, they complain to the R. I., if they'd only talk sense. "You can't tell me the government has any right to license a person to talk such nonsensical dither!" They are referring, of course to the ham's vernacular, and to his pet topics of conversation—tri-tets, Johnson Qs, buffer-doublers and what haven't we. Personally, we'd like to make a recording of a few BCLs doing a post mortem over a recently defunct bridge hand, and let them listen to that in their more sober moments. It is the most natural thing in the world for two amateurs to discuss their hobby when they get together—just as a couple of chess players might argue the Muzio gambit versus the queen's pawn opening, or two philatelists get hot and bothered about a Pom-bal Commemorative Issue.

Nevertheless, we must admit a certain monotony in the subject matter of radiofone conversations, and we list below sundry topics of conversation which might be employed after the merits of the respective rigs have been thoroughly aired and duly reported upon. (1) The pro and con of garnishing an old fashioned cocktail with fruit. (2)

The nine old men. (3) Montesquieu's theories on political liberty. (4) The love of the tree toad. (5) The Songs of Solomon. (6) Warped hyperbolic space. (7) Genesis 38.9. Or simply take a tip from Lewis Carroll—

"The time has come," the walrus said,
"to talk of many things.

Of ships and shoes and sealing-wax, of
cabbages and kings."

♦

THERE IS, HOWEVER, one subject that should be definitely taboo in amateur conversations over the air—namely, the questions asked in amateur radio license examinations. And yet every day or so you will hear some Class A opr (who of all persons should know better), recently advanced from Class B, spilling to the ether—and *perhaps to the listening ears of a half dozen FCC monitors*—the exam questions put to him. This is a violation of stipulation 412 of the Rules and Regulations concerning "copying or divulging questions used in examinations," and may cost the violator his newly acquired honors plus five hundred bucks for each day of violation. (If you must violate, concentrate it all in one day—as many times as you wish—for it will only cost you half a grand.)

Frequency Conversion Chart

Frequency in Kilocycles

1000 10,000 100,000 1,000,000

900 9,000 90,000 900,000

800 8,000 80,000 800,000

700 7,000 70,000 700,000

600 6,000 60,000 600,000

500 5,000 50,000 500,000

400 4,000 40,000 400,000

300 3,000 30,000 300,000

200 2,000 20,000 200,000

100 1,000 10,000 100,000

$$\lambda = \frac{300,000}{f}$$

λ in Meters
 f in Kilocycles

100 1,000 10,000 100,000

Scale A

Scale B

Scale C

Scale D

.3 .6 .8 1.0 1.2 1.4 1.6 1.8 2.0 2.2 2.4 2.6 2.8 3.0
6 8 10 12 14 16 18 20 22 24 26 28 30
60 80 100 120 140 160 180 200 220 240 260 280 300
600 800 1000 1200 1400 1600 1800 2000 2200 2400 2600 2800 3000

Wavelength in Meters

THEY CRAM

FOR EXAM

The Time Draws Near

Dear Gerald:

It was nice having lunch with you last week. From what you said, I take it that you intend concluding the preliminary instruction next month, and that from then on we will be more or less on our own until we get a "ticket." Well, that's okay with us, and unless you change your mind and decide to carry the instruction a bit further, we'll figure on taking the examination in February.

In the meantime we are going to go in for intensive study of the questions and answers in the License Manual and back this up with dope from the Amateur Handbooks in instances where the questions and answers themselves are not clear to us. As for the code, we will merely continue our practice to keep us in form. We have reached "a good fifteen" and feel that if we hold this we should have no difficulty with the sending and receiving tests.

So, it won't be long now (we hope). Both of us are looking forward to getting on the air, and since our success (?) with the code has left us with an interest in c.w., we like your suggestion that we plan using the 10-, 20- and 40-meter bands, with phone on 10 meters. We understand that "ten" is good only at times, but it should satisfy our "phone inclinations" until such time as we may be able to get Class A licenses.

For all of our confidence, we would like a bit of coaching before we take the exam. Will you go over the questions and answers with us to see where we stand? A final check-up on your part would help a lot.

Barb and Ernest

Station Plans

Dear Barb and Ernest:

I agree with you that we should get together and go over the questions and answers prior to the examination. Suppose we plan on doing this shortly after you have had the opportunity of digesting my next, and possibly last, letter. I can determine then whether you have progressed far enough in your supplementary studies of the License Manual and the Handbooks to take the examination. If not, I will plan to continue these letters until I am confident that you are fully prepared.

On the other hand, if you have the questions and answers down pat, I will commence the preparation of a series of letters dealing with transmitting and receiving equipment. This data will form the basis of the design of your own station. The "plans" will be handled in much the same way an architect deals with the plans of a house—your requirements will be studied and the plans made accordingly. Barb and yourself will be the "prospective builders" and I will be the "architect." It will be up to you to advise me of the general requirements of the equipment—such as, where it is to be used, the space that can be allotted to it, the frequency bands in which you wish to work, etc. When these requirements are known, I will make recommendations, and in doing so, point out the advantages and limitations of various points of design. I believe that you will be able to pick up a great deal of practical knowledge in this way, to say nothing of a clear understanding of the basis of transmitter and receiver design.

But, we'll get around to the fine points of this idea when the time arrives. For the present we have more to say with

regard to the application of vacuum tubes—so let's get on with it.

Tube Services

In my last letter I dealt with the basic operation of the vacuum tube and illustrated the differences between such types as the diode, the triode, the tetrode and the pentode. There are definite uses for each type in both receivers and transmitters, and such tubes as the triode and the pentode in particular may be employed in a number of different ways. In some instances a given tube type may be made to perform an entirely different service by merely changing the values of the voltages applied to it.

The requirements of each section or stage of a radio receiver or transmitter are not identical. Each stage has a certain service to perform and must be designed accordingly. In a receiver, for instance, the input or first stages must be so designed that they will be sensitive to the very weak signal impulses picked up by the antenna. It is necessary, therefore, that the tubes in these circuits have a high amplification factor so that the minute signal voltages may be built up in strength as they pass from one circuit or stage to the next. For this reason it is customary to employ pentode tubes in these circuits as the pentode has a much greater amplifying factor than a triode or tetrode. This was explained in my last letter.

After the radio-frequency signal voltages have been brought up to a satisfactory level to actuate a detector tube, they are rectified, as explained in my last letter. This process consists of separating the audible component of the signal from the radio-frequency carrier and is often referred to as *demodulation*. The diode tube is used for this purpose in modern receivers.

The resultant audio-frequency voltage in the output of the detector is still too weak to actuate a loudspeaker, although it might actuate a pair of headphones satisfactorily. It is therefore necessary to build up these audible voltages in much the same way that the radio-frequency voltages were built up in the first stages of the receiver. This is done by

passing the signal through an audio-frequency amplifier stage, and the tube used in this stage may be a triode or a pentode, depending upon how much gain or amplification is needed to actuate the output tube.

Voltage and Power Amplification

Up to this point in a receiver, all tubes dealing directly with the signal—with the exception of the diode detector—are *voltage amplifiers*. They are not called upon to develop power for the simple reason that the vacuum tube itself is a voltage-operated device. It is sufficient, therefore, that each of these tubes, including the audio-frequency amplifier, merely increase the signal voltage level so that the amplification will be progressively greater in each succeeding stage. In this manner a signal at the input or antenna circuit of the receiver having, say, a value of one-millionth of a volt is progressively built up so that its value may be in the neighborhood of 20 volts at the output of the audio amplifier tube.

But it takes power to actuate a loudspeaker, and power is not developed unless there is appreciable current flow. You are aware of the fact that a 25-watt light bulb will not produce as much light as a 100-watt bulb, yet both operate at the same voltage. The difference is that the 100-watt bulb draws more current. The watt is the unit of measure of electrical power and is equal to the voltage multiplied by the value of current in amperes. Thus, if the voltage is 100 and the current is one ampere, the power in watts is 100.

In a receiver, therefore, it is necessary to convert the signal voltage into actual power in order that it may actuate the loudspeaker. The function of the output tube is therefore that of a *power amplifier* rather than a voltage amplifier, and since the signal voltage has already been stepped up appreciably, it is not necessary that the output or power tube have a high amplification factor. It may therefore be a triode of huskier proportions than the triode voltage amplifier, and capable of delivering from 2 to 10 or more watts to the loudspeaker. Or it may be a power pentode, in which

case less signal voltage will be required to "drive" it and in consequence the number of voltage amplifier tubes may be reduced.

Transmitter Tubes

In a transmitter, a small amount of radio-frequency power is built up by stages and eventually fed into the antenna. No so-called voltage amplifiers are used in the transmitter proper as a sizeable amount of power is generated to begin with. The tubes are therefore of the power type, each succeeding tube being of a type capable of handling a greater amount of power than the preceding one. The output tube is usually referred to as the *final amplifier* and it is this tube that feeds the radio-frequency power into the antenna where it is radiated into space.

If a transmitter is designed for code transmission only, no audio-frequency voltage- or power-amplifier tubes are used—and, of course, there is no detector tube in any case. The first tube in a typical transmitter of this type is the *oscillator*. It is this tube that generates the radio-frequency current, the frequency of which is determined by the values of the coil and condenser in the circuit.

If the transmitter is designed to operate on a single frequency only, the second tube in the line-up is a radio-frequency power amplifier or *buffer*. The circuits related to this tube are tuned to the same frequency as that of the oscillator. The third and last tube is the final amplifier. The circuits related to this tube are also tuned to the same frequency as that of the oscillator. The final amplifier tube is of a type capable of developing high power and is usually larger than the audio power amplifier tubes used in radio receivers.

In transmitters designed to operate in more than one frequency band, and where the frequency of the oscillator remains fixed, the second tube is often made to function as a *frequency doubler*. In this instance the output circuit of the doubler tube is tuned to twice the frequency of the oscillator and the tube itself so biased that it develops a strong second harmonic of the fundamental

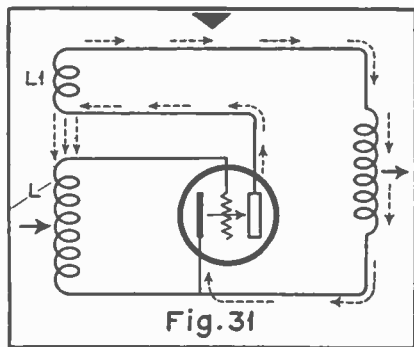


Fig. 31

Illustrating regenerative or feedback action in vacuum-tube circuit.

oscillator frequency. If, for instance, the oscillator tube generates a frequency of 7000 kilocycles (40-meter band) the doubler tube will produce a frequency just twice that amount, or 14,000 kilocycles (20-meter band). If the circuits of the final amplifier are then tuned to 14,000 kilocycles, the radiated signal will be in the 20-meter band.

The above is purposely sketchy as it is intended only to point out the purposes to which the tubes may be put. These points will be covered in detail in my next letter. In the meantime it may also be pointed out that final amplifier tubes may be so operated that their power output for given voltage values is proportionately higher than the outputs obtainable from the power amplifier tubes used in receivers. This is due to the fact that we can tolerate certain forms of distortion developed in amplifiers of radio-frequency power that cannot be tolerated in audio-frequency amplifiers. When so operated the tubes reach high values of plate current not permissible in audio power tubes.

Generally speaking, there is little difference between a code transmitter and a phone transmitter. In the former the radio-frequency section alone is used, and the power interrupted by a key at some point in the circuit to form dots and dashes. In the latter an audio-frequency amplifier with large power output is added to the radio-frequency section so that the r.f. in the final amplifier stage may be voice-modulated.

This audio amplifier is no different in operation than the audio amplifier in a

receiver. The voice impulses from the microphone are amplified and eventually used to mould or modulate the radio-frequency carrier. In this case, however, the audio power amplifier tubes are referred to as *modulators*.

Regeneration

Regeneration is a very important function even though it is not used as extensively today as it was in the earlier days of radio.

Any type of grid-controlled tube can be made to regenerate by coupling the plate circuit to the grid circuit by inductive or capacitive means. In this case the amplified radio frequency in the plate circuit can be fed back into the grid circuit and *re-amplified*. The tube is therefore made highly sensitive to weak signals as the regenerative action provides a progressive build-up in signal voltage.

A typical inductively-coupled regenerative circuit is shown in Fig. 31. Its action is almost self-explanatory; the signal induced in coil *L* reaches the grid of the tube and is amplified in the usual manner. The amplified signal in the plate circuit is made to flow through an additional coil, *L-1* (known as the "tickler"), which is inductively coupled to the grid coil *L*. The current flowing through *L-1* therefore induces a larger voltage in *L* than the original and this voltage is again amplified. The amount of regeneration or amplification that can take place is limited by the inherent operating conditions of the tube. If the degree of voltage fed back from the plate to the grid is too large, the tube will break

into oscillation and act as a generator of radio-frequency currents, the frequency of which will depend on the circuit constants. Thus the regenerative circuit may be converted into a generator of radio-frequency power by increasing the feedback to the point where the tube oscillates.

The Oscillator

However, if a tube is to function solely as an oscillator, there are other more appropriate circuits, one of which is shown in Fig. 32. This is "stripped down" for the sake of simplicity. The coil *L* forms the plate and grid inductance, the portion below the cathode tap being in the grid circuit and the portion above the tap being in the plate circuit. The entire coil is tuned to the desired oscillating frequency by means of the variable condenser connected across it.

Such a circuit is self-starting, for any small voltage on the grid will set up a correspondingly larger voltage in the plate circuit. This voltage is in turn fed back to the grid and re-amplified so that almost instantaneously the voltage has become so large that oscillatory currents are developed in coil *L*. This is brought about by the charging and discharging of the variable condenser through the coil which sets up an alternating current. The voltage developed across the coil alternates from positive to negative values and the grid is therefore alternately positive and negative. When it is negative little or no plate current flows, but when it is positive the plate current reaches comparatively high values. In effect, then, the oscillating circuit composed of the coil and the variable condenser provides the grid stimulus and in turn receives its power from the plate. The action is therefore continually repeated and the frequency of the oscillation is dependent upon the resonant frequency of the coil-condenser combination. If the setting of the variable condenser is changed the frequency of the radio-frequency current generated by the tube will also change. The action, as you will perceive, is similar to that of a pendulum-type clock.

The circuit shown in Fig. 32 is known as the shunt-feed type, because the power

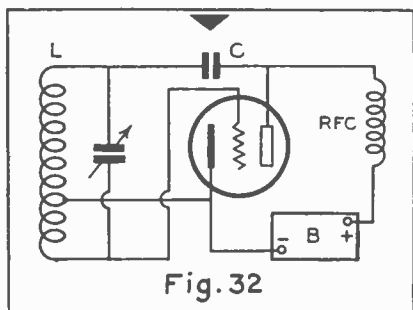


Fig. 32

Typical vacuum-tube oscillating circuit—the heart of modern radio.

from the battery B, is fed to the plate of the tube in shunt or parallel to the oscillating circuit. There are, as a matter of fact, two distinct circuits effectively isolated from each other. The condenser, C, feeds back the radio-frequency currents from the plate to the grid circuit, both of which are common to coil, L, but effectively blocks the high d.c. plate voltage from reaching the grid. On the other hand, the choke, RFC, prevents the oscillating currents from flowing through the d.c. circuit but does not retard the flow of d.c. plate current.

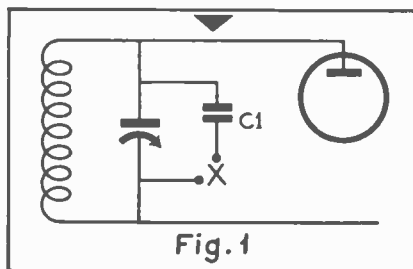
It is this general type of circuit that is used in a transmitter to generate radio-frequency power. Under proper conditions a large tube of the "final amplifier" type can be used in such a circuit and coupled directly to the antenna. However, there are objections to this method—one of them being instability—and it is therefore the practice to use a tube having a lower power rating as the oscillator and to build up the radio-frequency power by degrees through the medium of separate amplifiers.

I have purposely refrained from discussing the various classes of power-amplifier operation as these will fall naturally into the general design considerations which I shall cover in my next letter. At that time I shall also deal with representative receiver and transmitter circuits so that you can get the hang of them. Until then—cheerio.

Gerald

HAVE WE GOT a handful of razzberries for these "professional type" Hams who use Bugs! Easily 95 per cent of them sound like V wheels gone completely berserk. For tittle-wittles and tweet-tweets, they take the cake. They've got a code all their own in which "s" is four dots, "h" is five dots, and a letter like "T" is whatever they make it. When it comes to "ch", either they leave it out or show a bit of originality by resorting to the four dashes used by the square heads.

If you fellows can't pound straight brass, who not use side-swipers?



Simple circuit for chirp and click elimination.
Dope in text.

Eliminating Key Chirps

KEYING HAS LONG been the bug-a-boo of the Ham troubled with key-clicks and chirping. Various cures have been advanced for the evil and some have been highly successful, but none more so than the one shown in Fig. 1. It is applicable to rigs using receiving tubes in the first buffer stage.

Here "X" is a relay in series with a 1000-mmfd fixed condenser. The relay should be of the back-contact variety in which the contacts are normally closed. When the key is pressed the contacts open, taking C-1 out of the circuit. When the key is open the relay contacts are closed; C-1 adds so much capacity to the system that the buffer tank circuit is detuned cutting the r-f excitation to the final, which must be biased to cut-off or beyond.

Such a system is chirpless, without a backwave, and affords a splendid method of break-in operation. It is, however, subject to one disadvantage—the plate current on the tube keyed will rise to values which may be abnormal when the tank is detuned if the excitation from the oscillator is large. So long as this "detuned" plate current is not much greater than the rated plate current for the tube no damage will be done to receiving type tubes.

THERE IS certainly no doubt that the eyes have it. No sooner does RCA come out with Magic Eye receivers than our own Uncle Sam inscribes a similar optic on the reverse side of the new dollar bill.

Boy-oh-boy-oh-boy . . . some pull!

Amateur Operating

BY DOROTHY HAGERTY • W6JMH

EVERY person interested in short-wave radio must be aware of the constant advancement in all branches of the art: In transmitting and receiving equipment, diathermy, television; in aircraft, marine and police activities, as well as the vast army of Amateurs. Because of their efforts and interest, all this other activity has been made possible. Amateurs are progressing rapidly, both in number and achievement.

Any of you who are active in one or more of the Amateur bands are aware of the congested conditions. There are about 50,000 licensed Amateurs at the present time. With all this existing equipment and more being added each day, the bands are pretty well saturated with short waves. And it seems to me that the Amateurs are not making as much progress in operating methods as they might.

Sociality

The manufacturers are continually turning out new tubes and parts and many of the Amateurs will work and scheme to modernize their equipment, but seem to forget all about keeping up-to-date in operating methods. Yet it is a matter of good sportsmanship and consideration for the other fellow that ought to promote better technique, rather than the former. By that I mean better quality, fewer superfluous CQ's, better keying on c.w. as well as better modulated 'phone and more intelligent conversation.

This no doubt sounds strange coming from a feminine member of the clan, but as I have been active in radio, Amateur and otherwise for some time, I have had opportunities for many observations. I am not criticizing, but merely trying to point out the absurdity of unintelligent operating.

Lawlessness

Five meters is the worst offender, with radiating receivers, poor quality, ridiculous conversations and the greater evil—illegal operation.

The illegal operator is a definite menace with not only unlawful authorization but failure to abide by regulations as well, in many cases. It should be noted that the Amended Radio Act of 1927 is severe in its fines and punishment.

I have no patience with the person who is operating unlawfully, for if a member of the "weaker sex" such as myself, with a limited knowledge of fundamentals and not an especially brilliant mind, can obtain a license with something more than a passing grade, there is not much excuse for the fellow who is able to put together an assortment of condensers, transformers and tubes—make it work and then neglect to obtain a license.

I have known of several cases of illicit operation. Some with excellent technical ability claimed they could not master the code—others pleaded lack of sufficient understanding and interest—but I can assure you that in most every case, their reluctance was due to lack of ambition and I should say—downright laziness.

Ten meters seems to be a pretty good band with a minimum of poor operation, though it takes real skill to complete a QSO when conditions are unfavorable.

Twenty-meter phone and twenty-meter c.w. in my opinion, provides the highest standard of operation and equipment. Of course the many high power stations on this band do not serve to minimize the QRM. High power is not essential. And it has been my experience that better DX results can be obtained with low power and efficient operating, with perhaps a good directional antenna, rather than a "California kilowatt."

Second Series

Gets Under Way

Recapitulation

Dear Gerald:

So you're going to explain circuits at last. Barb and myself have been yelling "wolf" for so long that we figured you'd commenced to ignore our yelps for help in understanding the surrealist drawings you radio experts call "schematic diagrams." They're schematic all right—schemes to prevent Embryo Hams from getting the hang of circuit wiring.

But maybe the joke is on you, because we have slowly accumulated a speaking acquaintance with the lines that represent coils, condensers and resistors—not to forget vacuum tubes—so our yelp is of a different breed now. We don't claim to be able to read off a complete diagram and trace every action and circuit, but we have a general idea of things. After all, boss, you've been casting diagrams in our path for a long while, so we ought to know something about 'em. I guess you've made us soak them up against our better judgment!

But our yelp is this—your letters have covered bits of information that explained lots of radio functions, but never in such a complete way that we could get the hang of what takes place in a transmitter and receiver—and in between! So, before you get all involved in your schematic diagrams, *please*, mister, give us a complete picture of radio as she is worked, and by means of simple illustrations of some sort. We can understand regeneration and oscillation and amplification and a lot of other things, but for once we'd like to see all of them sort of hooked together and working. How about it? If it will delay the examination a bit, okay. We've waited this long, so a few weeks more or less won't make a great difference.

Barb and Ernest

Restatement of Fundamentals

Dear Barb and Ernest:

Your wishes are mine, so I will attempt to summarize the points we have previously covered by means of simple block diagrams, and leave the schematics for another time.

I have resorted to the "plumbing" analogy; therefore, all you need do is visualize the electrical currents as the flow of water through pipes from one tank to another.

You are acquainted with the abbreviations used—a.c. for alternating current, d.c. for direct current, a.f. for audio frequency, r.f. for radio frequency, etc. In the sketch, a.c. is indicated by stippling, d.c. by the black areas, a.f. by lines slanting to the left, and r.f. by lines slanting to the right.

In Fig. 1 a radiophone transmitter and a receiver are shown in this block diagram form. Sound waves fed into the transmitter via the microphone are converted into electrical currents of audio frequency. These are amplified and subsequently impressed on the radio-frequency current generated in the transmitter. The combined wave is radiated into space by the aerial and eventually intercepted by the aerial connected to the receiver. In the receiver the combined r.f. and a.f. currents from the transmitter are amplified and then rectified or "detected." This process eliminates the r.f. currents and leaves only the a.f. The a.f. is then amplified to a degree sufficient to actuate a loudspeaker which in turn converts the electrical sound into mechanical sound.

That is the action in brief—sound waves are converted into electrical waves, combined with radio-frequency waves which serve only to carry the electrical

sound, the waves then radiated, and eventually turned back into mechanical sound at the receiver.

The Transmitter

The transmitter is shown in three tiers. The first tier is the power supply which provides the operating voltages for the vacuum tubes. This consists of two units. The first is the high-voltage transformer which boosts the 110 volts a.c. from the light line to a value in the neighborhood of 500 volts or more, depending upon the power of the transmitter and the type of tubes used. There is, of course, another transformer which supplies filament current for the tubes. It has been left out to simplify the diagram.

The high-voltage a.c. is then fed into the rectifier and filter unit where it is converted into a direct current and filtered to remove the ripple. The resultant d.c. is smooth flowing and uniform. This current is fed to the tubes in the various units of the transmitter, and where lower voltages are required, a voltage-dividing resistor is connected across the output of the filter and a tap made on this resistor at the point which supplies the proper potential. In the sketch the power tubes are fed with 1000 volts while the smaller tubes are run at 500 volts.

The second tier in the transmitter includes all of the audio-frequency equipment—the microphone, the speech amplifier and the modulator. When the microphone is spoken into, electrical currents are produced which correspond to the original sound waves in form. These audio-frequency currents are built up in strength by the speech amplifier which is nothing more than the common type of audio amplifier. The amplified currents are then fed to the modulator which is a power audio amplifier. The power build-up in this unit is usually large, and the a.f. output may be in the vicinity of a few hundred watts—far in excess of the power delivered from the output amplifier in a receiver. This audio power is in turn fed into the output of the r.f. unit of the transmitter which occupies the third tier.

The r.f. unit, in the simple form shown, consists of an oscillator and an r.f. power or “final” amplifier. The oscillator generates the radio-frequency currents, the

frequency of which is dependent on the oscillator tuning. These oscillations are of comparatively low power, and though they could be fed directly into the aerial and radiated, the total power of the transmitter would be governed by the power of the oscillator alone. It is customary, therefore, to build up the output of the oscillator by means of an r.f. power amplifier and feed the output of this stage into the aerial. If the oscillator is tuned to, say, 3900 kc, then the r.f. power amplifier is tuned to the same frequency. The radiated wave will therefore have a frequency of 3900 kc (in the 75-meter phone band).

The diagram shows that the a.f. from the modulator combines with the r.f. in the output of the final amplifier. This mixing of the two frequencies is indicated by the cross hatching—the a.f. superimposed on the r.f. The radiated wave is therefore a combination of r.f. and a.f.

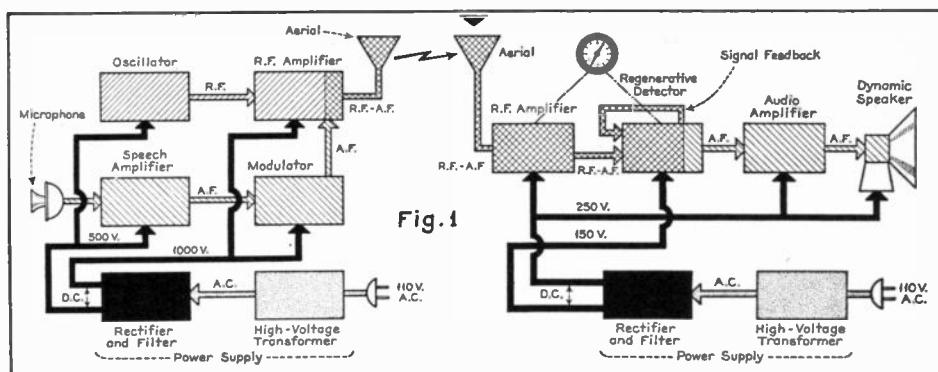
The process of superimposing the audio currents on the radio currents is known as “modulation.” The r.f. current may be considered as having a constant amplitude. When it is modulated by the audio-frequency currents its amplitude is altered in conformance with the a.f. currents. The degree of change in amplitude is dependent upon the percentage of modulation—which is another way of saying that greater audio power will make more of a dent in the r.f. current. The resultant r.f. wave assumes somewhat the same shape as the audio current variations created by the original sound waves.

The r.f. wave is the carrier for the audio frequencies in radio transmission. The combined currents are radiated into space by means of the aerial.

Radio Waves

Radio waves are rather complex, but it is not necessary that you understand all of their characteristics to pass the examination. It is enough that you know they travel through space in practically the same way sound waves travel through air and energy waves travel over the surface of a body of water.

If a stone is thrown into a pond, waves travel out in ever-widening circles. The height (amplitude) of all of these waves



"Animated" block diagram of a complete transmitter and receiver in operation.

will not be the same, the ones further away from the source of disturbance being weaker. But the distance from the crest of one wave to the crest of the next will be the same in all cases. This is the "wavelength" or, if expressed in the number of waves that pass a given point in a given time, the "frequency." The relation between the wavelength and the frequency never varies.

We usually picture radio waves as wavy lines, which is the way the cross-section of a water wave would appear. However, were we able to see radio waves, a bird's-eye view of one would be quite similar to the bird's-eye view of a water wave on a pond. It is easy to understand, then, why the signal from a radio transmitter can be intercepted at one point as readily as another. The condition changes only in the event that the transmitted signal is "beamed" as light waves are from a searchlight, or in the event that the signal leaves the earth altogether.

A transmitting antenna radiates a "ground wave" and a "sky wave." The ground wave follows the surface of the earth but dies out very rapidly. The sky wave is radiated at an angle, travels upward, and eventually strikes a layer of electrically charged particles (known as the ionosphere) above the earth from which it is reflected back, much in the same way that a mirror reflects a beam of light. There are areas of the earth,

therefore, where the signal does not strike at all, though it will appear again possibly a thousand miles or more distant from the transmitter. In other words, it "skips" certain portions of the earth entirely. The distance from the source of the sky-wave signal to the point where it again reaches the earth is known as the "skip distance." The skip distance is not constant; it varies with changes in atmospheric conditions, and is different for various frequencies. Thus, there may be "short skips" or "long skips" in any of the ham bands. (See your handbooks).

The Receiver

The receiver in Fig. 1 is of the tuned radio-frequency type, with a regenerative detector. The power supply is identical to the one in the transmitter except that the voltages used are lower. It should be noted, however, that the power supply is also used to energize the dynamic loud-speaker.

The signal from the transmitter intercepted by the receiving aerial is, of course, very weak. Consequently it is amplified so that it will at least be strong enough to properly actuate the detector tube. It is therefore passed through a tuned radio-frequency amplifier and then fed to the regenerative detector. A portion of the r.f. signal in the detector is fed back and re-amplified, as explained in my last letter. This is indicated by the additional feed line from the output to the input of the detector marked "Signal

Feedback."

Up to this point we are dealing only with r.f. currents on which are superimposed the audio currents. In the process of detection (which is really rectification) the r.f. carrier is eliminated and only the a.f. component of the wave is left. This is indicated in the change from cross-hatching to the slanting lines representing a.f. only. The a.f. at the output of the detector is sufficient to actuate a pair of headphones but not a loudspeaker. Therefore an audio amplifier is used to further amplify the audio signal so that there is sufficient power developed to operate the dynamic loudspeaker.

In order to receive the 3900-kc signal from the transmitter, it is necessary that the receiver be tuned to that frequency. This means that both the r.f. amplifier and the regenerative detector stage in the

receiver must be tuned to 3900 kc. Both circuits are tuned by means of variable condensers. Since both stages are always tuned to the same frequency, the condensers are ganged together on the same shaft and controlled by a single tuning knob and dial. Then, if the circuits are properly aligned, the frequency to which the r.f. amplifier is tuned will always be the same as the frequency to which the detector stage is tuned. If the receiver is tuned to 3500-kc, then both stages or circuits will be tuned to that frequency.

So much for the simple transmitter and receiver circuits. I'll take up the superheterodyne receiver and the more complex transmitter arrangements in my next letter.

Gerald.

Q S Y

"QSY" means change frequency or wavelength—and to QSY to 40,000 meters would be a pretty big order. As a matter of fact it is close to impossible as this would bring the frequency down within the audible region—to 7.5 kilocycles. The frequency-wavelength relationship is such that 300,000,000 divided by the wavelength in meters or the frequency in cycles per second will give the other factor. The quotient of 300,000,000 divided by 40,000 meters is 7,500 cycles—or 7.5 kilocycles. About the longest wavelength ever used for wireless transmission is 30,000 meters, which, at 10,000 cycles, is also within the upper fringe of audio frequencies. Of course there is no good reason why audio frequencies could not be used if they could be radiated, but it happens that the radiation effect drops off very quickly on wavelengths longer than 25,000 meters, and is practically nil when one gets down into the audible frequencies. The energy, instead of being radiated into space, is returned to the wire. Were it not for this fact, it would be very convenient to carry on wireless telegraphic communication using 60-cycle house current, but as we all know there is no radiation, as

free energy, at this frequency.

As there is practically no transmission being carried on with frequencies below 100 kc. (wavelengths above 3000 meters), receivers are rarely designed to tune to lower frequencies (longer wavelengths). Short-wave channels are now carrying on much more effectively the work of the former long-wave transoceanic stations. Also, even with superheterodynes tuning as low as 100 kc., there is always a break of some 30 to 40 kilocycles in the neighborhood of the intermediate frequency which usually falls between 400 and 500 kilocycles. A superheterodyne cannot receive close to the i.f. due to the introduction of double frequencies, within audio frequencies of each other, into the intermediate-frequency channel. Assuming an i.f. of 465 kc., and a desired signal frequency of 460 kc.: The 460-kc. signal would be close enough to the intermediate frequency to force itself through the circuit. At the same time the 465-kc. replica would exist, caused by the oscillator at 925 kilocycles beating against the signal. The result would be an audible beat note of 5000 cycles.

Their Code

Speed Upped

Get-Together

Dear Gerald:

It was swell having you out to the house last Sunday, even if we did tangle on politics. We still aren't sure if you were giving us the straight dope on the code test you gave us, but you made us feel good just the same. As for the theory, we think a bit more study is called for, and I believe you think so, too.

Now we'll tell *you* something—you drag your dots and dashes like nobody's business, so you aren't so hot yourself! Remember the tape you made? Remember how the dots and dashes looked? Oh, boy—you'd better practice a bit yourself so you can learn to "clip 'em" the way Barb and myself do. We couldn't even copy some of your stuff, but we suppose a commercial operator could if there's anything to this "tropical swing" you tried to feed us. We'll say this much—the last tape you cut on the machine was pretty good, but you got clay feet like the rest of us.

All kidding aside, you gave us confidence, and we're looking forward to getting on the air real soon. So any time you want to start "planning" our equipment, we're ready to put our heads together with yours.

Barb and Ernest.



"Best By Test"

Dear Barb and Ernest:

You get me half lit with cocktails and then expect me to give you the perfect example of what a "fist" should be . . . pfhooy on you. But the dinner was excellent, and tell Marj I enjoyed her homemade chili sauce.

You two can just get off your high horse—I'll grant that you're both good

for a solid 15 per on both transmission and reception, but don't go around under-rating an old commercial operator who is used to pounding brass in the tropics where the static busts eardrums. And don't under-rate my "sleepy-time" sending because it has a perfectly beautiful off-measure beat like the so-called "swing music" one hears nowadays. Just live and learn, and don't be so bright all at once or you'll trip up on a continental comma.

I hate telling you that you're doing better than I had expected—*on code*. You get ideas. All right—you're good on code, but you'd better start brushing up on theory. You're fairly good as it is, but not good enough. So keep at it. In the meantime, I'll get along with these animated circuits of mine with the hopes that they'll teach you something. We're off.

What Makes a Super Soup?

If you can remember as far back as my last letter, you may recall that I explained the general operation of a tuned-radio-frequency type of receiver, to say nothing of a simple transmitter. Now we come to the superheterodyne type of receiver, which is lovingly referred to as a "super" by the "boys". Since this type of receiver is practically standard, you'll want to know just what makes it "soup". Here's the lowdown:

Look at Fig. 2. This is a block diagram of a superheterodyne minus its power supply; I dealt with the power supply in my last letter so there's little sense bringing that up again. The diagram shows the aerial feeding a modulated signal carrier (remember?) to an r.f. amplifier. The output of this amplifier is fed into the detector, and both of these circuits are simultaneously tuned,

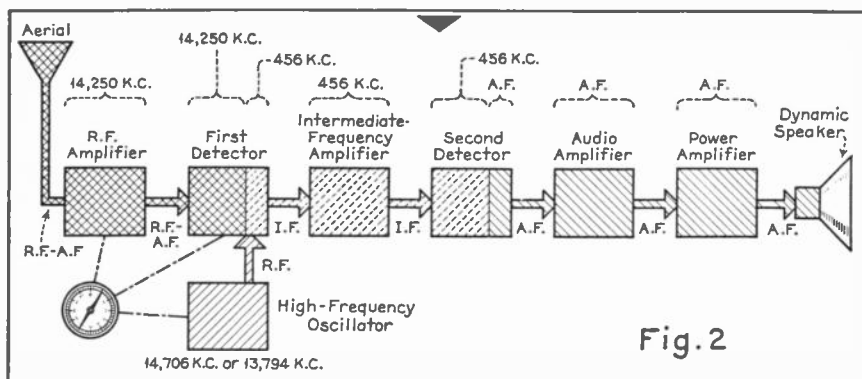


Fig. 2

Animated block diagram of superheterodyne receiver, illustrating method of its operation.

and to the same frequency. So far this is just like the tuned-radio-frequency receiver I covered last month, except that in this case the "detector" is referred to as the "first detector", simply because there are *two* detectors in a super. Furthermore, this part of the super is the same as a t-r-f receiver in that the r.f. amplifier and first detector are both tuned to the actual frequency or wavelength of the desired signal, *but the other circuits or stages of the super are not.*

We will assume that the super represented by the block diagram of Fig. 2 is tuned to a phone signal on 14,250 kilocycles, as indicated. The signal voltage is represented the same way as it was last month—lines slanting to the left for the a.f. and lines slanting to the right for the r.f. Since the signal is composed of r.f. and a.f., the lines are shown superimposed.

Now note that a high-frequency oscillator is shown directly below the first detector stage. This oscillator generates a radio-frequency voltage which is fed into the first detector stage where it combines with the signal voltage. But, as indicated, the oscillator is not tuned to the signal frequency of 14,250 kc, but rather to a frequency of 14,706 kc or 13,794 kc—just 456 kc above or below the actual signal frequency.

Before explaining the reason for this, note that the first detector is followed by an "intermediate-frequency amplifier" and a "second detector", both of which are *fixed-tuned* to a frequency of 456 kc, that is, these two stages are never varied in frequency.

Now let us return to the high-frequency oscillator and first detector; we will assume that the r.f. amplifier and first detector are tuned to a 14,250-kc signal and that the high-frequency oscillator is tuned to 14,706 kc, or just 456 kc *above* the signal frequency. The r.f. voltage fed into the first detector is therefore oscillating at a frequency of 14,706 kc. There are therefore two distinct voltages present in the first detector stage—the 14,250-kc modulated signal voltage and the 14,706 unmodulated r.f. oscillator voltage. These two voltages are mixed in the first detector stage and produce a *third* voltage which bears the modulation characteristics of the original carrier but differs in frequency by an amount equal to the difference between the oscillator frequency and the carrier frequency, or 456 kc. in our example—a simple case of subtraction.

It is evident, therefore, that by the process of *heterodyning*, a *beat frequency* is produced which has the original signal characteristics. This beat frequency is amplified by an *intermediate-frequency amplifier* of one or more stages the tuning of which is never altered. It is only necessary that the frequency of the oscillator be at all times 456 kc above the frequency of the received signal. Therefore the r.f. amplifier, first detector and oscillator tuning condensers can be ganged together on the same shaft, as indicated in the diagram, and the capacity of the oscillator condenser so adjusted that, irrespective of what frequency the r.f. amplifier and first detector are tuned to, the oscillator will al-

ways be just 456 kc higher in frequency. As a consequence, any signal tuned in will automatically be converted to a frequency of 456 kc, in the manner explained.

It should be pointed out that the same results can be obtained by tuning the oscillator to a frequency just 456 kc *below* the signal frequency, or 13,794 kc, as indicated in the diagram, but it is customary to tune the oscillator to the higher frequency.

The remainder of the operation of the super is quite matter-of-fact; the 456-kc signal frequency is passed through the intermediate-frequency amplifier, as indicated by the dotted slanting lines, and finally into the second detector where the audio component of the signal is separated from the carrier through the process of rectification. The detector output is therefore an audio-frequency voltage similar in all respects to the audio frequencies built up by the speech amplifier in the transmitter. These audio voltages are increased in amplitude in passing through the audio amplifier and finally converted into audio power in the power amplifier stage which feeds the loudspeaker.

The question now left is simply this—why bother to convert an incoming signal to another frequency when it would appear just as simple to amplify it at its original frequency, as it is done in a tuned-radio-frequency receiver. The answer is that the lower the frequency of the signal the greater its amplification, for we have already learned that high radio frequencies have the habit of skip-

ping from one tube element to another instead of waiting patiently to be amplified. Moreover, the selectivity of an intermediate-frequency amplifier, tuned to say 456 kc, is far greater than the selectivity of a radio-frequency amplifier tuned to a high radio frequency. As a matter of fact, the intermediate-frequency amplifier in a superheterodyne contributes most of the selectivity and signal gain—far more than a number of r.f. amplifier stages could possibly provide.

It is understood, of course, that the frequency of the i.f. amplifier need not be 456 kc. This merely happens to be a value commonly used.

C.W. Reception in Super

Now let us take the case of a superheterodyne receiver equipped for the reception of continuous-wave (c.w.) code signals. In this case we are dealing with an unmodulated carrier; that is, a pure radio-frequency voltage no part of which would be audible under the usual conditions. Let's see how it is done.

In Fig. 3 is shown a super which, in its general form, is no different than the one shown in Fig. 2. It is tuned to a frequency of 14,000 kc and we will assume that a c.w. signal on this frequency is being intercepted. In this case, then, the voltage in the aerial and in the r.f. amplifier and first detector stages is pure r.f., there being no a.f. component whatsoever (an ideal condition.) Since the r.f. circuit is tuned to 14,000 kc, it stands that the high-frequency oscillator

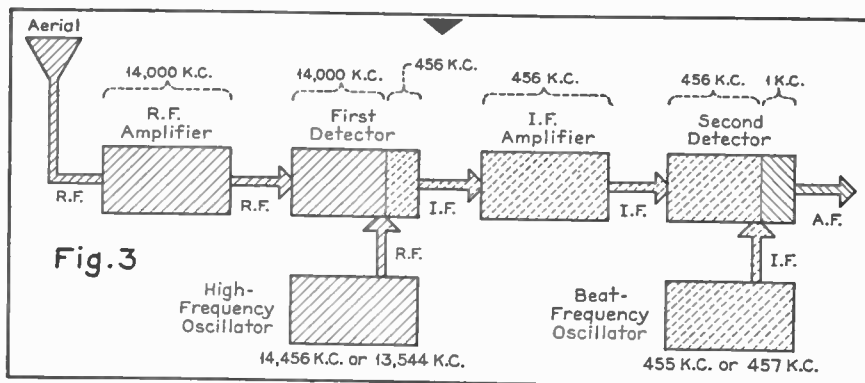


Fig. 3

Block diagram illustrating the manner in which a beat-frequency oscillator makes audible a c.w. code signal.

is tuned to 14,456 kc (or 13,544 kc) in order to produce the required 456-kc signal, the frequency to which the i.f. amplifier is tuned. This signal is indicated by the dotted slanting lines in Fig. 3.

Obviously the c.w. signal cannot be heard unless it is modified in some manner. Since it is an unmodulated signal, with no audio component, the action of the second detector cannot make it audible; as much as this detector can do is to rectify the r.f. and thereby produce a d.c. voltage which in itself cannot be heard as there is no fluctuation at an audible rate.

It is necessary, therefore, that an audio component be introduced, and this is accomplished by means of a *beat-frequency oscillator*, which, as shown in the diagram, feeds an r.f. voltage into the second detector. The oscillator is tuned so that the frequency of the r.f. voltage is slightly above or below the 456-kc signal frequency. As a consequence, there are two r.f. voltages present in the second detector (just as there are in the first detector). These voltages mix and produce a third voltage the frequency of which is equal to the difference between the frequency of the beat oscillator and the i.f. signal frequency. Since the beat oscillator shown is adjusted to 455 kc (of 457 kc), the beat or difference frequency is 1 kc or 1000 cycles. If a 500-cycle note were desired, then the beat oscillator would be adjusted to 455.5 kc. Or it could be adjusted to 456.5 kc and the results would be the same.

Since the i.f. amplifier and second detector are always tuned to 456 kc, the beat oscillator may also be adjusted to a fixed frequency and never again changed. However, it is common practice to place a control on the beat oscillator so that its frequency may be varied over narrow limits. This control is nothing more than a low-capacity variable condenser connected across the grid coil, and by means of which the pitch of the c.w. signal may be varied from a few cycles up to thousands of cycles to suit the ear. This control is also valuable when two c.w. signals of practically the same frequency are received simultaneously; in this instance it is usually possible to set the pitch of the desired signal at a frequency to which the ear is

particularly susceptible. There is usually enough difference in frequency between the two signals that the undesired one is either of very low pitch, and therefore more difficult to distinguish, or of such high pitch that it is almost beyond the range of hearing.

Image Reception

The superheterodyne receiver has one disadvantage not common to the tuned-radio-frequency set—its negative ability to produce the same signal at two different places on the tuning dial, or two signals of different frequency at the same place on the dial. These forms of potential interference are the result of the function of heterodyning in the first detector circuit, and the off-tune signals are known as “images.”

If you will consider the fact that in the case of Fig. 3 as an example, a signal of a frequency of 14,912 will also beat with the oscillator frequency of 14,456 and produce a 456-kc signal, it is evident that a signal of this frequency as well as one on 14,000 kc will appear as a 456-kc. signal in the intermediate amplifier. Assuming that there are stations operating on these two frequencies, the only factor that will prevent the 14,912-kc signal from getting into the first detector circuit when the receiver is tuned to the 14,000-kc signal is the r.f. selectivity. Even with one stage of r.f. amplification it is often the case that the other signal gets through, particularly if it is a strong one.

Conversely, if the receiver is tuned off the 14,000-kc signal, and the input selectivity is poor, this same signal will produce a 456-kc beat with the oscillator frequency when it reaches 13,544 kc—just 912 kc removed from the point where the signal would normally be received. In other words, a signal of given frequency will beat with the oscillator at two different points where it will produce a difference frequency of 456 kc to which the intermediate amplifier is tuned.

The safeguard in either case is sufficient selectivity preceding the first detector to prevent any signal from getting through when the receiver is tuned away from it by as much as 912 kc. Two stages of r.f. amplification afford enough

selectivity to accomplish this, except possibly on very strong local signals.

Despite this disadvantage, the super-heterodyne circuit is far superior to that of the tuned-radio-frequency type in both sensitivity and gain or amplifi-

cation. It has displaced the t-r-f set for this reason.

Next month we'll deal with a few more transmitter circuits, and then we'll be ready to get down to the business of planning your equipment.

Gerald.

FLOOD!

W8MGD-DB Set Up

At Cincinnati Headquarters Company, First Battalion, 147th Infantry, O.N.G., under First Lieutenant James A. Biehl, was ordered to supply communication facilities for the Cincinnati Flood Area. The official call assigned was DB, but Corporal George (Mike) Dively's call W8MGD was used for most communication purposes. The transmitter operated on 3527 kc and another operated in the five-meter band. From Thursday at 9 P.M. until Thursday at 8 A.M. of the following week Corporals Ray Murphy (exW8HGI) and Dively and the writer as chief operator operated continuously 24 hours a day under the most terrific traffic and QRM conditions. The aggregate sleep of the three men was 57 hours, or less than 20 hours' sleep per man during a seven-day period.

A mobile five-meter unit was operated

by Private Allen Holmes (exW8IGN) and Private William Goodrich (W8LNL). This unit enabled the runners to maintain constant communication with the headquarters station and speeded up the dissemination of information and traffic.

The excellent work of this unit has prompted the State to plan the erection of a 500-watt c.w. station with the most modern of receiving equipment for future emergencies.

Until the water around the Armory rose so high as to break down the insulation of the telephone lines, W8MGD had a private line to broadcast station WCPO so that that station might cooperate in the handling of the emergency urgent traffic that this station confined itself to.



Cincinnati Area Flood Station, W8MGD-DB, with Corporal George (Mike) Dively, W8MGD, and Corporal Raymond Murphy, ex-W8HGI. Stations MGD and YX were the net centers, with MGD working c.w. and YX fone.

Amateur Operating

BY DOROTHY HAGERTY

W6JMH

Outside Impressions

We should certainly give more thought to our operating methods from the BCL standpoint. For Amateur radio, if it is to continue, is dependent to a great extent on its value to people as a whole. And the general impression of Amateur radio has not been very favorable between floods.

On two occasions I have been interviewed on a Radio Broadcast. Speaking as an Amateur in the interests of Amateurs, I had opportunity to point out the beneficial and worthwhile effects of such a hobby—not alone to the Amateur but others as well.

The comments were most interesting—favorable and otherwise. Several expressed their disapproval of Amateurs and upon investigation, I found that this was due to a bad impression received when tuning in on some absurd “ham conversation” or a gathering of drinking contestants that turned out to be an Amateur station at its worst.

Regarding conversation in the ‘phone bands: there are many types—short, long, interesting, disgusting, technical and humorous. I have listened to school boys, professional men, business men, farmers. I have heard old men, young men, brilliant men and stupid men. And in regard to the YLs and XYLs—some were enjoyable and entertaining and some were revolting.

There is much controversy as to c.w. or ‘phone preference . . . it matters not. There is room for improvement in both places, “hi”

Shallow Talk

However, I am interested in c.w. operation and promote most of my activities in that direction. It is not that I don’t enjoy ‘phone—I do. It is personal and of greater appeal to my friends—but truthfully, some of the conversation on ‘phone has rather discouraged me at times. I refer to the group who try to mix liquor with radio, and the “young punk” who talks about nothing for hours

at a time. Especially too, some of the YLs heard—they giggle and gurgle and if I thought I sounded anything like some I’ve heard—I’d vow to never get within ten feet of a mike! Otherwise ‘phone is excellent. It requires more technical ability and in some cases a Class A license.

I would add that c.w. fascinates me until I hear someone calling CQ, CQ, CQ some twenty-five times without signing, or until I hear a fist too inclined to dots. There are certainly some rare sounding c.w. signals in the atmosphere—all the way from groans and squeaks—to chirps and squawks.

I believe there are a few who will agree with me when I humbly and “humbly” suggest a minimum of unnecessary CQs—intelligent conversation seasoned with good humor—properly adjusted equipment with few harmonics—legal operation within limits of Amateur bands and a little more attention to operating technique. Why create a questionable atmosphere when an Amateur is capable of ability and knowledge that many others lack?

Gain By Error

Oh, I have been guilty of several of these things mentioned. I have become confused in more than one QSO, I’ve forgotten whether I sent four dots or five—I’ve called CQ when it wasn’t necessary—my signal has been found to be chirpy occasionally—and I’ve faced a mike when I didn’t know what on earth to say—and said the wrong thing or laughed when I should have been quiet.

But I’m not proud of these things. I’ve mentioned them to let you know that I don’t regard myself above reproach. Anyway, there is some excuse for me as I am one of the “weaker sex” and admit that you men are superior—but I have tried to benefit by mistakes and believe that there is ever room for improvement. “wat sa OM?”

And that’s the dope on that!

Transmitters

And Things

Set To Go

Dear Gerald:

After reading your last letter about superheterodyne receivers, the boss and I feel more at home with our Philco, even though it is without a beat-frequency oscillator and therefore, as we see it, distinctly not a "Ham Receiver." But we hope for better things!

And another thing, the broader aspects of radio are certainly more interesting than the fundamentals. Probably this is so because it is less difficult to obtain a clear picture of the operation of a transmitter or receiver when there are no fundamental laws to keep in mind. This has been evident in your last two letters, in which you have refrained from dragging in such brain fags as reactance, electron flow, impedance, grid bias and the rest of the headaches. Still, we realize that all this stuff is important, and will prove to be a necessary part of our knowledge, but what you call the "surface stuff" is what we like.

Being on the second leg of the "course," we suppose your future letters will deal more with the practical than the theoretical, which seems to indicate that the time has come to take the exam. Well, you say the word, and henceforth we will trust that we can pick up enough practical dope from you so that we will know something about our equipment before we actually put it to use.

Your idea of putting us on 10-meter phone is okay with us. Considering that we are in an apartment, have limited space for the equipment, and do not hanker for a power house, 10 meters would seem to be the best band for a couple of Class B hams who hanker for a bit of real DX and local rag chewing without disrupting the neighborhood.

We're all for it unless you get a better idea. So start your planning, and hope we come running at you with a ticket one of these days.

Barb and Ernest

Transmitters and Things

Dear Barb and Ernest:

So be it—take a shot at the exam any time. You're both okay on code and I think you've done enough boning on theory and regs to be able to handle the second half of the ordeal. Time will tell! Lots of luck in any case.

Yes—the idea is to leave you to your own devices insofar as the examination is concerned, and get down to the practical design and operation of the type of equipment you will use. This is not all "surface stuff" by any means, but I venture to say that you will find it interesting just the same—and probably easier to grasp.

No change in mind about 10 meters, and my next letter will deal with the preliminary plans, with some sidelights on antennas, power requirements, why we will use certain components, and similar points having a bearing on the design of both the transmitter and receiver.

Meanwhile we will take a parting shot at the block diagram, and deal with the one point so far not considered; transmitter operating frequencies.

To begin with, a transmitter is usually tuned to a desired frequency in a given amateur band and not moved from that frequency thereafter. Although an amateur is privileged to operate his transmitter on any frequency in any of the bands his license covers, it is often to his advantage to select an operating frequency in each of the bands he works and stick to them, so that other amateurs will know where to tune for his signals.

This, however, is by no means a universal practice as there is also an advantage in shifting the operating frequency of a transmitter to get out from under heavy interference from another station. Moreover, in the 40-meter band in particular, the average amateur listens only in the vicinity of his own transmitter frequency with the result that it is impossible to raise him unless you alter the frequency of your own transmitter so that it will fall within the frequency range over which he will tune his receiver.

Pro's and Con's

The advantages and disadvantages of both fixed-frequency and variable-frequency operation of a transmitter are dependent upon a number of factors. The prime factor is the frequency band in which the transmitter is operated. The 40-meter c.w. band is highly congested and therefore it is advantageous to be able to shift transmitter frequency at will, for the dual purpose of seeking a spot free of QRM and to be able to park on or near the frequency of a station you desire to work. On the other hand, the 10-meter band is not as yet overcrowded and therefore there is less reason for shifting frequency to get away from QRM. Moreover, the average amateur working in the phone section of this band is able to cover at least half of the band with his receiver after a CQ and therefore has a reasonable chance of spotting you without the necessity of your shifting your own transmitting frequency to the vicinity of his.

Another factor involved with fixed- and variable-frequency operation is the frequency stability of the transmitter itself. Though a self-excited oscillator in a transmitter permits operation at any desired frequency point, such an oscillator is not altogether stable and is subject to frequency drift. In such an instance it is often difficult to hold the signal at the receiving point. If we assume that the receiver itself does not drift in frequency, it is obvious that it is quite impossible to hold a signal that drifts in frequency unless the receiver is constantly returned to compensate for the difference.

Drift

The drift of a self-excited oscillator is not so serious a matter in the longer wavelength bands, such as 80 and 160 meters, for the ratio of change is small. Moreover, self-excited oscillators of the electron-coupled type are moderately stable if properly treated with the result that the features of variable frequency can be enjoyed in these bands. On the shorter wavelengths however, such as 10, 20 and possibly 40 meters, the effects of frequency drift are more apparent.

It is at these frequencies in particular where the crystal-controlled oscillator is of exceptional value, for the frequency drift of this type of oscillator is practically negligible. But the use of a crystal in the oscillator circuit limits the transmitter to a single operating frequency in each of the bands worked, and it is therefore impossible to shift frequency unless additional crystals are employed, and even in this case the frequency range is not constantly variable, but can be adjusted only in steps, with a separate crystal for each additional step required. This is so because a crystal will oscillate at one frequency only, with the exception of special types and the new variable gap crystal holders which will provide a variation of a few kilocycles on either side of the fixed frequency—usually a sufficient spread to get out from under bad QRM.

Variable-Frequency Operation

You already know that the simplest form of c.w. transmitter is nothing more than a vacuum-tube oscillator coupled to an antenna. Many existing c.w. transmitters are of this type, and their power is dependent upon the size of the vacuum tube used and the plate voltage. If such a vacuum-tube oscillator is self-excited, it may be tuned to any desired frequency by means of the coil and variable condenser in the circuit, the frequency band and the range over which the circuit may be tuned depending upon the coil and condenser values.

This form of transmitter is not stable to begin with and, as you also know, its stability is further affected by coupling the oscillator directly to the antenna, for, in this case, a change in the effective ca-

capacity of the antenna system, which can be brought about by the swinging of the wires, will also alter the frequency of the oscillator.

This effect is readily eliminated by placing an additional vacuum tube between the oscillator and the antenna. This removes the antenna load and capacity from the plate circuit of the oscillator tube, and since the additional tube is used to amplify the radio-frequency power generated by the oscillator, it is possible to feed as much or more power to the antenna without placing a heavy load on the oscillator tube itself. Therefore the oscillator tube runs at a reduced and constant load and under these conditions is not subject to large variations in frequency caused by changing load conditions or alterations in output capacity.

Such a transmitter is shown in block diagram form at A in Fig. 4. The oscillator runs lightly loaded and supplies only the small amount of power required to drive the final amplifier where the radio-frequency power is developed. The tuned circuits of both the oscillator and the final amplifier are variable, as indicated by the slanting arrows, and in this particular case the transmitter has coils and condensers of such value that any frequency in the 3500- to 3900-kc band can be used. All the transmitter circuits are tuned to the same frequency, and if the operating frequency is to be changed, all the circuits must be retuned.

Though the arrangement shown at A has a higher degree of frequency stability than a transmitter composed of an oscillator only, its stability can be immeasurably improved by using a crystal-controlled oscillator in conjunction with a final amplifier, as shown at B in Fig. 4. In this case, however, the operating frequency cannot be changed unless the crystal is changed; that is, if the crystal used is ground to a frequency of 3500 kc, the transmitter will not function on, say, 3600 kc even though the tuned circuits are adjusted to this frequency. Consequently the circuits are not indicated as being variable as the transmitter can operate on 3500 kc only, unless a crystal of a different frequency is substituted for the 3500-kc crystal. If a 3600-kc crystal were used, of course,

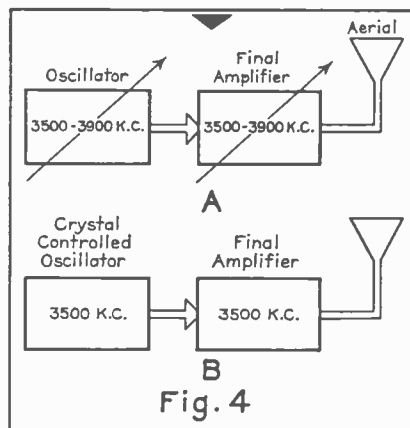
the oscillator and final amplifier tuned circuits would be adjusted to 3600 kc and locked at that point.

Fixed-Frequency Operation

It may be said, therefore, that if the oscillator in the transmitter is crystal controlled, the operation is on a fixed frequency. This does not imply, however, that the transmitter cannot be operated at frequencies that are harmonics of the original crystal frequency.

When the government allotted frequency bands to the amateurs it selected bands that are harmonically related to each other so that most harmonic radiation from an amateur transmitter would automatically fall in another amateur band rather than in channels allocated to commercial stations. It was a nice way of making the amateur suffer for his own shortcomings, but it has since shown itself to be a blessing in disguise.

To clarify this, let us assume that a transmitter operating on a frequency of 7000 kc, which is the low-frequency end of the 40-meter band, is radiating a strong second harmonic. As you already know, the second harmonic is twice the fundamental frequency, the third harmonic three times the fundamental frequency, etc. Therefore, the second harmonic of the 7000-kc signal would fall at 14,000 kc, the low-frequency end of the 20-meter amateur band, and not in one of the commercial channels adjacent



Block diagrams illustrating transmitters having variable-frequency and fixed-frequency tuning, the one at B being crystal controlled.

to 20 meters.

This harmonic relation of the ham bands has become a blessing since the advent of crystal control, for it is possible to operate a transmitter at a fixed and highly stable frequency in two or more bands with but one crystal.

The manner in which this may be accomplished is shown at A in Fig. 5. An additional tube is connected between the oscillator and the final amplifier and the tube so biased that it will produce a strong second harmonic of the frequency drift of this type of oscillator is practically negligible. But the use of a crystal in the oscillator circuit limits the transmitter to a single operating frequency in each of the bands worked, and it is therefore impossible to shift frequency unless additional crystals are employed, and even in this case the frequency range is not constantly variable, but can be adjusted only in steps, with a separate crystal for each additional step required. This is so because a crystal will oscillate at one frequency only, with the exception of special types and the new variable gap crystal holders which will provide a variation of a few kilocycles on either side of the fixed frequency—usually a sufficient spread to get out from under bad QRM.

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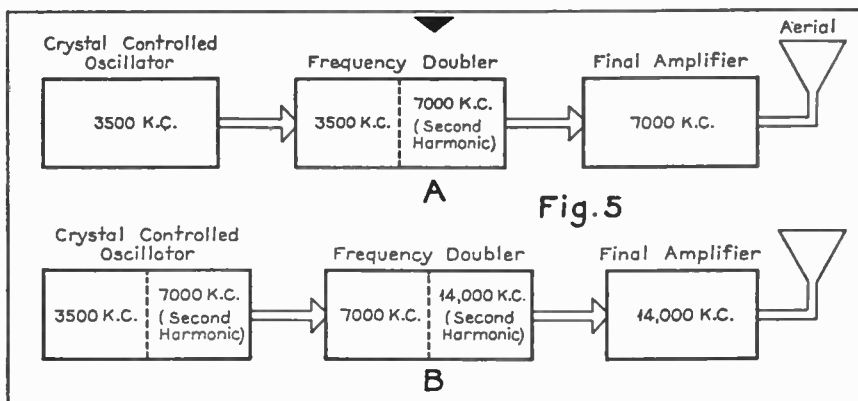
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Such a transmitter is shown in block diagram form at A in Fig. 4. The oscillator runs lightly loaded and supplies



Block diagrams illustrating the manner in which a crystal-controlled transmitter can be operated in a number of bands with the same crystal.

only the small amount of power required to drive the final amplifier where the radio-frequency power is developed. The tuned circuits of both the oscillator and the final amplifier are variable, as indicated by the slanting arrows, and in this particular case the transmitter has coils and condensers of such value that any frequency in the 3500- to 3900-kc band can be used. All the transmitter circuits are tuned to the same frequency, and if the operating frequency is to be changed, all the circuits must be retuned.

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The manner in which this may be accomplished is shown at A in Fig. 5. An additional tube is connected between the oscillator and the final amplifier and the tube so biased that it will produce a strong second harmonic of the frequency of the oscillator r.f. that drives it. Therefore if the oscillator crystal frequency is 3500 kc, the second harmonic output of the frequency doubler tube will be 7000 kc. It is this frequency, therefore, that drives the final amplifier tube, and the frequency of the radiated signal is therefore 7000 kc rather than 3500 kc.

There are, of course, tuned circuits involved with each of the stages of this transmitter. The oscillator and frequency doubler input are tuned to 3500 kc, while the frequency doubler output and final amplifier are tuned to 7000 kc. If it were desired that the transmitter operate on 14,000 kc, an additional frequency-doubler tube could be included to double the 7000-kc output of the first doubler to 14,000 kc. In this case the final amplifier circuits would be tuned to 14,000 kc.

However, operation on this frequency can be had without the use of an additional doubler tube by using the second harmonic of the crystal oscillator frequency to drive the doubler, as shown at B in Fig. 5. In this case the output circuit of the oscillator and the input circuit of the doubler are tuned to 7000 kc, while the doubler output and final amplifier are tuned to 14,000 kc. By the addition of another doubler tube, the

transmitter could be made to operate on 28,000 kc in the same manner previously outlined. This could also be accomplished under proper conditions, with the same arrangement shown at B in Fig. 5, by doubling in the final amplifier itself.

Thus, with three tubes and a single crystal, it is possible to operate the transmitter in four different bands. For 3500-kc "straight-through" operation, doubling is dispensed with and all circuits are tuned to 3500 kc. For 7000 kc operation, doubling is accomplished in the output of the oscillator, and the frequency-doubler tube is used as a buffer amplifier. For 14,000 kc operation, the frequency is doubled twice, as at B in Fig. 5, and for 28,000-kc operation the final amplifier is made to double, or an additional doubler is employed.

It is obvious, of course, that if three crystals of different frequency were available, three fixed frequencies in four bands would be available, a total of twelve operating points.

Until recently it has been difficult to

produce crystals that were satisfactory on frequencies higher than 7000 kc. However, now that good 14,000 kc, 20-meter, crystals are available, less doubling is required for operation in the higher frequency bands. If one desired to operate only in the 10- and 20-meter bands, for instance, a 20-meter crystal could be used for straight-through operation from oscillator to final amplifier on 14,000 kc., and by doubling in the output of the oscillator for operation on 10 meters. With the addition of an 80-meter crystal and the necessary coils, the same two-tube transmitter could be operated on 80 and 40 meters.

The frequency stability afforded by crystal control far outweighs the disadvantages previously mentioned, particularly in view of the fact that two or more crystals will provide an equal number of fixed-frequency spots in each band worked. Then it is a simple matter to switch from one fixed frequency to another to clear of QRM.

Well, so much for that. 73.

Gerald

Queries

MOTORBOAT RADIOS

Question:

I should like to install a radio in my thirty-foot cabin type motorboat, and should appreciate your recommendation as to what sort of a set to buy.—*R. O. L., Greenwich, Conn.*

Answer:

There are several considerations involved in a nautical installation—the effects of humidity, particularly salt water air; antenna requirements; noise.

The modern automobile radio provides a satisfactory answer on all of these points. The receiver itself, with an external speaker, can be sealed air-

tight in any convenient box or cabinet, with the controls brought out, with the usual cables, to a panel on the box or cabinet. These receivers require no ventilation and are readily operable from the power sources available on small boats.

The sensitivity of the modern auto radio is very good, and they will operate exceedingly well from the shortest kind of an aerial—even on a rowboat—giving far better results than can be obtained when installed in a car.

Also, the filter circuit engineered into the up-to-date auto radio will be most effective in reducing or eliminating the electrical noise associated with the operation of small craft.

Review Questions & Answers

Question

Having recently acquired a Class B ticket, I built up a simple transmitter using a 6L6G tube as described in one of the handbooks. The transmitter is crystal controlled and operates—or rather should operate—in the 80-meter band. However, I have been unable to make it operate satisfactorily, even though I have tried variations of the circuit. While the circuit will oscillate feebly without load, the moment the antenna is connected, the transmitter either refuses to oscillate or does so with poor keying and a decided chirp. The tube tests okay—in fact is better than the average run, as it was selected from a group of six.—*A. W. P., Binghamton, N. Y.*

Answer The chances are the trouble is a poor crystal. Many beginners try to save money on crystals. It is poor economy, as only the best crystal will give really satisfactory service. This is particularly true in the case of simple transmitters where the maximum of power must be taken directly from the crystal-controlled oscillator. We suggest that A. W. P. borrow several crystals and note if there is any difference in operation.

If other crystals do not give better results, the crystal may be exonerated, and the trouble is probably due to too close coupling between the antenna and the plate tank circuit. A. W. P. does not say how the power is being transferred to the antenna, but the most simple method is by means of a twisted transmission line feeding the center of a half-wave doublet. The transmission line is coupled to the plate coil by means of a fraction of a turn to several turns of wire.

Many of the commercially made tank coils incorporate a two-turn coupling link. This is quite all right for link

coupling to a succeeding amplifier circuit, but is usually considerably too much for coupling directly to the antenna transmission line. With excess coupling, the circuit will not oscillate. At critical coupling, the circuit will oscillate, but the keying will lag, and the signal will have a pronounced chirp. Coupling should be loosened until keying is perfect and the signal is devoid of chirp. Sometimes less than three-quarters of a turn must be used.

This applies only when the antenna is being coupled directly to the crystal-controlled oscillator. When coupled to an amplifier tank coil, more turns may be used. In fact occasionally four to five turns may be necessary to load the finals so that they draw their rated power.

A.W.R. has found the most reliable of the simple 6L6G circuits to be that shown in Fig. 1. The data on C1 and L1 for the different bands can be secured from any of the handbooks. Coil L2 will be from $\frac{1}{2}$ to 2 turns, depending upon the diameter of L1 and the proximity. The other values are given in the

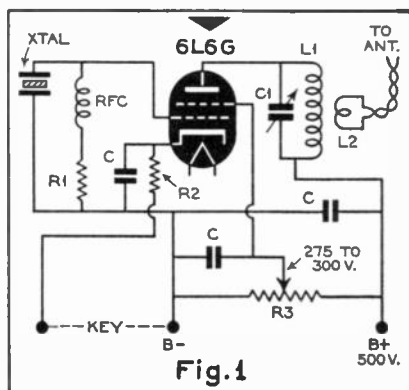


Fig. 1
This simple transmitter has worked well in the AWR lab. Values—C, 0.1 mfd.; R1, 10,000 ohms; R2, 200 ohms; R3, 20,000 ohms, 50 watts; RFC, 2.5 to 3 mh.

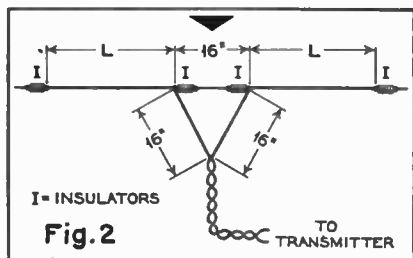
caption.

L2 is connected to the antenna by the transmission line, which may be any convenient length of Lynch Giant Killer Cable, Birnbach EO-1 cable or Bassett Concentric Feeder. The antenna is shown in Fig. 2. As a half-wave 80-meter doublet L plus L will equal 133 feet. For 40 meters L plus L should be 66 feet. However, a convenient "compromise antenna" will have a total length of 102 feet. This will work equally well on 80 and 20 meters, and by use of a doubler stage, which can be the beginner's next logical step, plenty of DX 20-meter QSOs can be had.

OSCILLATORS—AND HOW THEY WORK

Question: In answer to Question No. 34 in the A.R.R.L. License Manual, much of the explanation is left out. If the answer were memorized parrot-fashion, it would doubtless get the applicant by, but would leave him still without an intelligent idea as to how an oscillator works. I can draw the graph with my eyes closed, but I'm still doubtful as to what really happens, and it is no simple problem to me to understand how two different types of currents—*a.c.* and *d.c.*—can ramble peacefully around in the same circuit at the same time and not blow a head off or something.—*G. B. T., Los Angeles, Calif.*

Answer: Question No. 34 reads—"Draw a simple schematic diagram showing a self-excited oscillator using a single vacuum tube and briefly explain its operation." As *G. B. T.* remarks, while the answer will doubtless get one by in the examination, it leaves the student with



A recommended antenna for the simple c.w. transmitter shown in Fig. 1.

ALL-WAVE RADIO

THE primary purpose of the Queries Department is to solve the technical and semi-technical problems of our readers who feel they require such assistance. However, questions, so long as they are related to radio, need not be of a technical nature. ¶Every question will be answered personally, by mail. A self-addressed and stamped envelope should be included. ¶In questions concerning specific apparatus, it will be of considerable assistance to our technicians if the inquiry is accompanied with a wiring diagram, original operating instructions, and all relevant literature. While it is the desire of this department to be of assistance in all possible instances, it should be borne in mind that the manufacturer will occasionally be in a position to give better advice concerning his own product, and usually maintains a technical department at the service of those who purchase his equipment.

16 East 43rd St., New York

an inadequate idea as to how an oscillator functions. This is a common failing of all but engineering texts, and is due to the fact that an oscillator operates in a highly complex manner and nothing short of an involved mathematical dissertation is really satisfactory in explaining it. However, we'll do the best we can without getting beyond the depth of the average reader.

G. B. T. has drawn the diagram correctly as shown in Fig. 1. This is the familiar Hartley circuit. It will be convenient to consider coil *L* as composed of two sections—*X* and *Y*. Actually these could very well be two separate coils with a common connection to the filament and placed close to each other in the proper inductive relationship.

A simple analogy will assist in making an elementary explanation clear. We are all familiar with the howl produced when the telephone receiver is held to the mouth-piece of a telephone transmitter. What happens is that an incidental sound from the receiver is picked up by the mouth piece; which in turn makes a

sound in the receiver that is again picked up by the microphone to make another sound in the receiver, etc., etc. The result of say a thousand or so of these sounds per second is the howl. The microphone-receiver circuit can be said to be oscillating.

As suggested in Fig. 2, the receiver is equivalent to the plate circuit, or X of Fig. 1, and the microphone compares with the grid circuit Y. An initial impulse in the grid circuit causes a change in the plate circuit in accordance with the familiar action of the vacuum tube. However, X, the plate circuit, is closely coupled to the grid circuit, Y (as the receiver was closely "coupled" to the microphone), and the change in X will cause another change in Y. This change in Y will cause a change in X which again will induce a change in Y, and so on and so forth until the tube is turned off. This interchange of impulses is termed oscillation.

While the above is a reasonably acceptable idea of how the circuit of Fig. 1 oscillates, and should provide the student with a fairly satisfactory idea of what makes the wheels go 'round—the following exposition is a bit more technical and more accurate.

We learn from elementary electricity that whenever the strength of an electric current varies, so does the magnetic field about the conductor change. If that changing field "cuts" another conductor, a potential will be induced in that second conductor. As the field expands the polarity of the induced potential will be in one direction, and as it contracts or collapses it will be reversed.

Changes in the r.f. plate current through X are, of course, controlled by the grid circuit, Y. Section X and Y are so coupled that any variations in X will assist the voltage in Y which caused the variation in X. Assume an original impulse in Y (positive to the grid) which causes the plate current to increase. The expanding field in X will induce a potential in Y that builds up that original impulse (increases the positive grid charge). The building-up process continues until the plate current reaches a maximum imposed by the plate voltage, plate resistance, etc. (There must be

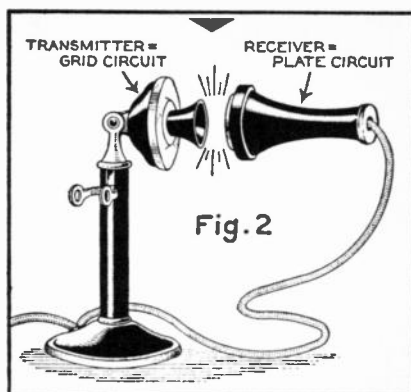


Fig. 2. Familiar analogy which helps explain how the circuit in Fig. 1 works. The RFC in Fig. 1 makes the r.f. go where it belongs.

some limit or the tube would blow up!) When the plate current no longer changes (increases in this case), there will be no change in the field surrounding X, and the grid circuit can return to its original potential which would produce a lower plate current. But as the plate current begins to drop, so does the field about X begin to collapse. This induces a potential in Y (now negative to the grid) which causes the plate current to fall (hastening the collapse of the field about X), and this continues until the plate current reaches a minimum imposed by circuit factors. Anyway, it can't go below zero. When the plate current ceases to fall, there is no change in the field (if any remains) about X, and the grid circuit is free to return to its normal condition. As it does so, the plate current increases, the field expands surrounding X, and the induced potential in Y increases the positive charge on the

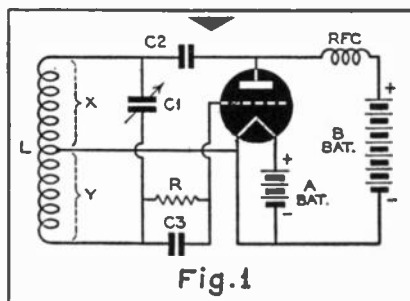


Fig. 1. The diagram that fills the bill on the U.S. government exam.

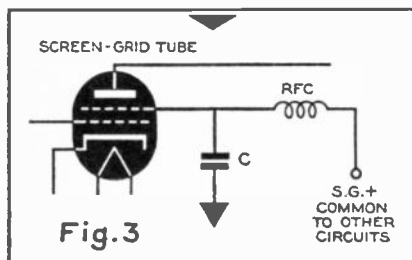
grid, thus still further increasing the plate current . . . etc., etc., etc.—and we start all over again.

Thus we have oscillations—which is about as good as we can do in the way of an explanation without going into higher mathematics.

As to direct and alternating currents playing merry-go-round in the same circuits, there is nothing wrong about that under certain conditions. Such currents exist simultaneously in almost every vacuum tube circuit—in some part of the circuit. However, very often it is desirable to separate these currents for one or both of two reasons—to make the r.f. current go where it is supposed to go, or to keep it from going where it is not supposed to go.

In Fig. 1, were it not for the radio-frequency choke, RFC, any r.f. in the plate circuit would tend to ground itself (to filament) through the low-impedance path offered by the "B" battery. However, the choke, RFC, blocks this path, and forces the r.f. through condenser C2 and coil section X to the filament, which path is obviously necessary if oscillations are to be produced.

In Fig. 3 we have the screen-grid portion of an amplifying circuit. It is desirable that r.f. current in that circuit exist in no other circuit—particularly a circuit common with another tube such as the power circuit supplying screen voltages to other tubes. Thus we include the bypass condenser, C, which bypasses all such current directly to ground (rather than permitting them to find their way there via the common power supply) and to make doubly sure none will get through to the positive screen grid connection we also insert the choke,



The radio-frequency choke in this diagram keeps the r.f. from going where it doesn't belong.

RFC, which holds up an effective Stop Sign to r.f. currents of the frequency to be encountered.

IMPROVING SELECTIVITY

Question

I have built the crystal radio receiver as described in your December 1936 issue. I am happy to state that it operates very well. However, I live in a vicinity where there is a long-wave broadcasting station and a police short-wave station. The standard broadcasting station comes through very clearly, but I occasionally hear the police signals in the background. Is there any way that I can separate these stations so that I can get either one of them without interference from the other? I should be grateful for any information concerning this problem. Also, I can only receive the two local stations. Can anything be done to make this receiver effective for distances up to fifty miles? *J. O., Johnson City, N. Y.*

Answer:

The circuit used by J. O. is a very simple and elementary one. It is neither sensitive nor selective. Increasing the number of taps on the coil will increase both selectivity and sensitivity, because more taps will permit the operator to tune in the station more accurately. By staggering the taps it is possible to tap every turn.

If this does not help, we suggest revising the circuit in accordance with Fig. 1. It is well to remember that any resistance in a circuit tends to make that circuit tune broadly. In the original circuit published in the December ALL-WAVE RADIO, the crystal detector, which has considerable resistance, is in the ground circuit (or, more properly, the antenna circuit). In Fig. 1, the antenna circuit may be tuned sharply—without the broadening effect of the crystal. Also, we now have two tuned circuits—the antenna circuit and the crystal or detector circuit—which contributes still further selectivity. It is another general radio principle that selectivity can always be

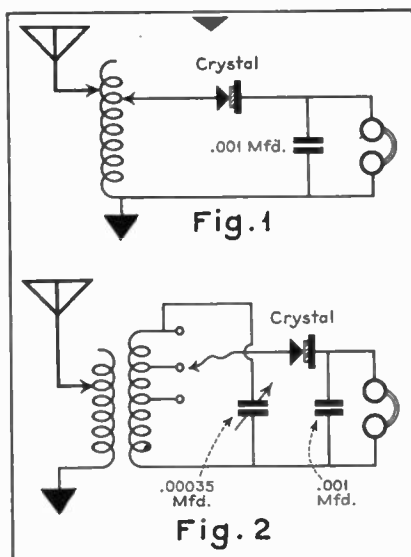
increased by increasing the number of tuned circuits.

In Fig. 1, the antenna circuit is said to be closely coupled to the detector circuit. If the selectivity is still insufficient, a third radio rule may be resorted to which recognizes the fact that selectivity is improved by loosening the coupling. Fig. 2 shows an improved circuit with looser coupling. Both coils are wound on the same tube, which should be about four inches long and two inches in diameter. The antenna (or primary) coil consists of 40 turns of No. 28 wire, while the detector or secondary coil is wound with 90 turns of the same wire. (Any type of insulation will be satisfactory.) The primary is tapped at the 4th, 8th, 16th, 24th and 32nd turns, and the secondary at the 15th and 45th turns. The primary and secondary windings should be separated by about one quarter of an inch. If still further selectivity is desired, the primary and secondary should be so arranged that the degree of coupling can be varied. A simple method is to wind the secondary on a slightly larger tube, cutting the number of turns down to 80, so that it can be slid farther away from the primary. In some cases it may be desired to employ tight coupling, in which instances the secondary can be slid over the primary.

The receiver is tuned by selecting the best ground and crystal taps, and by the tuning condenser. This condenser has a capacity of 350 micromicrofarads. The condenser which "bypasses" the radio-frequency currents around the high-resistance telephone receivers, has a capacity of .001 microfarad.

The circuit of Fig. 2 represents about as good a crystal receiver as can be made. The range will necessarily be limited, but such receivers have been known to be effective for distances of several hundreds of miles. Much depends upon location, the power of the transmitter and the height and length of the receiving aerial. As the sound heard in the telephone receivers is actually the energy picked up by the antenna, the longer and higher the aerial the better.

If still more sensitivity is required, we suggest that J. O. experiment with different crystals. Sensitivity varies with the quality of the crystal, and different



Basic crystal-detector receiving circuit, and additional circuit used to increase selectivity.

results will be obtained with various crystals of the same type.

Having exhausted the possibilities of the crystal receiver, a vacuum tube is the next and logical step. Everything but the crystal can be retained and utilized in the tube set.

SPECIAL HELP FREE

As described on adjoining page, the service of the Queries Department is open to all readers of ALL-WAVE RADIO magazine. This is only one of many helps to subscribers.

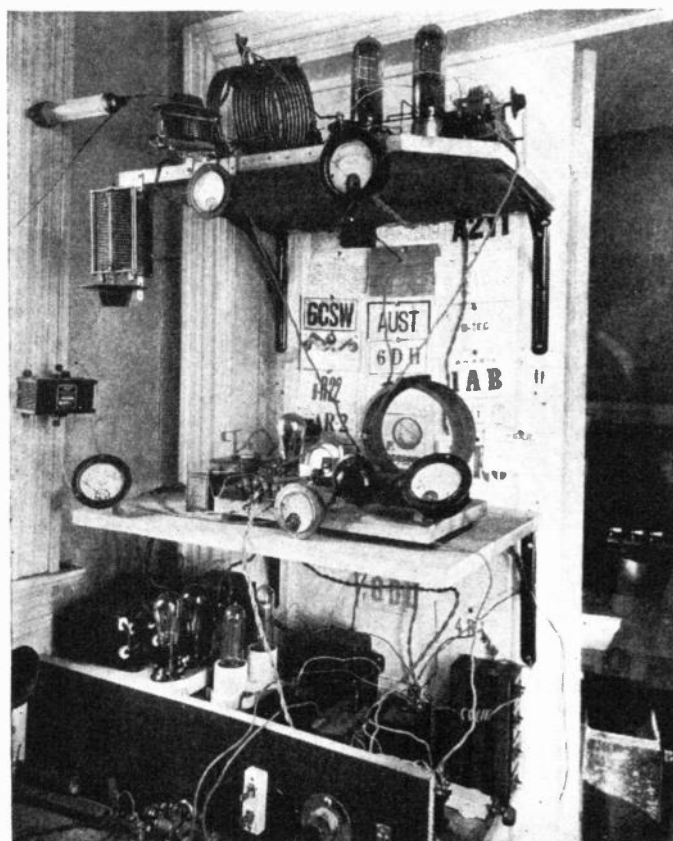
If you wish information on where to apply for license examination, drop us a line and we'll gladly forward address and information. When sending technical queries on sets, please enclose circuit diagram. If you can not get All-Wave Radio at your newstand or wish a free sample copy write the publishers.

ALL WAVE RADIO
 16 East 43rd Street
 New York



W2KDV, owned and operated by John Sanford, an old Morse man.

Amateur Stations



An early transmitter owned and operated by S. P. McMinn, W2WD. A pair of 211-D tubes were used. This was one of the first crystal-controlled c-w rigs.

HAM LINGO

THE VOICE OF THE AMATEUR

By G. S. GRANGER

HAM LINGO—the language of the radio amateur—is cockeyed, amusing, snappy and highly descriptive. It is made up of idioms, abbreviations, technical terms and phonetic words. It's Greek to the public and a source of distress to the beginner. It is enough to set anyone on his ear.

Some of the idioms used by the ham have their roots in the fields of commercial wire and radio telegraphy. The old-time Morse telegraphists originated the word "bug" as a happy and brief tag for the semi-automatic code keys used then, and now, for high-speed transmission. The early type hand keys were made of brass, and therefore the operators of such keys were dubbed "brass pounders." If an operator worked his key well, it was said of him that he had a good "fist," just as you might say that a singer has a good voice. Hand-key operators were often subject to a temporary or permanent loss of muscle reaction which affected their sending, in which case they were said to have developed "glass arms." Double-acting keys were known as "side swipers." These and other idioms originating with the old timers have been kept alive by the ham.

Short-Cuts

Many of the abbreviations also had their origin in the fields of telegraphy. Such short-cuts as "abt" for about, "ck" for check, "fm" for from, "hr" for here, "sig" for signature and "tks" or "tnx" for thanks, are good examples of a few of the many abbreviations the early amateur radio telegrapher appropriated for his own use. The substitution of the letter "x" for parts of a word, such as

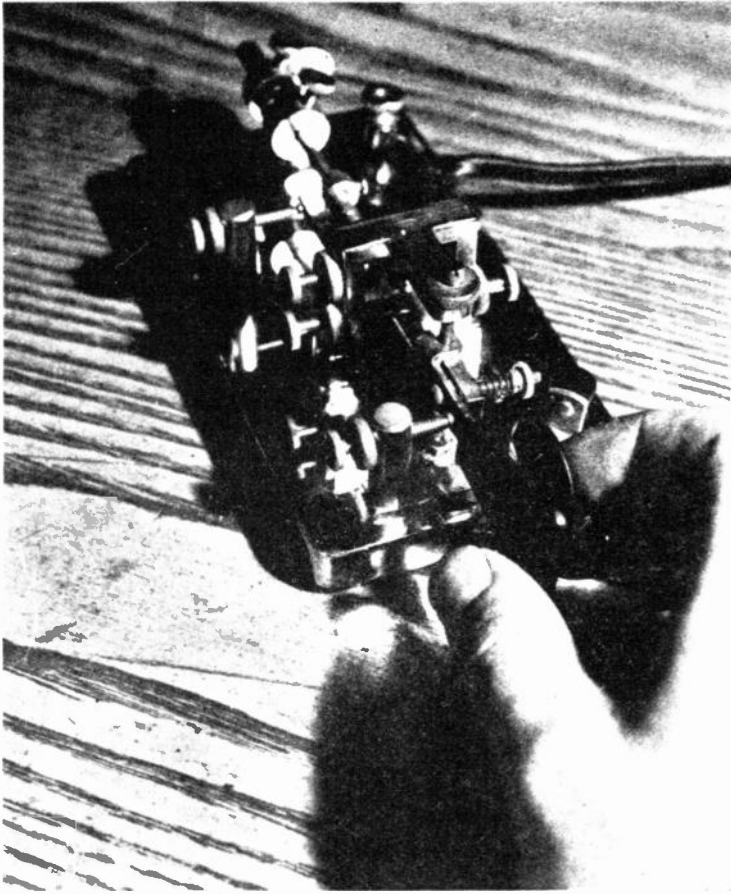
"tnx" for thanks, "dx" for distance, "px" for press, and "wx" for weather, had also been taken up by the ham, and he has added a few of his own, with the "x" tacked on to the front end of the word, such as "xtal" for crystal and "xmtr" for transmitter.

The ham also uses the International "Q" Code, together with a few letter combinations of his own making. He employs such universal signs as "R," meaning okay; "K," meaning to go ahead; "SK," indicating the termination of a transmission; "73," meaning best regards, and "88," meaning love and kisses!

But Ham Lingo is far from being a borrowed language. When it comes to trick idioms and phonetic spelling, the ham has it all over the commercial crew. It all started 'way back before vacuum tubes were in use, when powerful spark transmitters were called "rock crushers," synchronous rotary spark gaps were called "sinks" and headphones were called "cans." The first continuous-wave (c.w.) tube transmitters were cynically referred to as "peanut whistles" and their operators as ?#X&! A particular make of transformer was called a "coffin" and an aerial was known as a "sky hook." When licenses came into being they were known as "tickets," and transmitting tubes lovingly became "bottles." The district radio inspector was simply the "R. I."

Phonetics Et Al

There were no radiophone stations in those days, and it was a task for one ham to carry on a lengthy "rag chew" with another ham by means of telegraphy unless he resorted to various forms of



A "bug", the dispenser of plenty ham lingo. Hand courtesy of W2GNT—
photo by Ken Bohlen.

abbreviation. It thus developed that laughter was registered by simply transmitting the letters "HI," and the natural enthusiasm the ham had for the game was aired every few minutes by merely sending the letters "FB"—which, to you, is "fine business." Then, surprisingly enough, all hams, no matter their age, became old men, or simply "OM," over the air. Mother was referred to as the "OW," which was all right since she couldn't decipher the code, and the girl friend became the "YL." If the ham married the girl she immediately turned into an "XYL"—which has never seemed quite complimentary, but the gals seem to lap it up.

And then there was the phonetic spelling interspersed with abbreviations.

Typical copy would read something like this: "SA OM IS TT UR YL I SAW U WID LAST NITE? SHES A SWL NO ES HW! HL." Translated into English, this copy reads: "Say old man, is that your girl friend I saw you with last night? She's a swell number, and how! (laughter)."

The c.w. ham of today continues the use of the abbreviated form in his transmissions, but he is not, as a rule, apt to carry it to extremes. Aside from "es" for and, "tt" for that, "hr" for here, "hw" for how, and a few other straightforward short-cuts, he sticks fairly close to phonetic spelling. A few examples are; "fone" for phone, "gud" for good, "cum" for come, "sez" for says, "cud" for could, "ur" for your, and "sed" for

said. Some words are given the phonetic spelling and abbreviated as well, such as; "sked" for schedule, "freak" for frequency, and "sine" for sign or signature.

Improvement in vacuum-tube transmitters brought on a new group of words. Communication was established with hams in Australia, who were immediately dubbed "Aussies"—a name given Australian soldiers during the world war—and with New Zealanders, who were called "Zedders." High-voltage, radio-frequency currents were being used, and the word "hot," employed by electricians to denote a live wire circuit, came into use. Later on, high-power radio-frequency current came to be known as "soup." This term is also used to denote background noise in reception, and if a signal is lost in such interference it is said that the signal is "down in the soup" or "in the mud."

Fone Talk

When the ham commenced using radiophone equipment, such phonetic ab-

breviations as "mike" for microphone and "fone" for radiophone came into use. Some of the lingo of the c.w. ham was carrier over, and it is far from uncommon today to hear a ham on fone use the abbreviation "HI" when he could just as well laugh. It's just a case of habit. It's the same with "K" and "SK;" most fone hams have resorted to "take it away," "over," "come on in" or some such phrase when they are turning it back to the other fellow, but some of the fellows stick to the old "K" of their code days, and to "SK" when they are signing off.

The "Q" signals used by the ham are identical with those established by the International Radiotelegraph Convention. Each signal can be formed as a question or an answer. QRA? for instance, means; What is the name of your station? The answer would be, "QRA . . ." with the name of the station. There are a raft of these "Q" signals, many of which are of no use to the ham. The ones he does use are often given a slightly different or broader meaning that

Frank McKenna, the "ham with a dialect," raising a mean eyebrow.



they may better fit conditions. For instance, the original meaning of QSO? is: Can you communicate with . . . direct (or through the medium of . . .)? But the ham also uses QSO to mean a two-way contact or conversation. In talking to another ham, he may pass the remark that he had a fine QSO with such-and-such a station, and in this sense the signal has practically the same meaning as the word talk.

The "Q" Code

The following list of "Q" signals is not complete, but it contains the letter combinations most commonly used in amateur communication. The meanings are those given the signals by the amateur and are not necessarily identical with the originals. Each one can be posed as a question or an answer.

- QRA—What is your address?
- QRG—What is my frequency?
- QRK—Are my signals good?
- QRM—Man-made interference
- QRN—Static interference
- QRP—Shall I decrease power?
- QRT—Shall I stop sending?
- QRX—Stand by
- QSA—What is my signal strength?
- QSB—Do my signals fade?
- QSL—Please acknowledge our QSO
- QSO—Two-way contact
- QSY—Shall I change frequency?
- QTR—What is your time?

Aside from these signals, the amateur has adopted the abbreviation QST, which is a general call to all stations, and QRR, which is the amateur distress signal—a virtual "land SOS" call. QST is used quite generally, but QRR is used in cases of emergency only. The well-known CQ differs from QST in that it is merely a call of inquiry, and is used to make contact with a station. QST precedes a general broadcast and is more or less of a radio "hear ye, hear ye."

Signal Report Systems

The signal QSA in conjunction with the numbers 1 to 5, is used as a measure of signal readability, as follows:

- QSA1—Barely readable
- QSA2—Occasionally readable
- QSA3—Fair; hard to read
- QSA4—Good; readable
- QSA5—Perfectly readable

This system is used in conjunction with the "R-System" of signal strength, which is as follows:

- R1—Faint, just audible
- R2—Weak, barely audible
- R3—Weak, but readable
- R4—Fair, readable
- R5—Moderately strong
- R6—Strong
- R7—Strong; over-rides QRM
- R8—Very strong
- R9—Extremely strong

By the use of this dual system of signal reporting both readability in the face of interference, and actual signal strength can be determined. Thus a Q5-R4 signal report would indicate a weak signal but excellent receiving conditions, whereas a report of Q2-R7 would indicate a strong signal and heavy interference at the receiving end. The R signals alone are handy for reporting the degree of fading on a signal. It is simple, for instance, to state that a signal went from R9 to R6, thus indicating a fade of three R's.

Some hams use the R-S-T system of signal reporting. The R report indicates readability, the S report signal strength and the T report signal tone. The R gradients are about the same as those for QSA reports and run from 1 to 5. The S gradients are practically the same as the R gradients listed. The T reports run from 1 to 9 and indicate the various tones of code signals, from an extremely rough hissing note to a pure d-c signal.

Technical Idioms

There are many technical or semi-technical words and phrases employed in amateur fone communication that are mystifying to the uninitiated. For instance, if you hear a ham say he is using a "Johnson Q," a "half-wave vertical," a "zepp," a "signal squirter," a "Hertz," etc., you'll know he is referring to the type of antenna he employs for transmitting. The numbers you hear are types of transmitting tubes which are used in the various stages of the complete transmitter—the speech amplifier, the modulator, the oscillator, the doubler, the buffer and the final amplifier. The "final" is connected to the antenna "feeders" or "transmission line" through a "tank" coil. One tube is said to "feed"

or "drive" another, and that's exactly what they do. The complete transmitter is called the "rig" and, as you have probably observed, the location of the complete station is always referred to as "the shack" no matter if it is the cellar, an upstairs room, the garage or the sun parlor.

Then there is that mystifying word "skip." It is an abbreviation of "skip distance," the area on the surface of the earth over which a signal jumps. A signal with a "short skip" returns to earth within a short distance; one with a "long skip" may not hit earth for a distance of 1000 miles or more. The length of the skip is dependent upon natural conditions, and when "short skip" conditions prevail nearby stations are heard.

And there are the references to "cross-band" or "cross-channel" operation, "duplex" operation and "break-in." And also to "working through."

In cross-band operation an amateur in, say, the 20-meter band talks to an amateur in the 75-meter band. Amateur No. 1 transmits on 20 meters and tunes his receiver to 75 meters, while amateur No. 2 transmits on 75 meters and tunes his receiver to 20 meters. The two can

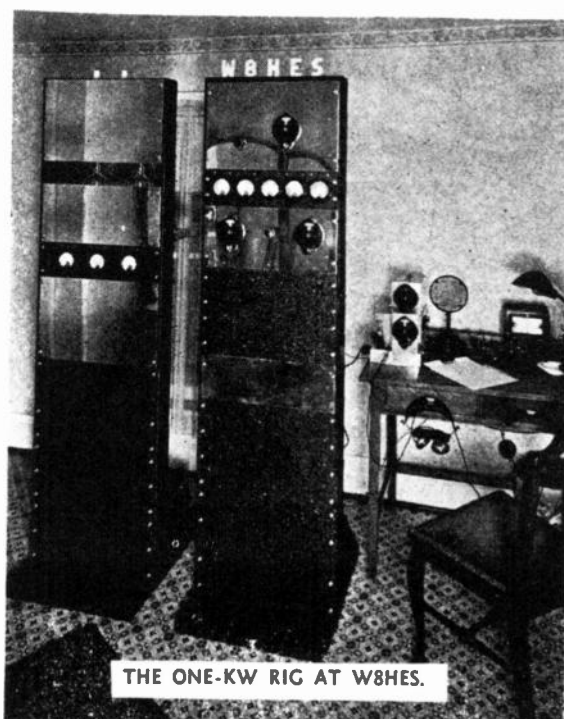
then leave their carriers on the air and talk to each other as they would on the telephone.

Duplex operation is carried on in the same manner except both amateurs work in the same band, with transmitters and receivers in continuous action.

In break-in operation, both receivers are left in action (one between pauses) but only the carrier of the station transmitting is on the air. This leaves the listening amateur free to "break in" through a hole in the transmission at any time if he misses a part of the message.

The system of "working through" is a form of re-broadcasting. For instance, one amateur will pick up the signals of a second amateur operating on, say, 5 meters and re-transmit them on 20, 75 or 160 meters to a third amateur. Since signals on 5 meters do not normally travel over great distances, the advantage of the system is obvious.

And that brings us to the end of our "linguistic" dissertation. It's not complete by any means. But we believe most of the more commonly used words and terms are included. No—we missed one, and that's "CUL." Have you heard it? It means "see you later."



THE ONE-KW RIG AT WBHES.

A GOOD STORY

ONE OF THE best after-dinner speakers and story tellers we have heard in many moons was brought to our attention when we were among the "stuffed shirts" at the banquet which terminated the Central Division A.R.R.L. Convention, recently held at Cleveland. We refer to Mr. Bail, Director of the A.R.R.L. for the First District. What's more, he claims that the yarn he told is a true story. As we remember it:

The Radio Inspector for the First District has his headquarters in Boston. The present incumbent is a rather pleasant but retiring gent by the name of Kolster. Brockton is a Massachusetts city, famous, among other things, for its Annual Fair. It is not too far from Boston and Mr. Kolster is reported to have taken himself to the Brockton Fair. Among the exhibits a certain amount of radio equipment was on display and among the radio equipment there was a buzzer hooked up with a key, of the type employed by amateurs for code practice.

Naturally the Radio Inspector gravitated to the radio exhibit and ultimately began toying with the key. A young fellow of some sixteen summers listened to the buzzer for a time and then remarked that he, too, knew the code. Mr. Kolster was pleased and turned the key over to the young man who went about his transmission with great zest. After batting out quite a little message he signed off with WIVH.

If our memory has tricked us regarding the call, we are sorry. It is unimportant except for the fact that the kid used a two-letter call. Looking at the boy rather quizzically, the R. I. seemed

to be of the opinion that he was rather young to be the possessor of such an old call.

On being interrogated, the youngster told Mr. Kolster that he had never taken a license examination and that he had seen a lot of call letters in a call book and had appropriated one for himself which he thought had a rather nice swing.

Further interrogation brought out the information that there was very little chance of his being caught and sent to jail for operating his station without a license; that the Radio Inspector was an old fogey, who spent all his time in Boston and would not be able to catch up with our young friend even if he did get to Brockton.

Mr. Kolster was then reported to have said:

"I don't suppose you have any idea who I am, do you?" The youth agreed that he didn't. After the Federal Badge, on the inside of the R. I's. coat had been displayed, the boy got off some such conversation as this:

"Don't some funny things happen when you least expect them? Here I am telling you all about myself not having a license and you being an old fogey and never getting to Brockton and all that. You know, I never thought about what I was doing. Well, I didn't know who you were and I don't suppose you have an idea who I am, do you?"

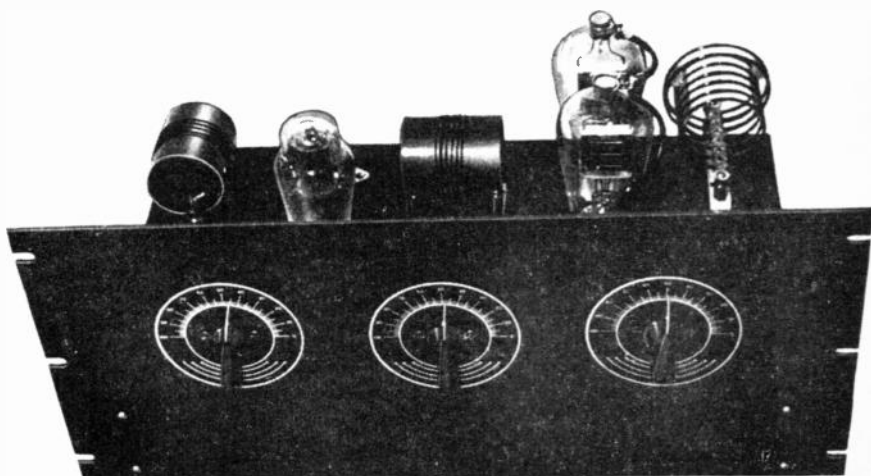
Mr. Kolster was taken a bit back by the question and agreed that he did not have any idea who the youth was.

"That's a swell break for me!" said the boy, as he turned on his heel and dashed out of the building.

The MB-100

C.W. KIT TRANSMITTER

A PROVING-POST REVIEW



THE present reviewer does not have to delve very far back into memory to recall the days when 50 watts was considered reasonably good power and represented an outlay of about \$75.00 for the transmitter proper and about the same for a motor generator delivering some 1500 volts of plate supply. The MB-100 does considerably better than that so far as power is concerned, and the cost, including tubes and crystal, should be under \$30.00. The power supply is extra, and the price will vary with the desired power output, which can be pushed to as high as 175 watts! For lower powers — in the neighborhood of 80 watts input to the finals, such as was employed in the transmitter under test at the Proving Post—standard receiving parts, can be used, and the cost of the power sup-

ply, complete with rectifier, should be under twelve dollars. Thus the MB-100 is an ideal recommendation for the beginner, who is usually somewhat limited in reference to the exchequer and who will have the advantage of considerably more power than that usually available to the amateur newcomer at no greater than the average cost for lower-power rigs. At the same time, the MB-100 is altogether adequate for the established amateur, and its low cost in no way affects the excellent manner in which it fulfills his exacting requirements. During the two months this transmitter was on test in the Proving Post, it was used consistently on 80 meters operating on all schedules of the ENY net of the AARS, and provided one hundred per cent reliable service in traffic handling and drills. Reports were usually R7 and R8, occasionally R9, and always T9X.

A Kit Transmitter

The MB-100 is available in stripped kit form from the M & H Sporting Goods Company, Philadelphia, Pa. The kit includes a drilled chassis and all essential parts, less meters, tubes, crystal and power supply. It can readily be assembled in a few hours of pleasant labor. The transmitter received at this laboratory was equipped with a rack type panel which is nicely adapted to the beginner and the desirability of a commercial appearing job for the old timer. The rack and panel design provides for flexibility, and additional units—high power stage, modulator, etc.—can be added at a later date.

For the beginner, a wooden rack is suggested such as that shown in Fig. 1. The cost is negligible and it can be discarded later on when additional units are designed for standard relay rack mounting. The power supply sits on the table under the transmitter. While the most convenient power supply available was used at the Proving Post, it is suggested that the amateur construct his own on a rack panel, which can then be mounted directly under the transmitter on the same wooden rack. Logically and conveniently, the power supply panel can be dressed up a bit with the very essential plate milliammeter. (Plate current to the finals only. There is little necessity of a meter in the RK49 plate circuit as the bias resistor tends to keep the plate current constant, and there is relatively little dip at resonance.)

As will be observed in the wiring diagram, Fig. 2, the antenna is coupled to the tank coil without any special antenna coupling system. This is the easiest way of doing the job, and highly effective.

A twisted transmission line is used—such as EO-1 cable, Lynch Giant-Killer, or Bassett concentric feeder. No condensers, transmission line spacers, or other complications are required.

However, the number of turns provided on the coupling coil, L4, may not be sufficient to load the TZ-20s which should draw from about 125 milliamperes up—depending upon the plate voltage. Under such circumstances, additional turns should be added to L4 which in the stock coil is a simple 2-turn link.

In adding these turns, some form of radiation indicator is desirable. A standard 115-volt, 75-watt lamp works out nicely, and with 80 watts input this will light up to a medium brilliancy. It should be disconnected (shorted) when the proper number of turns on L4 is determined and the tank condenser retuned slightly for maximum dip. The additional turns on L4 can be conveniently wound with No. 18 bell wire directly over the spaces in L3. Be sure to wind and connect in the same direction. Incidentally, no jacks were provided for the banana plugs on L4. The same holds for antenna posts. We used loose jacks and wired them with short lengths of

flexible wire to the stand-off insulators (antenna posts) on the side of the wooden rack. Only two of the three stand-offs are generally used—the third merely providing a connection to a radiation indicating device when employed.

The Circuit

The oscillator will be recognized as a slightly modified tri-tet. For harmonic operation, the cathode coil, L1, is tuned by condenser C. When operating on the

TABLE I

BAND	XTAL	COILS		
		Osc.Cath	Osc. Plate	Final
160	160	shorted	55 turns, 2"	160B*
80	80	shorted	29 turns, 2"	80B*
40	80	14 turns,	14 turns, 2"	40B*
40	40	shorted	14 turns, 2"	40B*
20	40	7 turns, 2"	7 turns, 2"	20B*
10	20	4 turns, 1½"	5 turns, 1½"	4 turns, 1½"

* Barker and Williamson type numbers.

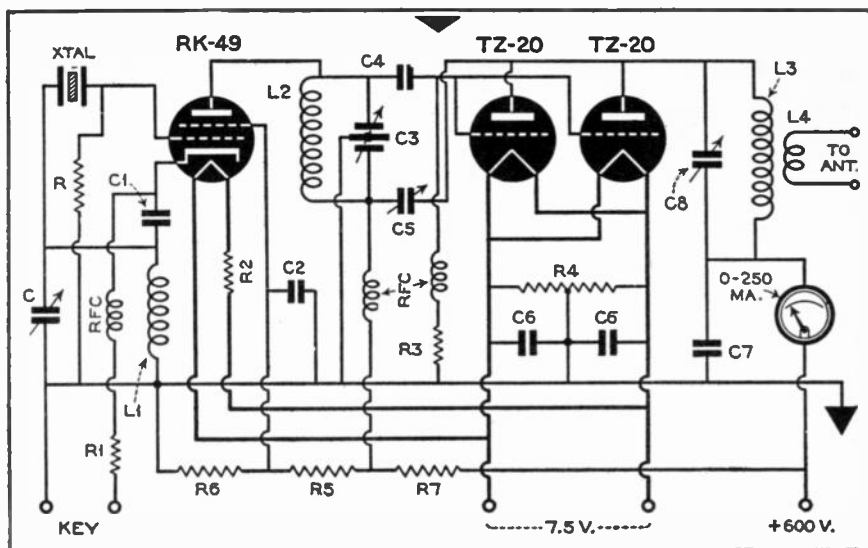


Fig. 2. Circuit diagram of the MB-100 transmitter. The TZ-20s are easily driven without use of a buffer stage.

KEY TO PARTS

R—25,000 ohms, 1 watt
 R1—400 ohms, 2 watts
 R2—1 ohm, 10 watts
 R3—2000 ohms, 10 watts
 R4—50 ohms, center tapped, 2 watts
 R5—12,500 ohms, 10 watts
 R6—17,500 ohms, 10 watts
 R7—1500 ohms, 10 watts
 RFC—(3 required) 2.5 mh.
 C—150 mmfd.
 C1—.002 mfd. 1000 volts
 C2—.002 mfd. 600 volts
 C3—100 mmfd. dual

C4—.0001 mfd.
 C5—15 mmfd.
 C6—(two required) .002 mfd.
 C7—.002 mfd. 1000 volts
 C8—100 mmfd.

Miscellaneous

6—large jack type feed-through insulators
 6—small feed-through insulators
 5—clip tite sockets
 2—large plate clips
 1—drilled chassis, 17 x 10 x 3 inches
 1—8 $\frac{3}{4}$ x 19 inches relay rack panel
 3—2 $\frac{1}{4}$ inch bar knobs
 3—3 $\frac{1}{2}$ -inch dial plates

fundamentals, C is shorted by turning to full capacity, the tip of a rotor plate being bent to scrape the stator. The RK-49 oscillator is a somewhat exalted 6L6G with an isolantite base. The oscillator tank coil, L2, is tuned with the split-stator condenser C3, the r. f. voltage being perfectly balanced to provide satisfactory neutralization to the TZ-20s in parallel through C5. In practice neutralization is constant and readily obtained with the usual neon lamp technique.

The zero bias TZ-20s are exceedingly easy to drive, and the output of the RK-49 is altogether adequate for this purpose.

Coil Data

While the transmitter on test was used exclusively on 80-meter c. w. there

is no reason why comparable efficiency should not be secured on other bands. The recommended data is given in Table I.

The gauge of wire used to wind the coils is not critical. Enamel wire is preferred, and in general No. 26 may be used for 160 meters, No. 22 for 80 meters and No. 18 for the balance.

Efficiency, Output and Operating Voltages

The efficiency obtainable with this transmitter is excellent and varies from 70 to almost 90 percent, depending upon the plate voltage available and other operating conditions.

With a plate potential of 500 volts, 87.5 watts can be fed to the finals with an output of 63.75 watts. With 600 volts,

the input is raised to slightly over 100 watts and the output to 75 watts. This is about as high as it is desirable to go with the zero bias TZ-20 tubes without some form of external bias. Employing self-bias across a 400-ohm resistor, the plate voltage can be raised to about 700, inputting 143 watts for a 100-watt output.

The efficiency rises with the plate potential, but at higher voltages battery bias is desirable if the oscillator is keyed. With a plate potential of 1040 volts and a fixed bias permitting 190 milliamperes to the finals, the input is 196 watts, the output 175 watts (we're getting into real power now) and the efficiency 87.5 percent.

As will be noted from the diagram the transmitter is keyed in the oscillator, making possible break-in operation on one's own frequency. This is highly desirable, and was of course necessary in operating on the AARS net frequency. The keying is instantaneous, even at high speeds, and chirpless. Clicks and thumps are equally conspicuous by their absence. In other words, the Proving Post definitely approves of this transmitter, and recommends it to lid and OT alike—to the impecunious and the opulent ham.

A Ham to Be

Editor, ALL-WAVE RADIO:

I think your "mag" is just about the best for the average person interested in Radio.

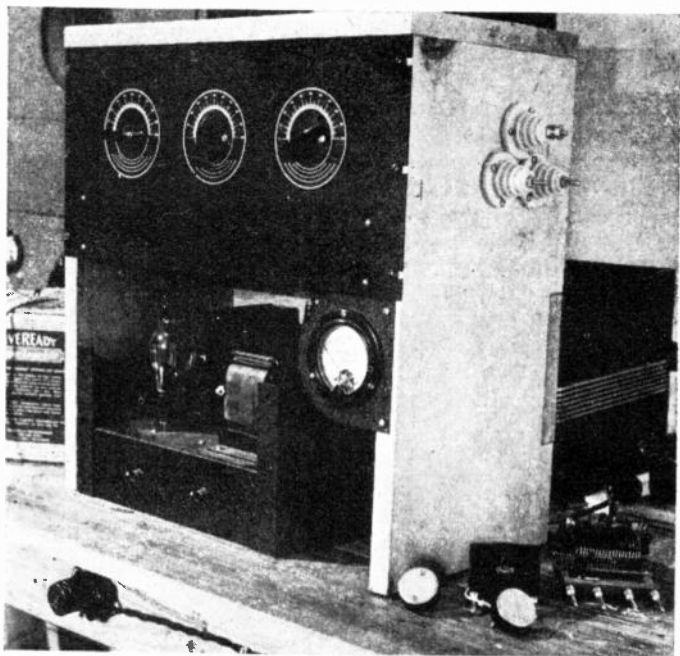
I am only a S.W.L. but about a year ago I became real curious about amateur radio, and made up my mind to find out what it was all about. I was, or still am, in the same position as Barb and Ernest and about their age. I was real sore at those C.W. sigs which I thought were causing interference. Have since found out that code interference is negligible. In fact, I think the greatest offenders are B.C. stations. Most of the harmonics I hear are from them.

Anyway I bought a code machine and went to work seriously. Manage to get in an hour or two every day. At present, I am able to copy Spanish and German press solid. I have timed them; they run about 20 w.p.m. I am up every day at 3 A. M. to catch WHD (N.Y. Times). He is a little too fast for me, but I'll catch him soon. As for keying, I think I can do better than a lot of the boys who have "Tickets." At least I'm alright until my fist gets tired. It seems to me as though some of the amateurs could stand a lot of practice or something.

I surely would like to put a decent rig on the air, but want to do it right, so that I will not be a source of interference to anyone. Well, here's wishing you the very best of luck.

WILLIAM A. GORDON,
NEW YORK, N. Y.

Fig. 1. An economical arrangement for an economy transmitter. Also both neat and effective. The wooden relay rack can be discarded later when additional units are built up.



TRAFFIC RIG

For 40 and 80 C. W.

By **ROBERT LORD • W2ADY**

Engineering Department.

AMPEREX ELECTRONICS PRODUCTS, INC.

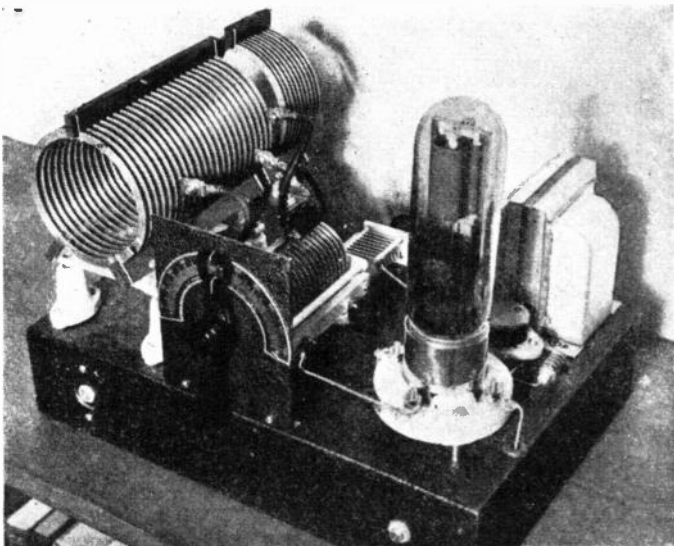
THE average amateur operator, a few years ago, was satisfied to have his station operate efficiently on but one band. Both transmitters and receivers, at that time, proved awkward to manipulate when returning to bands other than the accustomed one. This condition was particularly true of the transmitting portion of the station. The process of changing coils, crystals, etc., plus the accompanying retuning and re-neutralizing process was sufficiently distasteful to discourage multiband operation.

Band Changing Problems

Present-day transmitters are much less cumbersome insofar as band changing is

concerned. The development of transmitting tubes embodying a high degree of power gain has materially reduced the number of stages required. The low interelectrode capacities of these tubes make possible constant neutralization over a range of several bands. High power pentodes and beam tubes, for those amateurs who prefer them to triodes, make possible the elimination of the neutralization problem entirely. Various types of low-loss, high current r.f. switches permit coil changing for at least three bands in any one transmitter.

Despite the present availability of the aforementioned newer products, and many others to boot, the average amateur of several years' standing is still in somewhat of a quandary when the prob-



THE COMPLETED JOB—ONE TUBE, XTAL CONTROL, 120 WATTS.

lem of band changing crops up. Said average amateur, over a period of years, has built up to the limits of his pocket-book a transmitter which is as efficient on his pet band as his experience and pocketbook has permitted. A complete rebuilding program in the interests of rapid band changing is therefore not considered worthwhile by the amateur. He usually prefers to spend his extra dollars in increasing power.

Extra transmitters for extra bands has always been considered the ideal solution of the band changing problem. When the extra transmitter is to be of the same power as the main transmitter, the time, money and additional space required are often an effective preventative to the adoption of such a program. When the extra transmitter may be of relatively low power and simple design such an arrangement is quite feasible.

An extra transmitter need not have its own power equipment. The main transmitter can furnish all necessary voltages. It is most practical, though, to mount the filament transformers directly on the extra transmitter. It is always simpler to run a single 110-volt cord than several pairs of heavy filament leads. It is also a neater way of doing the job. Several well insulated wires will suffice to carry the plate voltages.

Extra Transmitters

In the April 1937 issue of *ALL-WAVE RADIO* there was presented an extra transmitter embodying these general design features. This was the DX4UCW two-tube, high-power transmitter. With but two tubes—an RK-39 and a ZB-120—powers ranging from about 70 or 80 watts on 10 meters to 150 watts or so on the lower frequency bands could be obtained. With the filament transformers self contained, only three connections to the power supply of the main transmitter were required.

The bottle that made this simple two-tube, high-power transmitter possible was the Amperex ZB-120. We refer the reader back to the April article for a listing of the general characteristics of this versatile tube. Under the heading (b) was the following: "120 watts r.f. output as a Class B telegraphy amplifier

with zero grid bias and a driving power of but 1.2 watts." As the figures indicate, this is a power gain of 100, which is as good or better than the power gain of various types of power pentodes and beam tubes now available.

The use of these power pentodes as crystal oscillators suggests the use of the ZB-120 for the same purpose, i.e., a one-tube, high-power, crystal-controlled transmitter. In the DX4UCW rig an extra oscillator tube was required in order to permit 10-meter operation. For lower frequency operation, however, the use of a ZB-120 as crystal oscillator is eminently practicable.

In a normal connection of a crystal-controlled oscillator, the crystal is excited by the feedback from the plate circuit through the grid-to-plate capacitance of the tube. The ZB-120 requires so low an exciting voltage, that the feedback must be reduced. This is accomplished in this transmitter by partially neutralizing the tube grid-to-plate capacity feedback. At the proper feedback to provide the required r.f. exciting voltage, it is possible to obtain high output from the ZB-120, without any harm to the crystal.

The characteristics of the ZB-120 used as a high-power crystal oscillator are such as to make it ideal for use as a one-tube traffic transmitter on the 40- and 80-meter bands. Traffic work on these two bands can be consistently handled with powers of the order of 100 watts or so, which figure may be easily obtained with the ZB-120 power oscillator, outputs of 120 watts being possible on the 80-meter band.

Ideal Break-In Operation

One requirement for rapid traffic handling is the ability to work "break-in," even directly on the transmitter frequency. Many multi-stage transmitters, keyed in the driver or power stage, are suitable for break-in operation if the frequency of the other station is not too close to the transmitter frequency. For most effective use of the single frequency network type of operation now in vogue, it is imperative that the transmitter go completely "dead" with the key open. This requirement is met by

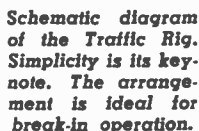
Another advantage of the Traffic Transmitter is in its economical operation. There are no extra oscillator, buffer or driver stages to needlessly draw power. It is not necessary to shut off the power while receiving, as the transmitter draws nothing but filament power with the key open. It is only necessary to key when it is desired to send, and forget the power switch until the operating period is concluded.

Degeneration to reduce the feedback is obtained by use of the usual "neutralizing" circuit. As very little excitation is required the degeneration or neutralization tap is located very close to the lower or "dead," end of the plate coil, L. This also permits of larger capacity in the degeneration condenser NC, making its adjustment less critical.

The positions of all components are clearly shown in the photograph. The

A type 624 inductor is used for the plate coil, L, and is mounted on four type 20 stand-off insulators. This type of edgewise wound coil was chosen in preference to the more usual type because its construction adapts it ideally to the tap changing procedure necessary for proper adjustment of this circuit. The heavy inductor clips make as good a contact as if the tank leads were actually soldered in place. The usual type of coil would require soldered connections, an awkward procedure when taps must be changed.

No antenna tuning condensers are shown. The method of antenna tuning required will change with each particular antenna. The 10 turns of the antenna coil with the pair of inductor clips



for adjustment should provide coupling to practically any antenna. As most 40- and 80-meter antennae are of the familiar Zeppelin type, either one or two antenna condensers, for parallel or series tuning, respectively, are all that are required in most cases.

The two current-reading jacks are mounted on the front of the chassis; the grid-current jack under the tube and the plate-current jack under the coil. As one side of the grid jack is grounded this jack need not be insulated from the chassis. The plate jack, however, should

be insulated for the plate voltage. This is done by mounting this jack on a small piece of hard rubber, which is fastened to the chassis with two bolts. A large hole should be drilled in the chassis so as to amply clear the jack.

The ZB-120 socket should be mounted off the chassis a half inch or so to prevent possible breakdown from the plate terminal bolt to chassis. This is done with a pair of long bolts and spacers. One nice thing about this transmitter is that no large socket holes are necessary. This makes it possible to drill the entire chassis with a hand drill.

The plate condenser, C, is mounted on a pair of type 22 stand-off insulators. It is mounted far enough forward so that the shaft projects through the small panel. The shaft hole in the panel should be about an inch in diameter for ample clearance. This small "panel" was cut from an old sheet of aluminum. Any small piece of metal or wood may be used to mount the dial.

The neutralizing condenser, NC, is mounted directly to the chassis with the usual type of Trimair bracket. It should be turned upside-down for greater clearance above the chassis.

Preliminary Adjustments

Preliminary adjustments should be made with a low plate voltage of around 300 or so. The correct procedure is as follows:

(1) Set neutralizing condenser NC at maximum capacity.

(2) Place an 80-meter crystal in socket.

(3) Set inductor clips on L for 80-meter operation. The photograph shows them set in the proper positions for this band. The clip, G, going to the "grid" end of coil, L, taps at the end turn next to the antenna coil, L1. The high-voltage clip, P, is placed 3 turns away. The "plate" clip is placed 16 turns from the "grid" clip. This placed 16 active turns in use for L, with 3 turns used for degeneration.

(4) With the key closed and meters plugged into both jacks the low (about 300) plate voltage should be turned on. With the condenser, NC, still set at maximum capacity the plate condenser, C, should be rotated through its full range

PARTS LIST

AMPEREX

- 1—type ZB-120 tube

BLILEY

- 1—type LD2 80-meter crystal
- 1—type LD2 40-meter crystal

CARDWELL

- 1—type MT-150-GS tuning condenser (C)
- 1—type ZT-30-AS neutralizing condenser (NC)

CORNELL-DUBILIER

- 2—type 9 .002 mfd. 600-volt filament bypass condensers (C1)
- 1—type 9 .002 mfd. 2500-volt plate bypass condenser (C2)

HAMMARLUND

- 1—type CHX r.f. choke (RFC1)
- 1—type CH500 r.f. choke (RFC2)

JOHNSON

- 1—type 624 inductor (L)
- 1—type 623 inductor (L1)
- 1—type 211 socket (for ZB-120)
- 1—type 204 handle indicator
- 4—type 20 standoff insulators (for mounting L)
- 4—type 22 standoff insulators (for mounting L1 and antenna posts and C)
- 5—type 40 feedthru insulators (for high voltage, and key connections)
- 1—type 225 Alsimag 5-prong socket (for crystal).

PAR-METAL PRODUCTS

- 1—10 x 14 x 3 inch black crackle chassis

UNITED TRANSFORMER

- 1—type CS409 10-volt filament transformer

YAXLEY

- 2—type A-2 closed-circuit jacks

MISCELLANEOUS

- 1—a.c. receptacle
-

slowly. No indication of oscillation should be had, and both meters should show no movement. The plate meter will indicate a low non-oscillating current, while the grid meter will read zero. If any indication occurs, the high-voltage clip on L should be moved slightly from its original position, 3 turns from the end, until a non-oscillating condition is reached. This indicates that the tube is neutralized. As this neutralized position is relatively broad the original position given for the clips should be satisfactory if the construction is duplicated.

(5) A 10-watt light bulb should be connected across 4 or 5 turns of L1. These turns should be the ones nearest to the plate coil and both coils should be tightly coupled.

(6) the condenser, NC, should then be very slowly turned from its maximum capacity position while C is swung back and forth across its high-capacity end. With the capacity of NC sufficiently reduced the tube will go into oscillation, indication of which will be observed on both meters and by the light bulb. It will be observed when tuning into resonance from the low-capacity side of plate condenser, C, that, when the tube begins oscillating, the plate and grid current will both be very high, while the bulb will only light dimly. As the capacity of C is increased the plate and grid currents will come down, while the output, as indicated by the light bulb, will increase. This latter condition will hold with increasing capacity of C until the tube again stops oscillating. When tuning back into resonance the opposite will hold true, the tube first giving high output and drawing low current. The position of C for maximum output of the tube will be found to be at a slightly lower capacity setting than that where the tube begins oscillating (tuning from the high capacity side).

The condenser, NC, should be reduced from its maximum capacity position just far enough to provide stable keying. If reduced too far the feedback will be too great and will result in an unnecessarily high crystal r.f. current. A reading of 25 ma. on the grid meter indicates the maximum permissible crystal r.f. current of approximately 60 ma.

(r.f.)

(7) High voltage may now be applied to the tube. This should not exceed 1250 volts. The operating conditions for maximum output on 3500 kc. are as follows:

Plate voltage—1250 volts

Plate current—140 ma.

Grid current—22 ma.

Crystal r.f. current—60 ma. (r.f.)

Note: Grid current should not exceed 25 ma. for correct crystal r.f. current.

With the high plate voltage applied, and the 10-watt bulb replaced with a 100-watt bulb, step (6) should be repeated. Condenser, NC, should this time be reduced very slowly until the oscillating condition is reached. When making this adjustment with 300 volts on the plate, NC could be reduced in capacity more than necessary without harm to either tube or crystal. With high plate voltage, however, too great a reduction in the capacity of NC will result in excessive grid, plate and crystal currents. The capacity of NC should be reduced just enough to provide stable keying. This adjustment is not at all critical but should be made carefully, as suggested, to prevent possible damage to tube or crystal. It would be an excellent idea to mount a small dial on NC so that the proper position may be checked or duplicated. It would also be wise to tighten the locking nut on this condenser so that the proper setting will not be accidentally disturbed.

Once NC is properly set the plate condenser may be swung completely through resonance without causing the grid current to rise higher than about 25 ma. The crystal, therefore, cannot be injured during tuning operations once the proper position of NC is found.

While the reader may infer from the above instructions that the adjustments are extremely critical and something liable to pop at the first opportunity, such is not the case. We have merely explained the preliminary adjustment procedure so that a careless operator will not first apply high voltage, swing the condenser aimlessly and damage something. The transmitter is actually very easy to adjust if the instructions are meticulously followed, and is practically foolproof in operation once NC is cor-

rectly set and locked. There are just not enough parts in this "transmitter" to make it difficult to either construct or operate.

The transmitter will operate as well on 40 meters as on 80. This particular transmitter was tested on 40 by merely replacing the crystal with the proper 40-meter one and moving the plate tap on L down so that 14 active turns were employed instead of 16. It might be wiser to move this plate tap still further down on the coil, with a corresponding adjustment of the high-voltage tap, as explained in step (5). A different setting of NC will be required than that used for 80-meter operation. The use of a smaller active coil will permit of higher capacity in C to reach resonance.

All adjustments should preferably be first made with low plate voltage, final adjustment of NC being made with high voltage applied. It is not necessary, of course, to use the full 1250 volts to realize a useful output. Voltage of between 500 and 1000 will provide sufficient output for effective communication on 40 and 80 meters.

Transmitter Characteristics

The note from this little transmitter is crystal PDC. When a power supply of reasonably good regulation (choke input filter) is used no chirp can be detected when keying. The varying resistance of the lamp bulb during tests may cause a slight chirp. This condition will not exist when an antenna is connected as the resistance of the antenna remains constant.

One peculiarity of this transmitter is that there is no spark visible across the key. Consequently no key clicks. This is accounted for by the fact that the crystal requires a tiny fraction of a second to start oscillating. This peculiarity of keyed crystal oscillators is often employed for key-click elimination. It has been necessary, heretofore, to follow a low-power keyed crystal oscillator with one or more higher powered stages. In our particular case we can "crystal key" an entire, 120-watt transmitter and still use only one tube and one stage. This is surely worthwhile.

If we were writing this article from

Los Angeles, instead of somewhere in the wilds of the East, we would say that "this 120-watt 'exciter' would also make a good low-power 'transmitter' for local work." Being on the East Coast, however, we will merely say this, this 120-watt transmitter will also make an excellent exciter for a really high-powered final stage. This should prove helpful for the West Coast boys who need a kilowatt to work the same stuff the East Coast boys do with 100 watts or so. Seriously, however, this 120-watt "exciter-transmitter" will permit of the construction of a two-stage kilowatt rig wherein nothing is overloaded.

Conclusion

In closing, we would like to differentiate between this transmitter and previous ones which used a "50 watt" type of tube in a crystal oscillator circuit. It is possible, by very critical adjustment, to pull a weakly oscillating high power stage into step with a loosely coupled crystal. Such an adjustment, however, holds over but a few kilocycles, so that the transmitter is liable to oscillate on an undesired frequency if not carefully watched. This cannot happen with the ZB-120 as the stage is merely regenerative with correct setting of NC. If the circuit is detuned, or the crystal removed it will merely cease operation. The plate current in this case will drop back to a safe value of 50 ma. or so.

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ALL WAVE RADIO
16 East 43rd Street
New York

THE DX4UCW XMTR

WITH XTAL ON 10-20-40-80

By Chester Watzel W2AIF

FOR a long time one of our pet ambitions has been to build a really simple two-tube, two-stage c.w. transmitter having a reasonably high output down to, and including, 10 meters. The attainment of this objective has been fraught with difficulty up to the present. It has been done with low power rigs, but with outfits of decently high power the bugaboo of power gain has been a stumbling block.

Power Gain

The power gain of a transmitter stage is simply the ratio between input driving power and output power. As all good transmitters should use crystal control, the chief problem to be solved in our simplified c.w. transmitter is that of producing sufficient power gain to multiply the fractional-watt power of the crystal to some 100 or 200 watts in but two stages. It would seem, at first thought, that a small oscillator tube driving a large transmitting pentode in the final stage would be the answer. This does not work out in practice, as we have found to our sorrow. With a 10-meter crystal to start from it might be possible. With a 20- or 40-meter crystal it is a rather hopeless task. Neither an RK20-804 or an RK28-803 will deliver enough power output when doubling to 10 meters to be of use. In fact, we doubt if an RK28-803 will double at all to 10. An RK20-804 will deliver enough 10-meter output, doubling, to drive a final stage. These tubes are used in this manner in our own transmitters.

An RK20-804 will furnish sufficient output as a straight amplifier on 10 meters but is difficult to drive from a crystal stage using a 20-meter crystal. Even if this combination were to be worked out satisfactorily on 10 it would still fall far short of the power output goal set for

20 meters and the other bands. An RK28-803 will work out nicely in a two-tube layout on 20, 40 and 80 meters, but will not work on 10 even if a private power house is used as a driver—at least this has been our experience.

If a triode is to be used as the final stage of our two-stage transmitter, it must of necessity be used as a doubler to 10 meters because of the higher driving power requirements of this type of tube over the pentode type. Various tubes of the 203A type, including the 203A itself, make excellent doublers to 10 meters. Other tube types, such as the recently developed low-C group are also suitable for this type of operation. The driving power requirements of any of these tubes, however, is more than can be furnished by a crystal oscillator stage.

The above statements on transmitting tube layouts are meant to apply to multi-band transmitters in general and not to some particular single-band job. It is often possible, by means of prolonged and critical adjustments, to refute some of these statements and produce a high 10-meter output from some simple combination. But we are not interested in these critically adjusted transmitters. It must be possible, in our simplified transmitter, to change bands by merely plugging-in the appropriate sized coils, throwing a switch or two, and retuning. Any more difficult course is out of the question.

It is obvious that a different type of tube than previously available is necessary for either the crystal stage or the amplifier stage if we are to attain the simplicity of a high-power, two-stage, multi-band transmitter. By the term "high power" we mean the East Coast brand of high power, where the hams can put a 203A in the final stage and work the world. For the West Coast ham, this two-stage transmitter we are

aiming at will make a nice driver for his brand of "high power" final amplifier.

The Answer

The tube which seems to be the answer to our prayer is the recently released ZB-120. This tube has low enough interelectrode capacitances to permit of full output on 10 meters, while the amplification factor is higher than that of any other triode at present available. High amplification factor in a tube obviates the necessity for fixed grid bias and permits the use of low driving power for full power output. This means that grid-bias power supplies may be eliminated for r.f. amplifier and Class B modulator stages and the r.f. exciter portion of the transmitter considerably simplified. In our particular case the high amplification factor of the ZB-120 means the difference between having and not having a two-stage transmitter.

The general construction and characteristics of this tube place it in the "203A" class, commonly known as the "fifty-watt" class. A standard fifty-watt type base is employed, as well as the standard filament voltage of 10 to 10.5 volts common to this type of tube. The maximum input ratings are also the same, being 1250 volts and 160 ma. The interelectrode capacitances, while not as low as in some of the recent low-C tubes, are lower than in any tube of this general construction. The plate-to-filament capacity is only 3.2 mmfd., while the grid-to-plate and grid-to-filament capacitances are, respectively, 5.2 and 5.3 mmfd. This order of interelectrode capacitances permits the ZB-120 to operate on full rated input at 30 mc.

The amplification factor of this tube (90) is about double that of the highest mu tubes of other types available at present. The combination of a very high mu, high constant input resistance and a high ratio of transconductance to interelectrode capacitance gives the ZB-120 certain advantages over other tube types, the most important of which are the following:

- (a) 245 watts of audio output at 1250 plate volts and zero grid bias.
- (b) 120 watts r.f. output as a Class

B telegraphy amplifier with zero grid bias and a driving power of but 1.2 watts.

- (c) 145 watts r.f. output as a Class C telegraphy amplifier with 135 volts grid bias from a grid leak and 5.5 watts driving power.

- (d) 45 watts of phone carrier as a Class B linear amplifier with zero bias and a grid driving power (at modulation peak) of 1.5 watts.

- (e) 42 watts of phone carrier as a grid modulated Class C r.f. power amplifier with 75 volts fixed bias and 1/6 watt driving power.

- (f) 105 watts output as a frequency doubler for telegraphy with grid leak bias and 7 watts driving power.

- (g) 45 watts of phone carrier (at 80 per cent modulation) as a grid-modulated frequency doubler with 330 volts of fixed bias and 7 watts of driving power.

- (h) 95 watts output as a plate-modulator class r.f. power amplifier with 1000 volts on the plate.

With the exception of (h), all the above operating conditions are for a plate voltage of 1250 volts. Lower voltages can, of course, be used with corresponding lower outputs. We have, for instance, gotten ten watts output from the ZB-120 as a 10-meter doubler with only 380 volts on the plates of both tubes, in this transmitter.

The operating conditions that were of most value to us for this particular transmitter were (c) and (f). Condition (b) would be of interest if doubling in the final amplifier (necessary for operation of our two-stage transmitter on 10 meters) were not contemplated. With a driving power of only 1/2 watt required, any of the receiving type power tubes (47, 2A5, etc.) may be used in the oscillator stage at quite low plate voltages. The determining operating condition for this transmitter, however, is that of (f), which requires 7 watts of driving power. As long as this much driving power is required for 10-meter operation, it is just as well to use this available power to operate the ZB-120 under condition (c) for the other bands and get the maximum output of 145 watts on these bands.

The Oscillator Stage

As the oscillator is to operate as a triet at times, one of the beam tube family was chosen for the oscillator. All of the beam tubes have a large second harmonic component which causes them to produce practically as high a second harmonic as fundamental output. The RK-39 was given preference over the other beam tubes because of its decidedly higher voltage and current ratings.

When using the triet circuit, an extra tank is necessary for the cathode circuit. This is not classed as an extra tuned circuit in this transmitter, however, because it is self-tuned with a self-contained mica trimmer condenser. This condenser tunes broadly enough so that it needs but a single adjustment to cover an entire band. When once set it may be forgotten.

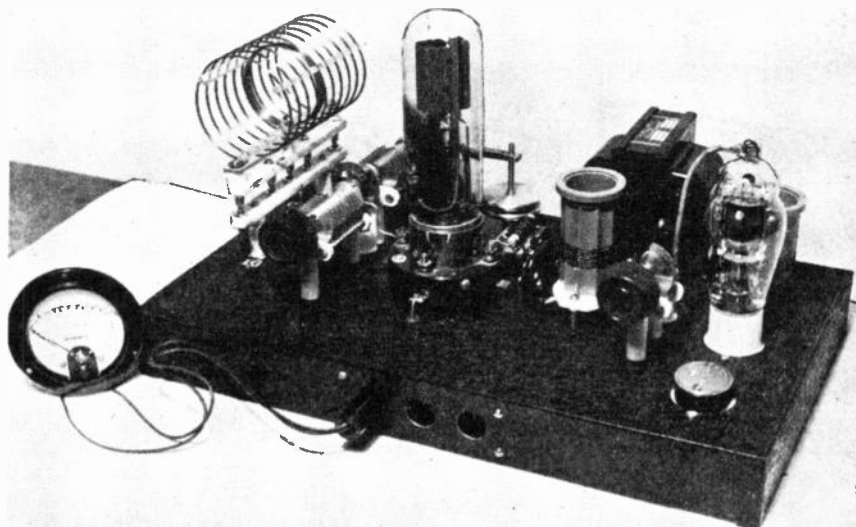
The use of small coil forms and a receiving-type condenser keep the cost of the oscillator parts low. The oscillator tuning condenser is mounted above the chassis with a pair of type CI-31 stand-off insulators. The socket for the plate coil is also mounted above the chassis with the metal spacers that come with the socket. This above-base mounting of both coil and condenser keeps the leads very short and permits of more turns in the plate coil.

The Amplifier Stage

The power amplifier stage is conventional in design and construction except for the use of the ZB-120 instead of one of the more familiar class of "50-watt" tubes. In order to save both space and cost, a pair of midget transmitting condensers are ganged to form a split-stator condenser which has more convenient proportions than the usual large frame condenser. Four more of the type CI-31 insulators mount these two condensers well off the chassis. A type FC coupling is used to gang them.

The ZB-120 socket is mounted about a half-inch above the chassis to reduce its capacity to ground. It should be oriented so the grid connection faces the oscillator coil. This gives the shortest leads for the amplifier stage.

The neutralizing condenser, NC, is of a new mycalex-insulated type. It has been found that more complete neutralization can be obtained with this type than with the usual frame type, due to lower capacity to chassis. The tank coils for the amplifier have a built-in link for coupling to an antenna or larger amplifier stage. These links have been found to be the correct size for coupling directly to a 400- or 500-ohm line, such as is used with the Johnson Q type of antenna.



Two tubes, crystal controlled, high power—the c.w. transmitter for 10, 20, 40 and 80 meters, using the new ZB-120 in the final. It may be readily adapted to phone.

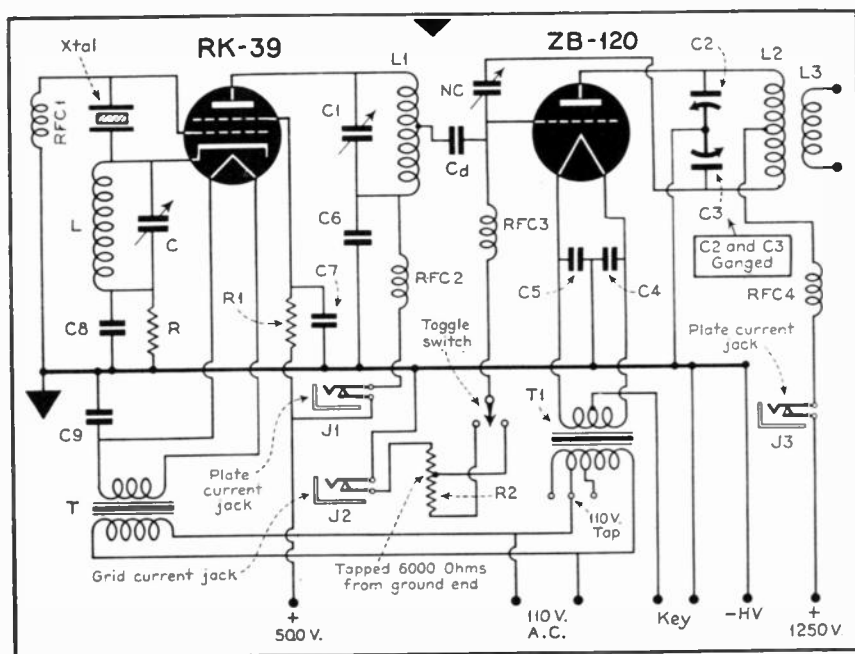
volts on the plate, for instance, the plate current will be only 50 mills with no excitation. Two different values of grid bias, and therefore two different values of grid leak resistance, are necessary, one for straight-thru and one for doubler operation. The exact values to be used depend on the plate voltage used, as well as the amount of driving power furnished by the RK-39. For c.w. operation we found that 6000 ohms for straight amplifying and 15,000 ohms for doubling were optimum. A single 15,000-ohm resistor with slider takes care of both resistance values required. An S. P.D.T. toggle switch, mounted on the back edge of the chassis, switches to either tap.

The Power Supply

While the filament of the ZB-120 may be run at 10 volts (2 amps.) under several of the operating conditions enumerated for conditions (c) and (f), under which the tube is running in this transmitter, 10.5 volts are required. Unfortunately, no 10.5-volt transformer of reasonable size and cost is at present available. The problem was solved by using a standard 10-volt, 6.5-amp. trans-

A small feed-thru insulator is mounted on the chassis between the two condenser sections. This insulator connects, on top, to the frames of the condensers and on the bottom to the common ground bus. *Don't forget to connect both of the condenser frames to this insulator—we did, and took an evening to find the "trouble" in the amplifier.*

The high μ of this tube makes grid leak bias practical for both straight-through and doubler operation. With no excitation the plate current of the ZB-120 will drop to a safe value. With 1250



Circuit diagram of the two-tube, high power c.w. transmitter.
Parts values are given in list of parts.

former. This particular filament transformer has three primary taps, for line voltages of 105, 110 and 115 volts. By using the 110-volt tap on a 115-volt line the voltage at the tube socket came out to exactly 10.5 volts.

This transformer is mounted on top of the chassis in the position shown. The filament transformer for the RK-39 is mounted under the chassis. An a.c. receptacle on the back edge of the chassis connects to a 110-volt line cord. This arrangement greatly simplifies the power connections to the transmitter. With the filament transformers self-contained, grid leak bias on the final and cathode bias on the oscillator, the only other power connections required are the plate voltages for the two tubes. A pair of posts for connection to the key complete the external connections. Small feed-thru insulators, mounted on the back edge of the chassis, take care of all connections except to the 110-volt a.c. line.

A rather novel arrangement is used in mounting the three meter jacks. These jacks are mounted on a small piece of hard rubber, which is in turn mounted a half-inch back from the front edge of the chassis. Large holes are drilled in the chassis directly in front of the three jacks. With this arrangement the jacks are away from careless fingers. With the plug all the way into any of the jacks, the metal part of the plug is safely hidden. These holes in the chassis should be large enough to clear the plug. More than one meter may be plugged in simultaneously if desired.

Operation

The transmitter was first tested with low voltage on both tubes. The power supply used for the first tests is the one shown for the 2.5-meter "Ground Hog" in this issue. Under the load drawn by this transmitter the voltage was 380. With a 40-meter crystal an output of ten watts could be secured on ten meters. One difficulty was noticed in these first tests that was at first thought could not be eliminated in this layout. The crystal current was so high that the crystals heated very rapidly and the frequency drifted a number of kilocycles in a matter of seconds as a consequence. The

crystal holders were uncomfortably hot to the touch. In these tests a recommended grid leak of 15,000 ohms was used on the oscillator in addition to the cathode resistor.

Advice from a person who had experimented with beam tube oscillators to a greater extent than we had was to the effect that this crystal heating could not be eliminated except by the use of trick circuits of the "controlled oscillator" type. As a last resort the grid leak was completely shorted out, leaving only the bias resistor. The crystal current immediately dropped to a safe value while the output of the tube remained the same. A $\frac{1}{4}$ -watt neon bulb which had before lighted quite brilliantly when applied to the grid went completely out when this leak was shorted. On monitoring the signal it was found to hold as steady as a rock.

The transmitter should be first tested on twenty meters and the ZB-120 neutralized for that band. The neutralizing condenser, when set at this value, provides a desirable degree of regeneration for doubling to 10. With the final correctly neutralized and the trimmers in the cathode coils set for maximum output from the oscillator as a triode doubler, the transmitter is ready for operation with full voltage on the final. It is always a good idea to tune up the ZB-120 on low voltage. A switch to throw this final stage to either the low or high plate voltage is an addition well worth incorporating.

Specifications for an extra cathode coil are included so that 80-meter crystals may be used when desired. Although the transmitter was only tested on 10, 20 and 40 meters there is no good reason why it may not also be used on 80 meters. An oscillator plate coil of about 35 turns can be used. Whenever the oscillator plate circuit is tuned to the crystal frequency, a piece of heavy wire bent in the form of a U is used as a shorting bar in place of one of the cathode coils.

Test Operation Data

Operation on both 10 and 20 meters was tried with a variety of voltages on both tubes. The results of several of these tests are incorporated in the ac-

companying Test Operation Data Chart. In one of these tests the oscillator was run with a plate voltage of 720, using a 20-meter crystal. Both the tube and the crystal ran cool. Tritet operation of the RK-39 was tried with this plate voltage of 720 but the tube ran a bit red under these conditions. About 500 volts is a safe maximum for the RK-39 as a tritet. Under no conditions should either the ZB-120 or RK-39 plates show any trace of color.

Using a 40-meter crystal and plate voltages of 440 and 1000, respectively, on the two tubes an output of approximately 60 watts was obtained on 10 meters. We doubt if the increase in output to 100 watts or so would be noticeable in most cases at the receiving end on this band.

The operating conditions listed in the chart do not represent the conditions for maximum output, but rather the particular conditions under which the transmitter was tested. Somewhat higher outputs may be obtained with optimum voltages and currents on the tubes. While plate voltages of 1000 and 1250 are given in this chart it must not be thought that the transmitter cannot be used effectively on lower voltages. Some tests were run

with 600 volts on both tubes. The ZB-120 ran quite efficiently at this voltage, in fact even at the low voltage of 380 with which the transmitter was first tested. For the chap who has at present only a 500- or 600-volt power supply this transmitter is still an effective and low-cost rig. The voltage on the final may be increased at any time with no change in the transmitter. This rig is, in fact, extremely tolerant of plate voltages. This makes for an easily-operated job which may be changed to various bands when desired without applying advanced engineering tactics.

Low-Cost Power Supplies

One type of power supply for this transmitter which is both adequate and cheap is the now popular bridge rectifier circuit. A power transformer having 500 to 750 volts each side of center should be used. The best rectifier tubes for this circuit are the 5Z3 type. The 5Z3s have been used by us on voltages up to 1700 volts, believe it or not. At voltages of around 1000 or 1250 these tubes seem to last indefinitely. We have yet to see one of our 5Z3s give up the ghost. Type 83s have a short life when used on high voltages and have a habit

COIL DATA CHART

Nature of Coil	Turns	Wire	Spacing	Excitation Tap	All forms Hammarlund SWF4, 1 1/2" diameter. Cathode coils have Hammarlund 1BT-220 trimmer condensers mounted in coil forms with screw.
				10 ZB-120 Grid	
Cathode coil for 40-meter crystal	6	No. 20 enam	diam. of wire		
Cathode coil for 80-meter crystal	12	No. 24 d.s.c.	close wound		
Osc. plate coil for 20 meters	9	No. 20 enam.	diam. of wire	4 turns from plate end	
Osc. plate coil for 40 meters	14	No. 20 enam.	diam. of wire	5 turns from plate end	

TEST OPERATION DATA CHART

Crystal Used	Oscillator Output	Amplifier Output	Oscillator Plate Volts	Oscillator Plate Mils	Amplifier Plate Volts	Amplifier Plate Mils	Amplifier Grid Leak	Amplifier Grid Mils	Amplifier Grid Volts	Approx Output
20 M.	20 M.	10 M.	440	37	1000	125	15,000	10	150	75 W.
20 M.	20 M.	10 M.	720	50	1250	135	15,000	15	225	100 W.
40 M.	20 M.	10 M.	440	30	1000	110	15,000	10	150	60 W.
40 M.	20 M.	20 M.	500	50	1250	135	6,000	25	150	120 W.

of shorting the power supply when they blow.

Other low-cost supplies may be constructed with either the new dual winding or multiple winding power transformers, which require only two 5Z3s.

Nothing has been said about fone operation. For the ham who wants a cheap 10-meter fone, the ZB-120 may be operated under condition (g). A simple grid modulator using a receiving power tube for the output tube should be sufficient. Adjustments for operation

under these conditions are somewhat critical, as in all grid-modulated transmitters. Probably the best arrangement for 10-meter fone is to use a small amplifier for plate modulation. The 6L6 modulator described in the 2.5-meter "Ground Hog" article is sufficient to modulate a 10-meter carrier of the order of 40 or 50 watts. As has been mentioned in previous transmitting articles, this amount of power is quite ample for 10-meter work.

PARTS FOR C.W. TRANSMITTER

AEROVOX

- 3—.002 mfd., mica bypass condensers, 600 v. working (C4, C5, C6)
- 1—.00025 mfd., mica bypass condenser, 2500 v. working (Cd)
- 3—.01 mfd. midget mica condensers (C7, C8, C9)

AMERICAN RADIO HARDWARE

- 1—type 1303 neutralizing condenser (NC)

AMPEREX

- 1—type ZB-120 tube

BIRNBACH

- 8—type 458 feedthru insulators
- 7—type 478 feedthru insulators

BLILEY ELECTRIC

- 1—type LD-2 40-meter crystal
- 1—type HF-2 20-meter crystal

COTO COIL CO.

- 1—type 10BTL coil (L2, L3)
- 1—type 20BTL coil (L2, L3)
- 1—type 40BTL coil (L2, L3)
- 1—type CI-6BTLM mounting base
- 6—type CI31 standoff insulators

HAMMARLUND

- 2—type S4, 4-prong isolantite sockets
- 2—type S5, 5-prong isolantite sockets
- 4—type SWF4 coil forms (L, L1)
- 3—type CHX r.f. chokes (RFC1-2-3)
- 1—type CH500 r.f. choke (RFC4)
- 1—type FC shaft coupling

- 1—type MC-50-S tuning condenser (C1)
- 2—type MC-50-SX tuning condensers (C2, C3)
- 2—type IBT220 trimmer condensers (C)

JOHNSON

- 1—type 211 socket

LEEDS

- 1—17" x 10" x 2" crackle finish chassis

OHMITE

- 1—500 ohm, 10 watt resistor (R)
- 1—15,000 ohm, 25 watt resistor with slider (R2)
- 1—50,000 ohm, 10 watt resistor (R1)

THORDARSON

- 1—type T6414 filament transformer, 10 v. (T1)
- 1—type T6185 filament transformer, 6.3 v. (T)

TRIPLETT

- 1—0-300 ma. bakelite case 3-inch milliammeter

YAXLEY

- 1—bakelite case fone plug
- 3—closed circuit infant jacks

This transmitter has been thoroughly tested and has given satisfactory performance. The parts listed or their equivalent will give satisfactory results. Substitutions should be made with care.

A SIMPLE A.C.-D.C. CODE-PRACTICE SET

By GUY FOREST

THIS code oscillator is designed to operate a loudspeaker, and with it either one person or a roomful of persons can practice. However, in addition to a loudspeaker, any sort of earphone, headphones, or speaker unit can be plugged into the output jacks and the unit will function satisfactorily.

The power supply is taken from the house circuit of 110 volts, either a.c. or d.c., and as a result the unit is always ready for use even after being on the shelf for a year. The tubes used are a 6J7 audio oscillator and a 1-v rectifier. While capable of relatively high-power output and 110-volt operation, the set is built up from a surprisingly small amount of raw material. Exclusive of tubes, the cost of the parts adds up to less than \$1.25.

Construction

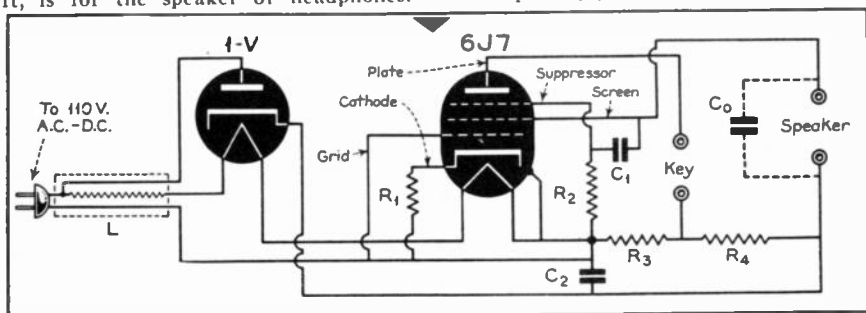
The set is assembled in a cigar box, which had best be given a coat of paint for appearance. A wooden block, about $2\frac{1}{4}$ " x 5" is screwed to the inside of the box lid, and on this are mounted the tube sockets for the 1-v and 6J7. One tip-jack pair goes in the right corner of the lid, for the key; and the other, to the left, is for the speaker or headphones.

The tube filaments connect in series with the line-cord resistor and the 110-volt source. A 16-mfd. electrolytic condenser constitutes the filter.

Other circuit details are as shown in the accompanying diagram. If a different tone is wanted, a condenser of from .005 mfd. to .05 mfd. may be connected across the loudspeaker tip jacks as shown by the C_0 and the dotted lines.

Should the oscillator be connected to 110 volts d.c. and fail to start after a sufficient warm-up period, the connector plug must be reversed in the outlet socket. In common with all a.c.-d.c. sets, it is possible under some circumstances to get a shock when touching both a grounded object and a part of the set wiring. Therefore, reasonable care should be exercised.

- L —Line-cord and combination resistor, 330 ohms
- R1—400-ohm, 1-watt resistor
- R2—500,000-ohm, $\frac{1}{2}$ -watt resistor
- R3—4,000-ohm, 1-watt resistor
- R4—10,000-ohm, 1-watt resistor
- C_0 —.005 to .05 mfd. condenser for variable tone, if desired
- C_1 —.01 mfd., 300-volt paper condenser
- C_2 —16-mfd., 200-volt electrolytic condenser
- 1—4-prong socket for 1-v tube
- 1—8-prong octal socket for 6J7 tube
- 2—pair tip jacks



Here is the schematic diagram of the code-practice set. The 1-v tube is the rectifier and the 6J7 tube the oscillator. The filaments are in series with a resistance line cord, L, and operate directly from the power line. Tip jacks are used for the key and the loudspeaker, these being mounted on the front panel. Headphones may be used if desired.

PORTABLE or QRR

Self-Powered C. W. Xmttr-Receiver

BY MYRON C. MORRIS, W_{210J}

WITH summer in full swing, amateurs are turning their thoughts to vacation and the open road. This in turn brings forth visions of an inexpensive portable rig that may be adapted to various conditions of operation away from the home shack.

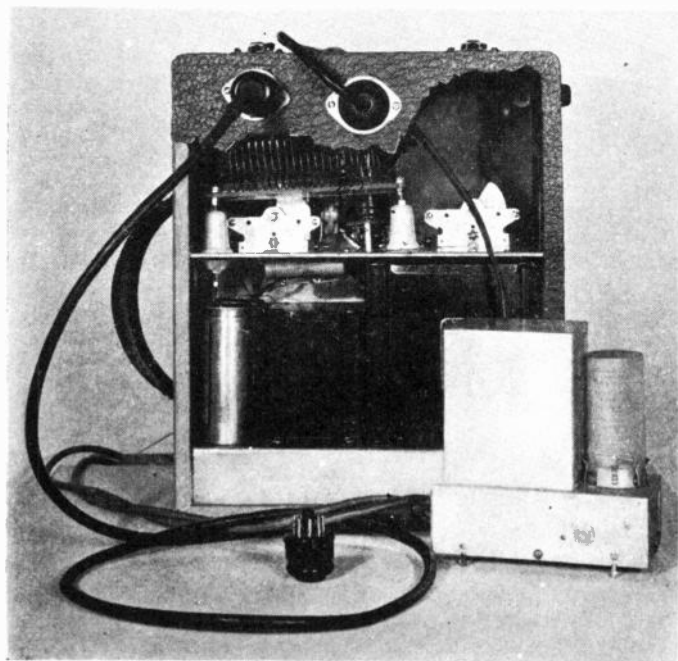
Five-meter rigs for this sort of operation are nothing new, but a compact, light-weight rig for low-frequency, fixed-portable operation, that may be used during vacation, and later retained for practical emergency operation either from power line or storage battery, is somewhat of a novelty. Such an outfit also suggests itself as an auxiliary transmitter-receiver for the shack, to be used in case of power-line or equipment

failure, and ready for instant use.

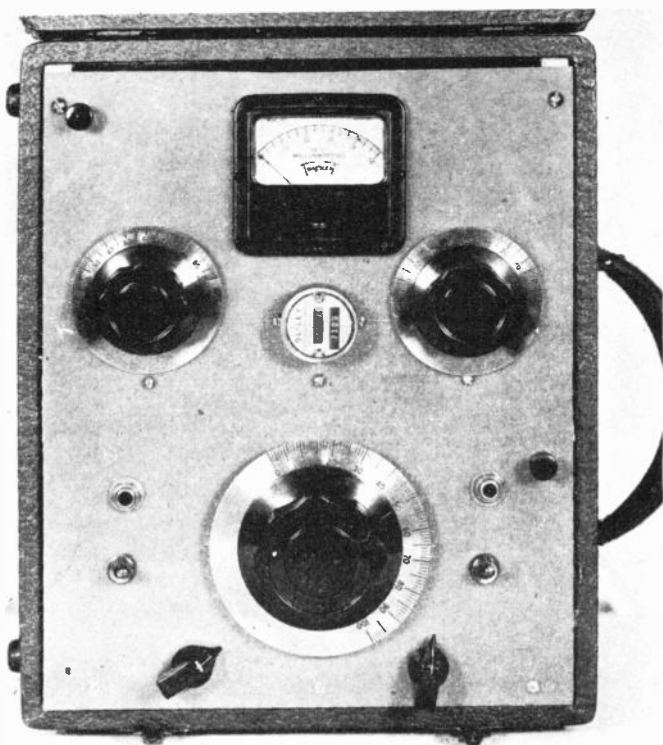
Design Details

The outfit to be described was designed with these points in mind. It will fit in the back of your chariot, in a boat, a trailer, or what have you. If the operating locale is a hotel or summer bungalow, the rig will work on 110 volts a.c. if available, or from a 6-volt storage battery. On the road it may be operated portable (but not mobile, due to F.C.C. regs.) from the car battery. The method of change-over from 6 to 110 volts is simple, foolproof and effective.

In designing a rig to be used in portable service, several important fac-



Rear view, with case broken away, to show location of parts. The Mallory "Vibrapack," which supplies filtered high voltage from a storage battery, is shown in the foreground, plugged in ready for use.



The completed transmitter-receiver mounted in a portable phonograph case. Any similar case will do, or a metal cabinet can be used. The crystal is mounted directly on the front panel, below the meter.

tors must be kept in mind to insure stable operation and trouble-free results. One of the most important is rugged construction. Both chasses of the transmitter-receiver are bent up from heavy gauge aluminum. A strap across the back supports both chasses and makes one rugged unit, permitting the whole works to be lifted up without fear of chassis warping. The panel is made of 3/32" grade bakelite. This material is easily drilled and gives a nice finish. The entire rig measures only 10" x 12" x 6" overall. All coils and adjustments are readily available by simply tilting the front panel forward.

The 6-volt "Vibrapack" is not included in the rig itself, as it is an auxiliary unit. A single cable and plug arrangement connects the "Vibrapack" with the rest of the "works." An 8-prong socket mounted on the back of the case provides connec-

tions to the 6-volt pack. When the external cable is plugged in, it not only makes all power connections, but is so arranged that if accidentally the regular power cord is plugged into a 110-volt outlet, no damage is done, because the primary of the power transformer is opened until the "jumper" plug is inserted in the power socket.

The Transmitter

It was decided the transmitter should be capable of putting out 10 to 15 healthy watts, be crystal controlled, have a minimum of adjustments, and be easily adaptable to varying antenna requirements. The circuit decided upon was a 6L6 tetrode, with a regenerative impedance in the cathode. This circuit permits greater loading of the oscillator with lower crystal current than a straight crystal circuit. When an active crystal

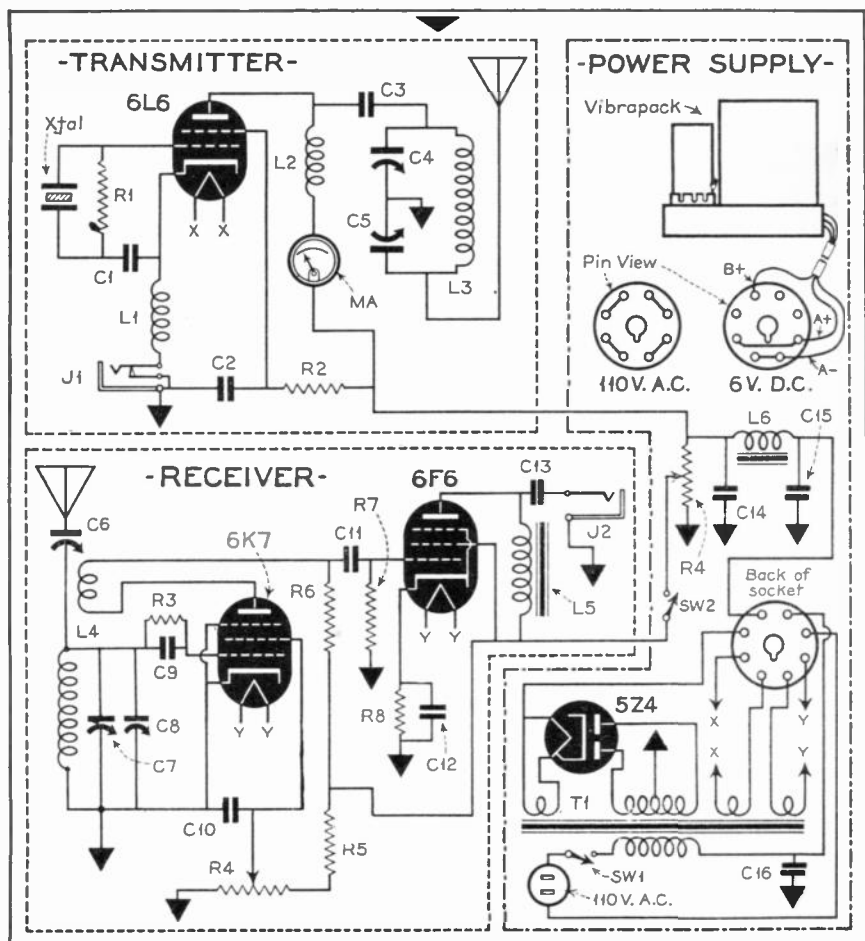
is used in this circuit, the output tank may be worked at twice the crystal frequency. However, care must be used in tuning up to prevent overloading of the oscillator, and subsequent damage to the crystal. The plate is shunt fed to permit grounded rotors on the tank and antenna condensers and also to use the unusual antenna coupling circuit that is employed here. This tuning system may be used on any single-wire antenna or any single-wire feeder arrangement.

For convenience, the crystal is mounted on the front panel by fastening a small 5-prong socket on the rear of the panel and providing two holes for the crystal holder pins to pass through. The tuning condensers, C4-C5, are mounted on small angle brackets which are in turn

screwed to the chassis with self-tapping screws. The plate coil, L3, is mounted on two small jack top insulators. The 6L6 oscillator tube itself is mounted "above board" to give short leads to the coil, condenser, and crystal socket. The only parts under the chassis are the screen dropping resistor, R2, and its associated by-pass condenser, and the cathode r.f. choke, L1, and its by-pass condenser. A small closed-circuit jack, J1, provides connection for the key plug. All power connections drop down to the lower chassis in a 4-wire cable.

The Receiver

The receiver must be on a par with the transmitter in performance, because you can't work 'em if you can't hear 'em. For



Schematic diagram of the sections comprising the transmitter-receiver. A plug arrangement permits operation from a.c. line or 6-volt storage battery.

compactness, simplicity, and general performance, a good old "blooper" fills these requirements. A 6K7 as regenerative detector has sufficient sensitivity to adequately meet all demands. A high-gain audio channel with a 6F6 follows which gives enough sock for speaker or phones as desired.

After laying out the space necessary for the power-supply section, little room was left in which a 2-tube receiver could be squeezed in, but with a little care in layout, all the parts necessary can be arranged so as even to leave a little room to spare.

The layout of the parts can be seen in the accompanying photograph. The detector tube socket is mounted on the extreme right of the chassis and is also raised on small threaded bushings. Doing this brings the grid close to the bandspread condenser, C7. The rest of the

connections pass through a large hole punched in the chassis. The Mycalex coil socket is also raised on threaded posts and wired directly to the tuning condensers.

The 6F6 audio amplifier is mounted directly in front of the filter choke. The output choke, L5, is a small a.c.-d.c. affair mounted under the deck, and connected to this is a small open-circuit jack provided for speaker or headphone use.

The regeneration control, R4, is under the chassis as well as the tank tuning condenser, C8. The coils are wound on standard $1\frac{1}{2}$ " forms. The coils used are manufactured, and gave excellent results.

All connections are made with ordinary push-back wire with the exception of the connections to the tuning condensers which are made with No. 12 bus bar. Doing this ensures a permanent, rigid

LIST OF PARTS

AMERICAN RADIO HARDWARE

- 4—No. 1600 octal sockets
- 1—No. 1304 Mycalex coil socket
- 1—No. 1330 35 mmfd. condenser (C7)
- 1—No. 1318 100 mmfd. condenser (C8)
- 1—No. 1789 jack (J1)
- 1—No. 89 jack (J2)
- 2—No. 30 insulators
- 2—No. 154 binding posts
- 1—No. 1000 hardware assortment

BLILEY

- 1—LD2 crystal

CARDWELL

- 1—MR-260BS variable condenser (C5)
- 1—MT-50-GS variable condenser (C4)

COTO COIL

- 1—type "B" coil for each frequency (L3)

HAMMARLUND

- 1—S-8 octal socket
- 1—set SWK-4 coil, (L4)
- 2—type CH-X r.f. chokes

I.C.A.

- 2—No. 1155 bar knobs
- 2—No. 2171 $2\frac{3}{4}$ " dials
- 1—No. 2169 4" dial
- 1—No. 611 condenser (C6)
- 2—No. 1230 switches (S1, S2)
- 2—No. 1176 Electrolloy panels for chassis
- 2—s.p.s.t. toggle switches

I.R.C.

- 1—50,000-ohm potentiometer (R4)

- 2—.1 meg., $\frac{1}{2}$ watt, (R1, R6)
- 2—.5 meg., $\frac{1}{2}$ watt, (R3, R7)
- 1—15,000-ohm, 10-watt, (R5)
- 1—10,000-ohm, 10 watt, (R2)
- 1—40,000-ohm, 50 watt, (R9)

KENYON

- 1—T206 power transformer (T1)
- 1—T515 choke (L6)

MALLORY

- 1—VP552 "Vibrapak"

MICAMOLD

- 2—BK450 8 mfd. 450-volt, (C14, C15)
- 1—TP400 .5 mfd. 400-volt, (C10)
- 3—TP600 .1 mfd. 400-volt, (C21, C11, C13)
- 1—TP600 .02 mfd. 600-volt (C16)
- 1—WM900 .0001 mfd. mica, (C9)
- 1—HM1500 .00025 mfd. mica, (C1)
- 1—HM2500 .002 mfd. mica, (C3)

RAYTHEON

- 1—6L6
- 1—6F6
- 1—6K7
- 1—5Z4

TRIPLETT

- 1—No. 322 0-100 ma. meter

Miscellaneous

- 2—8-prong octal plugs
- 1—male receptacle
- 1—female plug
- 1—a.c. cord
- 3 ft.—3-wire cable

connection.

The Power Supply

The power supply used is necessarily unusual, because of the unique power requirements. The 110-volt a.c. supply utilizes a 5Z4 as a full-wave rectifier. A brute-force filter with a 5/25 henry swinging choke, L6, and two 8-mfd. dry electrolytic condensers, C14-C15, complete the filter. A feed-thru cable switch, SW1, turns the power supply on or off and a stand-by switch, SW2, in the B positive lead to the receiver permits killing the receiver during transmission without turning off the heaters. The line cord terminates in a female cord plug which in turn plugs into a male receptacle mounted next to the octal power socket.

The 6-volt supply uses the new Mallory "Vibrapak." This unit comprises a transformer and a synchronous vibrator and rectifier. A built-in noise filter removes all noise and vibrator "hash" from the power supply. This, however, does not filter out any ripple so an additional filter is required. To economize both on space as well as cost, the same filter as is used with the 110-volt pack is utilized by means of the previously mentioned octal power socket. This connects the output of the vibrator pack to the set filter, disconnects the primary of the set power transformer from the a.c. receptacle, and connects the filaments across the 6-volt input.

The 6-volt input leads are directly connected to the "Vibrapak." These leads must be of at least No. 10 gauge stranded wire because at the maximum output of 300 volts at 100 mils, the input current is 7 to 8 amps. A pair of battery clips provide easy connection directly to the battery posts.

Another 8-prong plug is wired to "jump" the socket, and to reconnect the filter to the 110-volt power supply.

Tuning Up Transmitter

Assuming that the transmitter-receiver has thus far come along without serious trouble or complication, the next step is to set the rig in operation. The first step, naturally, is to connect the power

supply to be used.

To tune the transmitter, first turn the antenna condenser, C5, to maximum capacity. Next, set the oscillator tank condenser, C4, to approximately half capacity, press the key and quickly tune to resonance, as indicated on the plate milliammeter. Keeping the key pressed, tune the oscillator to a few mils higher than the lowest dip. This should be done by decreasing the capacity slightly. With no load, the plate current should be approximately 10 to 15 mils. If the reading is higher than this, readjust the screen voltage dropping resistor, R2, until the reading comes close to this value.

The next step is to adjust the antenna loading. First, set up the antenna, adjusting it to approximately 32 to 33 feet, depending upon the frequency used. Connect it to the antenna post and adjust the antenna condenser, C5, to maximum reading on the oscillator plate milliammeter. Retune the oscillator tank condenser to minimum dip, repeating this process until the oscillator plate current reads approximately 60 mils. This will give an input of approximately 19.5 watts.

Take the brick off the key and the transmitter is all set to ride.

Receiver Operation

Now comes the receiver. Plug in the proper coil and advance the regeneration control until a soft "plop" is heard in the phones. Adjust the series antenna condenser, C6, until a signal is heard. Readjust the condenser to a point where the set oscillates smoothly over the entire band. Turn the band-setting condenser until the desired band is reached. Note the setting of the condenser for returning to this point.

A short length of hookup wire is sufficient for the receiving antenna under most conditions.

Trouble Shooting

If any of the troubles mentioned here arise the suggested remedy will undoubtedly help. If the screen current of the oscillator "creeps" or -rises slowly over a period of time, readjust the screen voltage until this condition is overcome. With a plate voltage of 325 volts,

the screen voltage recommended is about 100 volts. If the crystal starts to sing, increase the antenna condenser capacity thus reducing the loading, but don't forget to retune the oscillator.

Perhaps the receiver does not oscillate. To check this, place your finger on the grid cap of the 6K7. If this brings forth a loud howl in the phones, all is well. But if no signals are heard, reverse the tickler winding connections on the plug-in coil. If the set does not slide into regeneration smoothly, adjust the tap on the power supply bleeder re-

sistor, R4. The plate voltage should be about 250 volts.

If excessive hum is experienced when operating on a.c., connect a .02 mfd. condenser from one side of the line to the chassis. In severe cases, connect a .002 mfd. mica condenser from one plate to one side of the filament of the 5Z4, using the plate-filament combination giving the least hum. If hum is experienced while using the "Vibrapack," a short, heavy ground connection to the chassis of the power supply will cure this.

Ham Notes from Zeh Bouck's Column

ONE OF THE WORST hamfesters on the air these days is the misuse of the simple letter R. R is supposed to mean exactly one thing—Okay, every word received. To rattle off a flock of Rs, and then the addendum—"OK, om, I pulled you through solid" is not merely superfluous but indicates a degree of cranial solidity as well. Still worse is to send "R, R, R" and then meander through a detailed acknowledgment—"OK on your fb report . . . OK on your QRA . . . OK about your this that and the other." When you send "R" you have already indicated that you received all the dope beyond a reasonable doubt of accuracy. Of course, about the worst of all is to come back with a snappy high-powered McElroy "R," and then make a liar out of yourself with—"Sorri ob—I missed out on that—QRM—QRN—."

Perhaps there should be some convention for indicating partial reception—for instance "R?" The letter R followed with the interrogation would indicate that some but not all of the transmission had been copied perfectly—and the operator could then ask for a repeat on the dubious portions.

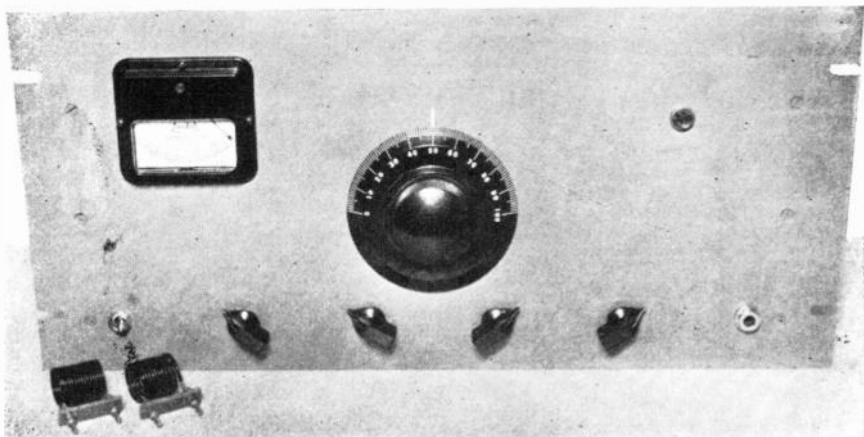
Another hamfester in the same category is the lad whose CQ you answer. He comes back with an "fb, om" and gives you an RST 589X. You return the compliment, tack on your QRA (or QTH if you insist) and he replies with a "sorri om—QRN, QRM—etc., etc."

Obviously, if things were as bad as that, his original report to you should have been an R2 or 3.

♦
SPEAKING OF QRA—QTH, we got into an argument on that point with N2HJT. N2HJT is a commercial operator and he says that as far as he and the rest of the professional brass pounders are concerned there won't be any hair splitting so far as land stations go, and that it's still QRA to him.

This led to a conversation concerning the Q sigs in general, and neither of us could figure out why they had ever been changed back in 1928-9. How many of you old timers remember when QRH meant what is your wavelength, instead of QRG . . . when QRL was a request for a test signal instead of QSV . . . when QRW meant are you busy instead of QRL . . . when QSR meant will you relay instead of QSP . . . when QSK meant cancel the last msg instead of QTA, and QTA meant please repeat . . . when QSB meant your note or tone is bad instead of QRI . . . when QSC meant your spacing is bad instead of QSD, and QSD meant what is your time . . . when QSQ meant who is calling me instead of QRZ . . . when QST was a general call to all stations . . . etc., etc., ???

Of course with the passing of the spark some changes were in order—but why so complete a revision of an internationally accepted and arbitrary code? You've got me.



FRONT-PANEL VIEW OF THE COMPLETED 5-AND-10 SUPERHET.

A 5-AND-10 SUPERHET.

By S. O. OEHRMAN • W2HG

THERE has been a marked reticence on the part of 5-meter adherents to employing superheterodyne receivers for this band. One objection has been the lack of a variable selectivity control—either the receivers respond excellently on crystal or m.o.p.a. signals and are useless on modulated oscillators, or else are so broad in their intermediates as to resemble strongly super-regenerative sets in lack of sharpness and discrimination between broad and controlled signals.

Noise Problem

The second objection is noise. Two means of combating noise are utilized in this model. The first is a radio-frequency stage which really gives an excellent amount of gain and at the same time makes the detector tuning over a wide band of frequencies extremely smooth and stable. This is due to the effect of constant load which is offered by the r.f. stage to the input circuit of the detector. The r.f. stage also prevents "pulling" of the detector. This is very noticeable in receivers which have the antenna coupled to the detector circuit. It is caused by the loading effect of the resonant antenna and

results in a large decrease in detector regeneration at one end of the band or the other. Therefore it is a distinct pleasure to operate a receiver perfectly smooth in regeneration over this extremely wide band.

The second combatant of noise is a silencer which really "goes to town." It is of the damping type, as shown in the circuit diagram, and has been tried and tested over and over again with equal success each time. It is foolproof, but will not work unless the terminals of the 6H6 tube are properly connected.

Since such great strides have been made in improving the stability of transmitters operating on the ultra-high frequencies, it seems only logical that some step must be taken in receiver design to realize and appreciate the benefits of a controlled signal.

This receiver was built with this in mind and in operation it gives preference to the better class of signal. Some very peculiar effects have been noticed in this respect. One of the queerest is the possibility of receiving a stable signal of R7 strength right through the middle of an R9 signal. This certainly is a boon to stable signals.

The Circuit

The circuit consists briefly of a tuned-radio-frequency stage using a 956 acorn tube, a 6J7 *autodyne*, first detector, two stages of intermediate frequency, with 6K7s, using iron-core transformers and resistors which peak about 30 kc., a 6H6 second detector providing automatic volume control and noise silencing, and two stages of audio amplification using a 6C5 followed by a 41 power pentode.

Several advantages have been gained from the omission of the high-frequency oscillator. Generally, it is necessary to have a separate tuning control for the oscillator since it is almost impossible to keep an ultra-high-frequency oscillator tracking properly with the detector.

Aside from this fact, the proper degree of oscillator-to-detector coupling is a hard thing to reach. An optimum is almost impossible for both ends of the tuning range.

Several superhets tried were guilty of image interference and therefore much time was spent in eliminating this annoyance. Including the r.f. stage seemed to lessen to a degree much of this, but regeneration in the first detector is the answer.

Probably the most interesting part of the circuit is the L2-C7-C8-C9-C4-C5 portion in the r.f. stage. Stumbling upon this has certainly resulted in a great deal of extra gain and band-spread.

Referring to Fig. 1, C7 is the r.f. coupling condenser, C8 the tuning con-

LEGEND

AMPHENOL

- 5—octal sockets
- 1—6-prong wafer socket
- 1—4-prong wafer socket

CARDWELL

- C2, C8—type ZR15AS variable

HAMMARLUND

- C1, C7, C13—3-30 mmfd. trimmers
- 2—insulated shaft couplings
- 1—acorn tube socket

LEEDS

- 1—chassis 8" x 3" x 17"
- 1—panel 8 $\frac{3}{4}$ " x 19" x $\frac{1}{8}$ "
- 1—set angle brackets
- T, T1—General Radio 30-kc. i.f. transformers
- 2—aluminum sheets for baffle shields

MICAMOLD

- C3, C4, C5, C6—.006 mfd. mica
- C9, C12—.0001 mfd. mica
- C11, C18, C20—.01 mfd., 400 v.
- C10, C14—.01 mfd., 400 v.
- C22, C23, 24—.025 mfd., 400 v.
- C19, C21, C25—10 mfd., 30 v. electrolytic
- C16, C17, C26, C27—.002 mfd. mica

NATIONAL

- 1—type A dial

OHMITE

- R1—1500 ohms, 1 watt
- R2—70,000 ohms, 1 watt
- R3, R20—500,000 ohms, $\frac{1}{2}$ watt
- R5—15,000 ohms, 1 watt
- R6, R7, R8—500,000 ohms, 1 watt
- R9, R10, R12(2), R14—50,000 ohms, 1 watt
- R11—250,000 ohms, 1 watt
- R13—50 to 100 ohms, 1 watt

- R15—1 to 5 megs, $\frac{1}{2}$ watt
- R16—1 meg., 1 watt
- R18—2000 ohms, 1 watt
- R19—100,000 ohms, 1 watt
- R21—600 ohms, 2 watts
- R23—500 ohms, 10 watts
- R24—25,000 ohms, 2 watts
- R25—6000 ohms, 2 watts
- R26—1000 ohms, 2 watts

RCA

- 1—type 956
- 1—type 6J7
- 2—type 6K7
- 1—type 6H6
- 1—type 6C5
- 1—type 41

TRIPLETT

- M—square type 0-10 ma. milliammeter

YAXLEY-MALLORY

- R4—500,000-ohm potentiometer
- R22—10,000-ohm potentiometer with switch
- 1—jewel pilot light
- SW1—No. 151L "Hamswitch"
- SW2—s.p.s.t. switch
- J1—switch jack
- J2—insulated closed-circuit jack

MISCELLANEOUS

- L1—For 5 meters:—10 turns No. 15 bare wire $\frac{1}{2}$ " inside diameter.
For 10 meters:—15 turns No. 15 bare wire $\frac{3}{4}$ " inside diameter.
- L2—For 5 meters—8 turns No. 15 bare wire $\frac{1}{2}$ " inside diameter.
For 10 meters:—12 turns No. 15 bare wire $\frac{3}{4}$ " inside diameter.
- RFC—Single layer No. 28 enamelled $\frac{1}{4}$ " long on $\frac{1}{4}$ " form.

denser, L2, the tuned plate and grid coil, and C4 and C5 by-passes for radio frequency. Notice that C7, the inter-stage coupling condenser, being in series with C8, (the tuning condenser) will also act as the band-setting condenser. C4 is used to return the bottom of L2 back to the grounding point of the r.f. stage, and C5 is used to return the ground of the grid circuit of the detector stage. This condenser is necessary since it completes the grid circuit and makes its return ground much shorter. Short ground leads and return condenser leads have as much control over performance as short grid and plate leads. C5 is also the return which completes the process of regeneration.

Though this circuit may not be new, it really has its advantages in ultra-high-frequency work, and the autodyne principle is practical, and satisfactory for use at frequencies as high as 56 megacycles.

The r.f. choke in the cathode of the first detector is made on a $\frac{1}{4}$ -inch form and consists of one layer of No. 28 enameled wire close-wound to a length of $1\frac{1}{4}$ inches. It provides smooth regeneration and is not critical, but must not be placed too close to any large object such as the sub-base. In other words, its capacity to ground must be as low as possible.

This brings up a point which is very pertinent at the frequencies herein considered. It is the problem of "capacity to ground." In this circuit especially a

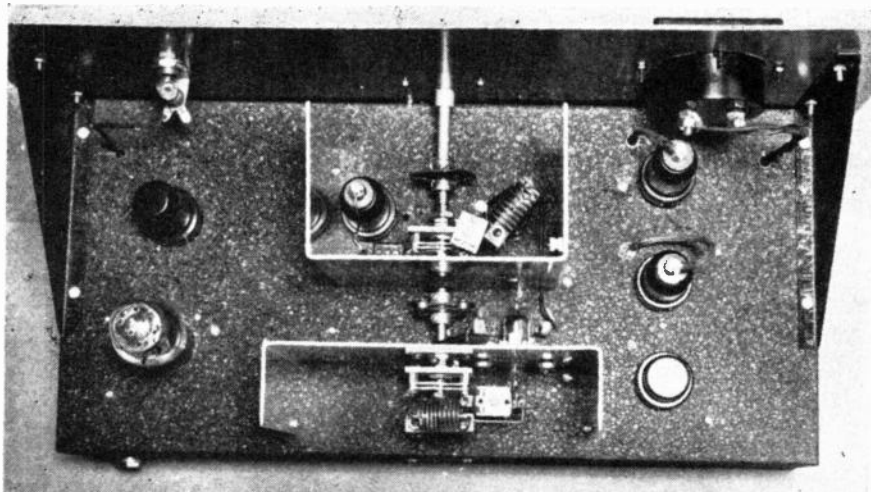
very low amount of capacity to ground is desirable because it is necessary to have the detector oscillate smoothly and weakly over a very wide band of frequencies. Therefore it is often advisable to concentrate more on this idea than it is to worry about short leads.

In order to secure better tracking the r.f. stage has also been fitted with a series band-setting condenser similar to C7. Incidentally, the tuning condensers had a capacity of 15 mmfd., but after much experimentation with different capacities the final result is the same r.f. tuning condenser minus the one back rotor plate. This value seems just about right for 75 or 80 degrees of band-spread on the actual 5-meter band, and allows some leeway at each end to receive some of the experimental stations operating nearby.

Numerous methods of coupling to the acorn tube grid circuit may be used and will probably be decided by one's own location and available antenna. However it is always necessary to load this grid enough to prevent self-oscillation of the r.f. stage.

Acorn Tube Mounting

The one part of the layout that is unique is the mounting of the acorn tube for short leads and the better shielding afforded by the *double* baffle. The shield partitions are made of 1/16-inch aluminum, scored and then bent to



Top of chassis, showing layout, and construction of double baffle shields.

shape in a large vise. They are made from stock $4\frac{1}{2}$ inches wide and bent as per the base layout sketch. The opening for the grid end of the 956 was punched with one of the $\frac{3}{4}$ -inch electrolytic condenser hole punches. These punches do an excellent job and certainly save a lot of time. Incidentally, the socket holes were also punched out and their appearance leaves little to be desired.

The shields are anchored with the usual BCL type of shield can anchor, or spade lug as they are called.

The coils are air wound of heavy bare wire and are soldered to a jack strip as shown in the photograph. The coil jacks are mounted on strips of insulation and then on pillars salvaged from end rods of old variable condensers. Coils have also been made for 10 meters and results on this band have also been very gratifying. There is no doubt that the circuit will perform equally well on 120 mc., and coils can readily be wound for this band if desired. The one advantage of the coil system is the fact that it is possible to make coils for any frequency without regard to taps, and therefore a great deal of experimenting may be done with a minimum of effort.

The I.F. Amplifier

The intermediate-frequency amplifier is a two-stage affair using 6K7 tubes. The general layout is as follows: the plate of the first detector is coupled to the input of the first 6K7 by a 30-kc.

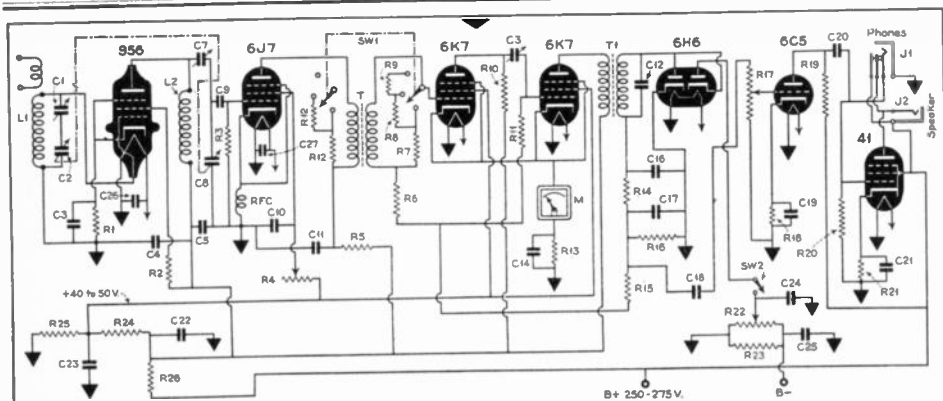
iron-core i.f. transformer. The output of this stage is resistance-capacity coupled to the second 6K7 which in turn is transformer coupled to the 6H6 circuit. These transformers were made by the General Radio Company and are just about right for use in this circuit.

No attempt has been made (with this model) to use transformer coupling throughout because of the extreme amount of gain already available and because, when tried before, the selectivity was of much too high an order for practical use at the present time. In certain services this may be helpful but it is just out of the question for amateur communication at these frequencies.

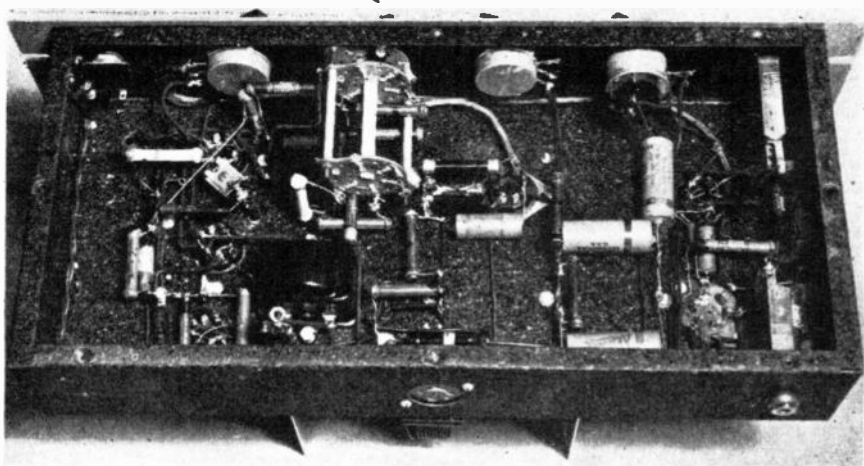
The coupling between the two intermediate-frequency stages is a 3-30 mmfd. mica trimmer condenser. Though it seems extremely small, experiment with a great range of condenser values has proven that this capacity is just about right for stable operation. Being so small in capacity it will not pass any unwanted audio frequency that might enter the intermediate-frequency stages from rectification by the detector.

Notice that no by-pass condensers are used on the a.v.c. line. A serious amount of loss was encountered when using any kind of by-pass in this part of the circuit.

Little need be said about the noise silencer except that it works, and months of use have proven that a good superhet with noise silencing is far superior to



Schematic diagram of the 5-and-10 superhet. The screen of the 956 should be bypassed to ground through a .002 mfd. condenser. Shorting prongs not shown in speaker jack.



Under-chassis view of receiver, showing location of the special i.f. transformers and the variable-selectivity switch.

a good super-regenerative set. Aside from the advantages of greater selectivity, the sensitivity of the superhet adds a great deal of pleasure to operating.

The Audio Amplifier

The audio may almost be forgotten since it is standard everyday practice. One point worth noting, however, is the preference in some cases of greater audio gain. Therefore, it may be advisable to use a 6F5 instead of a 6C5 in the first audio stage. Though this was not necessary in the present model, some constructors may be used to a great deal of gain and this is about the best way to obtain it.

The receiver is built on a standard relay rack base fitted to the standard 8 $\frac{3}{4}$ -inch panel made of $\frac{1}{8}$ -inch aluminum. This heavy panel is important for several reasons, one of which is the elimination of microphonics. It is sprayed a battleship gray to give it a truly commercial appearance. The smooth gray finish does not hold dust as a crackle finish does, and therefore it is always neat and may be cleaned easily.

The reasons for not including the power supply and speaker are obvious. A serious bit of hum has been avoided by isolating the power supply, and a tremendous amount of microphonic feedback has been eliminated by using an external speaker. This microphonic feed-

back is very bothersome even on moderately strong signals and is enough at times to render a perfectly good signal unintelligible. It is well to note in this respect that a sensitive speaker is necessary for proper operation of the noise silencer. One of the new moving coil permanent-magnet types is therefore just about what is needed.

The Power Supply

Any good power supply can be used that will deliver, under load, 6.3 volts a.c. and 250 to 275 volts d.c. However, some attention must be given in order that it shall have good regulation.

It has been found desirable to ground one leg of all filaments (No. 2) and bypass both the r.f. stage and first detec-

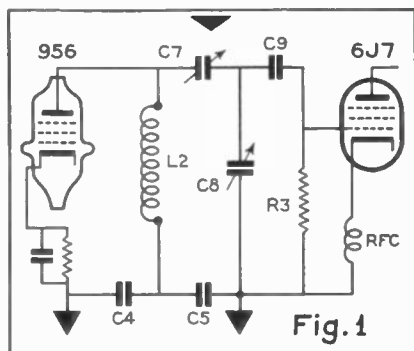


Fig. 1. The unique r.f. circuit used in the 5-and-10.

tor filaments (No 7) right at the socket back to ground. The grounds of the 956 stage must all converge at one point as should all the grounds of the detector. It is generally best to return the detector grounds to No. 1 pin of the socket and return all the r.f. stage grounds to the rotor of its tuning condenser.

Variable Selectivity Control

The selectivity switch uses a very simple method of broadening the acceptance of the i.f. stages. Having tried several systems of selectivity control, the final decision was in favor of the simplest. Variable selectivity is obtained by "switching in" various resistors shunted across the transformer windings to broaden out the frequency response. Since every other system that was tried also decreased the gain to about the same degree, and since some of the commercially-built receivers are guilty of the same thing, this system was thought to be about the best available.

The tuning or "R" meter is an 0-10 milliammeter of the square type. It has been mounted upside-down so that the needle swings to the right when a signal is tuned in. This meter reads the cathode current of the two i.f. stages and is high (to the left) when no signal is received. With a signal in the i.f. amplifier this current drops in proportion to the strength of the signal. It should be easy for local signals to push the meter needle almost to the end. With a lower

voltage power supply it would seem advisable to short out R13. In any case this meter should read about 9.5 to 10 ma. with no signal or noise pickup.

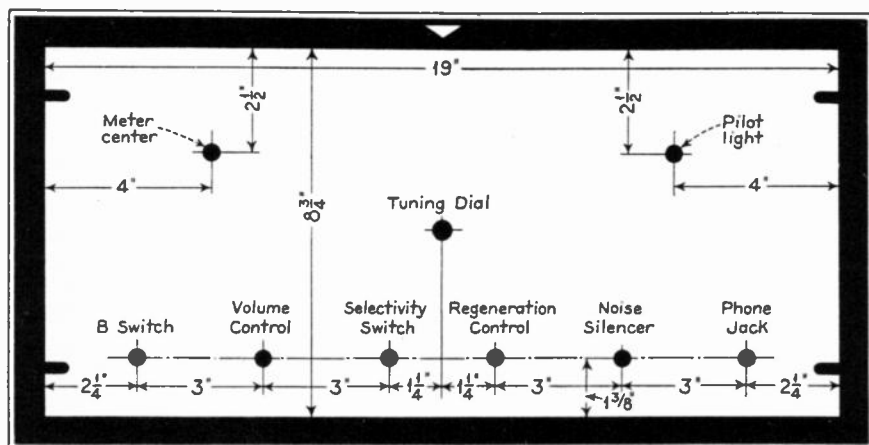
Aside from indicating signal strength, this meter also provides an excellent check on frequency modulation of any carrier. Some very startling results were had in this respect. For instance, a great many signals listened to were fine with no modulation, but with modulation the carrier would almost completely disappear.

Small Parts Used

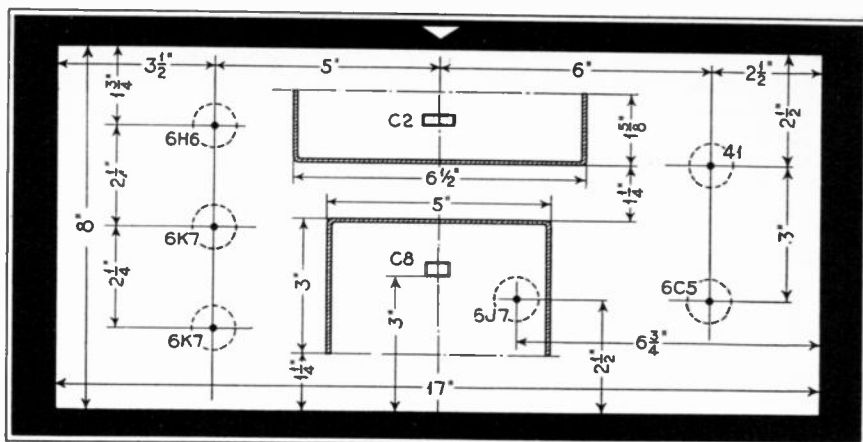
Some comment on parts may well be made. It is wise in the r.f. circuit to use parts of small physical size. This results in a much better arrangement of parts and much greater gain. The National dial was chosen because there were no airplane dials available that were in any way practical and at the same time not taking up too much space and being too expensive. The Type A dial is excellent because of its smooth performance and its ability to handle a large mechanical load without backlash.

Jacks have been provided for headphones and speaker. Being interconnected, the headphone jack automatically shorts out the speaker when phones are used.

Lock washers should be used wherever possible because it is far from encouraging to have the outfit fall apart after a few months of use. They are useful in keeping tension on the ground



Working drawing of front panel for the 5-and-10 receiver.



Working drawing of chassis and baffle shields for the 5-and-10 receiver.

connections and are recommended especially for the shield anchors. Self-tapping screws have also been put to use in this rig, and though not the best thing to use, they do save considerable time.

Needless to say a dust cover would aid

greatly in preserving the operation of the unit once it has been adjusted, and eliminates some very peculiar and annoying results experienced when ultra-high-frequency circuits become covered with dust.

Ham Notes from Zeh Bouck's Column

THERE IS SOME talk going the rounds complaining of unfairness in the government tests for ham licenses. As the story goes, the examination papers are turned over to a bevy of YLs in Washington the interiors of whose pretty heads would make an RK-21 look gaseous. Obviously the gals know nothing about radio and all answers are marked down unless they conform to a parrot-like formula. No variations on the theme are permitted. In other words, if the applicant knows his stuff and gives perhaps a better answer than required by the FCC, the chances are he will be flunked on the question. At least that's the story—and something obviously should be done about it, either in the way of denial or a correction of these conditions if they exist.

The idea seems to be that the questions must be answered precisely, word for word, diagram for diagram, as given in the ARRL License Manual. There is no doubt that such answers will get you through. (Don't depend on all

manuals, though. We know of one with a flock of answers that we wouldn't pass were we on the FCC side of the examination table.)

All we can say, personally, is that when we took the test last fall, we answered the questions in our own way, and the diagrams we drew varied (though not fundamentally, of course) from the ARRL recommendations. And we got the license. (Though if the call letters mean anything, we just skinned through!)

As described on adjoining page, the service of the Queries Department is open to all readers of ALL-WAVE RADIO magazine. This is only one of many helps to subscribers.

Hamfest

Zeh Bouck's Column

IT IS NOT illogical that the YLs should be much more gabbiest than the OM's. High in the ranks of the expert conversationalists is Dorothy of W2IXY. With something close to 200 consecutive days of consistent QSOs with Colombian HK1Z she still does an indefatigable job of rag chewing for a half hour every a.m.—from 7:30 to 8:00—on 20. We have heard her slide from monkeys to mosquitos (as a topic of conversation), which is evidence of genuine ability. Having owned several marmosets, we can testify that the logical transition would have been from monkeys to fleas.

Second only to W2IXY is Lillian at HH5PA. However, to this damsel goes an added honor in that she prefers c.w. to fone and thumbs a wicked bug with the swing of an old timer—which we understand she is. Briefly, she prefers her fist to words.

♦

SODDEN RAIN had fallen on the streets of Tyler, Texas all Friday afternoon. The mercury dropped that night, and the wind whipped the deluge into sleet—a vast tonnage of ice that by 2:00 A.M.,

Saturday morning had crippled every power line, and had isolated Tyler from the rest of the world via bus, train, automobile, telephone and telegraph. At 8:30 A.M., the sergeant of the Tyler police was hit with a bright idea, and skated around to an RCA-Victor mobile demonstration laboratory (that had arrived the day before) to see if this trailer could supply juice for a ham transmitter. It could—three kilowatts of the same so long as there was gasoline left in Tyler. So the laboratory was skidded around to the home of J. M. Burke, Jr., owner and operator of W5EME.

They were on the air by 10:00 A.M., and handled a continuous stream of emergency traffic until 1:15 A.M., Monday morning—and for another six hours starting at 4:00 P.M. Five hundred watts of fone was employed on 160. Burke and Heath Lamb, W5PH, divided the honors, with D. E. Chapman, announcer at KGKB, and Harold D. Knapp, RCA-Victor engineer in charge of the trailer, spelling at the mike. (Camden, N. J., papers pse copy.)

Chalk up another score for amateur radio!

♦

BREVITY IS THE soul of wit—and of approved calling technique. W1BES, Providencer Rhode Island, puts on a daily 20-meter demonstration of the fact that a snappy CQ can get results. And it seems to us that we recall something in the Rules and Regs on just that subject.

SOMETIMES we wonder just why abbreviations were invented. Take for instance, "fr" as a contraction of "for." Obviously, it saves one letter—but nine hams out of ten insist on substituting a different third letter for the eliminated "o", and transmit the "abbreviation" as "fer." We'll admit that "e" is shorter than "o" in code—but it is definitely not so short as nothing at all. Similarly, "hv" is the classical abbreviation for "have," but your average ham insists on sending "hve."



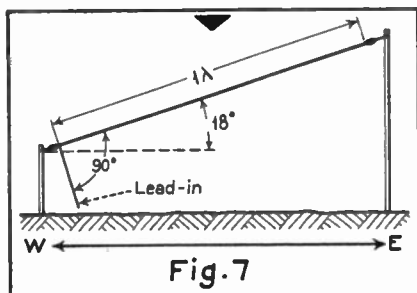
J. M. Burke, Jr., owner of station W5EME

enjoyment of this limited-space antenna with its directional effects, we simply extend the lower ends of the wires 10 feet to a transmission line, as shown in Fig. 5. The introduction of these two elements tends to reduce the directive selectivity as we find two small loops now extending at right angles to the original field pattern and at right angles to the plane of the added wires. However, we have obtained simplicity with effectiveness. A 12-inch insulator is connected between the two 10-foot leads and the transmission line of No. 16 rubber-covered wire is coupled to the antennas by a "V" whose sides are 12". Be sure to fan these sides so that they make a triangle.

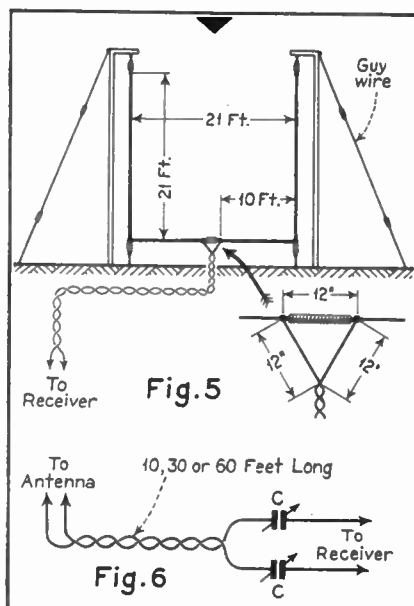
The Transmission Line

The two ends of the transmission line may then be connected either directly to the doublet posts on the receiver or to these posts through .0001-mfd. variable midget condensers, C, as shown in Fig. 6. The tuned circuit increases the effectiveness over a wide band of frequencies, but necessitates the use of a transmission line of proper length. The presence of the tuning capacitors, C, in the circuit makes the transmission line "hot"; i.e., it becomes a loop of the antenna and must be 10, 30 or 60 feet long. Variation in these lengths and in the tuning capacities will reduce directive selectivity since such variations will materially disturb the phase relationship existing between the two antennas.

We have used this arrangement with considerable success on apartment house-tops, the directional selectivity being made to follow the great circle path



A full-wave tilted antenna. This type of aerial is partial to both vertically and horizontally polarized waves.



Details of directional vertical dipole antenna. Fig. 6 shows a tuned transmission line that may be used with the dipole.

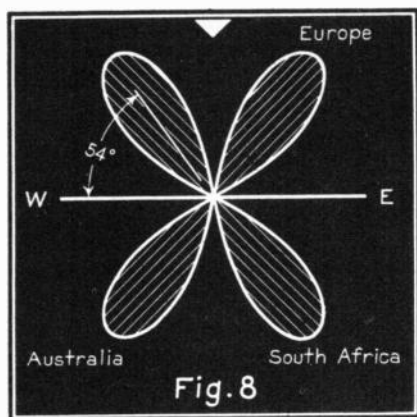
through the British Isles and Europe in one direction and Australia in the other.

The Tilted Antenna

Another easily constructed antenna for the backyard or roof-top was made by simply placing a single, full-wave antenna in a due east-and-west line, as shown in Fig. 7. The antenna was elevated at the eastern end; the elevation being one-fourth the length of the antenna or one-quarter wavelength high. The low end should be at such a height as to make the angle of incidence with the ground not more than 20 degrees, with about 18 degrees preferable. Such an antenna uses the ground as a reflector, is a high-angle affair, and discriminates against the ground wave. As illustrated in Fig. 7, the antenna is directive to the west.

A full-wave antenna does not have its maximum directivity at right angles to the direction of the wire like a one-half wave antenna, but has two lobes in the form of an "X". These lobes are at an angle of 54 degrees to the direction in which the antenna points, as in Fig. 8.

Now if the direction of our antenna

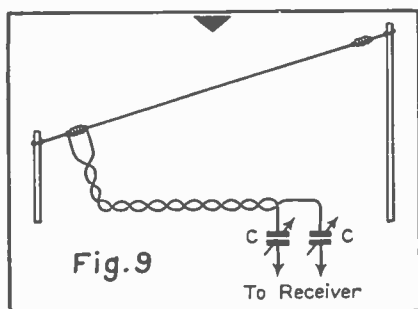


Directional characteristics of full-wave antenna.

(which in this case was due east-and-west) is fixed so that the lobes are fixed on the great circle, then strong signals will be heard from the points shown. In our particular case U. S. East coast stations were actually discriminated against, while European, South African and Australian signals were excellent.

The Lead-in Connections

To transfer the signal from the tilted antenna to the receiver we have found that a single wire line is most effective when connected at the end closest to ground. Experience has shown that this lead should be brought away from the antenna at an angle of 90 degrees to the inclined plane and should run without a bend for at least one-quarter wavelength. The shortest possible line should be used. Equally effective as to reception, more effective as to directivity, but again requiring a tuned circuit in the



Connections of tuned transmission line to tilted antenna.

transmission line, is the use of the zeppelin type twisted pair transmission line similar to the line so often used by transmitting amateurs. Fig. 9 shows how this is connected at both antenna and receiver.

Personally, I prefer this type of antenna construction to the semi-vertical antenna arrangement. Being non-directional in themselves, vertical antennas will not compare with horizontal or tilted antennas of equal length.

Of course, you may say, "Well, I want to hear all the stations." The answer is simple—if you live, as we do, in a congested district or anywhere, for that matter, where poor reception is the rule rather than the exception, then we most heartily recommend one of these, particularly the latter. Their use with directivity along the great circle path will bring all of the major stations to your receiver and bring them in with a volume and freedom from disturbances that will more than gratify you. Since our first experiments we have built numerous antennas along these lines for friends, and in every instance the improvement has been so marked as to be readily distinguishable by ear alone. It is particularly apparent when a change-over switch enables an actual comparison between the old and the new.

HAMFEST

from Zeh Bouck's Column

IF THE LADS PERSIST in using single-stage super regenerative receivers on 56 megacycles, conditions on that band are going to be as bad as on the old ham bands before the superhet pushed the single circuit tuner on to the shelf. Parked with Arthur H. Lynch, W2DKJ, in his mobile radio equipped car in Thatcher Park, N. Y., we worked stations in the neighborhood of Troy, Schenectady and Albany, N. Y. In many instances the radiations from their receivers was about as QSA as their transmitting carriers!

And by the way, we picked up several 20-meter fones on their 4th harmonics. Just because we get up pretty high in frequency doesn't mean that we don't have to watch out for harmonics still higher up!

Federal Communications Commission

Rules Governing Amateur Radio Stations and Operators

The following excerpts from the Commission's rules include all that deal solely with the amateur service and certain others that apply generally.

24. Answering notice of violation.—Any licensee receiving official notice of a violation of Federal laws, the Commission's rules and regulations, or the terms and conditions of a license shall, within 3 days from such receipt, send a written reply direct to the Federal Communications Commission at Washington, D. C. The answer to each notice shall be complete in itself and shall not be abbreviated by reference to other communications or answers to other notices. If the notice relates to some violation that may be due to the physical or electrical characteristics of the transmitting apparatus, the answer shall state fully what steps, if any, are taken to prevent future violations, and if any new apparatus is to be installed, the date such apparatus was ordered, the name of the manufacturer, and promised date of delivery.

26. If the notice of violation relates to some lack of attention or improper operation of the transmitter, the name and license number of the operator in charge shall be given.

27. Normal license periods.—All station licenses will be issued so as to expire at the hour of 3 a. m., eastern standard time.

e. The licenses for amateur stations will be issued for a normal license period of 3 years from the date of expiration of old license or the date of granting a new license or modification of a license.

28. Designation of call signals.—Insofar as practicable, call signals of radio stations will be designated in alphabetical order from groups available for assignment, depending upon the class of station to be licensed. Because of the large number of amateur stations, calls will be assigned thereto in regular order and requests for particular calls will not be considered except on formal application the Commission may reassign calls to the last holders of record.

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

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

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

Albuquerque, N. Mex.
Billings, Mont.
Bismarck, N. Dak.
Boise, Idaho
Butte, Mont.
Jacksonville, Fla.
Little Rock, Ark.
Phoenix, Ariz.
Salt Lake City, Utah
Spokane, Wash.

187. Definitions.—The following definitions shall apply generally to all services (see also International Telecommunication Convention).

188. Station.—The term "station" means all of the radio-transmitting apparatus used at a particular location for one class of service and operated under a single instrument of authorization. In the case of every station other than broadcast, the location of the station shall be considered as that of the radiating antenna.

189. Mobile station.—The term "mobile station" means a station that is capable of being moved and ordinarily does move.

190. Fixed station.—The term "fixed station" means a station, other than an amateur station, not capable of being moved, and communicating by radio with one or more stations similarly established.

191. Land station.—The term "land station" means a station not capable of being moved, carrying on a mobile service.

192. Portable station.—The term "portable station" means a station so constructed that it may conveniently be moved about from place to place for communication and that is in fact so moved about from time to time, but not used while in motion.

a. Portable-mobile station. The term "portable-mobile station" means a station so constructed that it may conveniently be moved from one mobile unit to another for communication, and that is, in fact, so moved about from time to time and ordinarily used while in motion.

193. Mobile service.—The term "mobile service" means a radio-communication service carried on between mobile and land stations and by mobile stations, communicating among themselves, special services being excluded.

194. Fixed service.—The term "fixed service" means a service carrying on radio-communication of any kind between fixed points, excluding broadcasting services and special services.

209. Damped waves.—Except for ship stations under the conditions hereinafter specified, no license will be issued for the operation of any station using, or proposing to use, transmitting apparatus employing damped wave emissions.

210. Distress messages.—Radio communications or signals relating to ships or aircraft in distress shall be given absolute priority. Upon notice from any station, Government or commercial, all other transmission shall cease on such frequencies and for such time as may, in any way, interfere with the reception of distress signals or related traffic.

211. No station shall resume operation until the need for distress traffic no longer exists.

or it is determined that said station will not interfere with distress traffic as it is then being routed and said station shall again discontinue if the routing of distress traffic is so changed that said station will interfere. The status of distress traffic may be ascertained by communication with Government and commercial stations.

214. Licensed operator required.—Only an operator holding a radiotelegraph class of operators' license may manipulate the transmitting key of a manually operated coastal telegraph or mobile telegraph station in the international service; and only a licensed amateur operator may manipulate the transmitting key at a manually operated amateur station. The licensees of other stations operated under the constant supervision of duly licensed operators may permit any person or persons, whether licensed or not, to transmit by voice or otherwise, in accordance with the types of emission specified by the respective licenses.

221. Licenses, posting of.—In the case of amateur, portable, and portable-mobile stations the original license, or a photostat copy thereof, shall be similarly posted or kept in the personal possession of the operator on duty.

In the case of an amateur or aircraft radio operator, and operators of portable or portable-mobile stations, the original operator's license shall be similarly posted or kept in his personal possession and available for inspection at all times while the operator is on duty.

b. When an operator's license cannot be posted because it has been mailed to an office of the Federal Communications Commission for endorsement or other change, such operator may continue to operate stations in accordance with the class of license held, for a period not to exceed 60 days, but in no case beyond the date of expiration of the license.

AMATEUR SERVICE

362. Definition, amateur station.—The term "amateur station" means a station used by an "amateur," that is, a duly authorized person interested in radio technique solely with a personal aim and without pecuniary interest.

364. Definition, amateur operator.—The term "amateur radio operator" means a person holding a valid license issued by the Federal Communications Commission who is authorized under the regulations to operate amateur radio stations.

365. Definition, amateur radio communication.—The term "amateur radio communication" means radio communication between amateur radio stations solely with a personal aim and without pecuniary interest.

366. Station licenses.—An amateur station license may be issued only to a licensed amateur radio operator who has made a satisfactory showing of ownership or control of proper transmitting apparatus: Provided, however, That in the case of a military or naval reserve radio station located in approved public quarters and established for training purposes, but not operated by the United States Government, a station license may be issued to the person in charge of such station who may not possess an amateur operator's license.

a. Operator's license.—An amateur operator's license may be granted to a person who does not desire an amateur station license, provided such applicant waives his right to apply for an amateur station license for 90 days subsequent to the date of application for operator's license.

367. Eligibility for license.—Amateur radio station licenses shall not be issued to corporations, associations, or other organizations: Provided however, That in the case of a bona fide amateur radio society a station license may be issued to a licensed amateur radio operator as trustee for such society.

368. Mobile stations.—Licenses for mobile

stations and portable-mobile stations will not be granted to amateurs for operation on frequencies below 28,000 kilocycles. However, the licensee of a fixed amateur station may operate portable amateur stations (rule 192) in accordance with the provisions of rules 384, 386, and 387; and also portable and portable-mobile amateur stations (rules 192 and 192a) on authorized amateur frequencies above 28,000 kilocycles in accordance with rules 384 and 386, but without regard to rule 387.

370. Points of communication.—Amateur stations shall be used only for amateur service, except that in emergencies or for testing purposes they may be used also for communication with commercial or Government radio stations. In addition, amateur stations may communicate with any mobile radio station which is licensed by the Commission to communicate with amateur stations, and with stations of expeditions which may also be authorized to communicate with amateur stations.

371. Amateur stations not to be used for broadcasting.—Amateur stations shall not be used for broadcasting any form of entertainment, nor for the simultaneous retransmission by automatic means of programs or signals emanating from any class of station other than amateur.

372. Radiotelephone tests.—Amateur stations may be used for the transmission of music for test purposes of short duration in connection with the development of experimental radiotelephone equipment.

373. Amateur stations not for hire.—Amateur radio stations shall not be used to transmit or receive messages for hire, nor for communication for material compensation, direct or indirect, paid or promised.

374. The following bands of frequencies are allocated exclusively for use by amateurs:

1,715 to	2,000 kilocycles
3,500 to	4,000 kilocycles
7,000 to	7,300 kilocycles
14,000 to	14,400 kilocycles
28,000 to	30,000 kilocycles
56,000 to	60,000 kilocycles
400,000 to	401,000 kilocycles

a. The licensee of an amateur station may, subject to change upon further order, operate amateur stations on any frequency above 110,000 kilocycles, without separate licenses therefor, provided:

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

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

375. Types of emission.—All bands of frequencies so assigned may be used for radiotelegraphy, type A-1 emission. Type A-2 emission may be used in the following bands of frequencies only:

28,000 to	30,000 kilocycles
56,000 to	60,000 kilocycles
400,000 to	401,000 kilocycles

376. Frequency bands for telephony.—The following bands of frequencies are allocated for use by amateur stations using radio-telephony, type A-3 emission:

1,800 to	2,000 kilocycles
28,000 to	29,000 kilocycles
56,000 to	60,000 kilocycles
400,000 to	401,000 kilocycles

377. Additional bands for telephony.—Provided the station shall be operated by a person who holds an amateur operator's license endorsed for class A privileges, an amateur radio station may use radiotelephony, type A-3 emission, in the following additional bands of frequencies:

3,900 to	4,000 kilocycles
14,150 to	14,250 kilocycles

378. Amateur television, facsimile, and picture transmission.—The following bands of frequencies are allocated for use by amateur stations for television, facsimile, and picture

transmission:

1,715 to 2,000 kilocycles

56,000 to 60,000 kilocycles

379. Licenses will not specify individual frequencies.—Transmissions by an amateur station may be on any frequency within an amateur band above assigned.

380. Aliens.—An amateur radio station shall not be located upon premises controlled by an alien.

381. Prevention of interference.—Spurious radiations from an amateur transmitter operating on a frequency below 30,000 kilocycles shall be reduced or eliminated in accordance with good engineering practice and shall not be of sufficient intensity to cause interference on receiving sets of modern design which are tuned outside the frequency band of emission normally required for the type of emission employed. In the case of A-3 emission, the transmitter shall not be modulated in excess of its modulation capability to the extent that interfering spurious radiations occur, and in no case shall the emitted carrier be amplitude-modulated in excess of 100 per cent. Means shall be employed to insure that the transmitter is not modulated in excess of its modulation capability. A spurious radiation is any radiation from a transmitter which is outside the frequency band of emission normal for the type of transmission employed, including any component whose frequency is an integral multiple or sub-multiple of the carrier frequency (harmonics and sub-harmonics), spurious modulation products, key clicks and other transient effects, and parasitic oscillations.

382. Power supply to transmitter.—Licensees of amateur stations using frequencies below 30,000 kilocycles shall use adequately filtered direct-current power supply for the transmitting equipment to minimize frequency modulation and to prevent the emission of broad signals.

383. Authorized power.—Licensees of amateur stations are authorized to use a maximum power input of 1 kilowatt to the plate circuit of the final amplifier stage of an oscillator-amplifier transmitter or to the plate circuit of an oscillator transmitter.

384. Transmission of call.—An operator of an amateur station shall transmit its assigned call at least once during each 15 minutes of operation and at the end of each transmission. In addition, an operator of an amateur portable or portable-mobile radiotelegraph station shall transmit immediately after the call of the station the break sign (BT) followed by the number of the amateur call area in which the portable or portable-mobile amateur station is then operating, as for example:

Example 1. Portable or portable-mobile amateur station operating in the third amateur call area calls a fixed amateur station: W1ABC W1ABC W1ABC DE W2DEF BT3 W2DEF BT3 W2DEF BT3 AR.

Example 2. Fixed amateur station answers the portable or portable-mobile amateur station: W2DEF W2DEF W2DEF DE W1ABC W1ABC W1ABC K.

Example 3. Portable or portable-mobile amateur station calls a portable or portable-mobile amateur station: W3GHI W3GHI W3GHI DE W4JKL BT4 W4JKL BT4 W4JKL BT4 AR.

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

a. In the case of an amateur licensee whose station is licensed to a regularly commissioned or enlisted member of the United States Naval Reserve, the commandant of the naval district in which such reservist resides may authorize in his discretion the use of the call-letter prefix N in lieu of the prefix W or K, assigned in the license issued by the Commission, provided that such N prefix shall be used only when operating in the frequency bands 1,715-2,000 kilocycles and 3,500-4,000 kilocycles in

THIS INFORMATION IS IMPORTANT

Judging from our heavy correspondence with "hams" all over the United States, the rules governing amateur operation are not well known or clearly understood, mainly for the reason that few hams have ever read them. Therefore, we are printing the official F.C.C. regulations herewith, with the suggestion that licensed and soon-to-be-licensed hams study them carefully.

The rules are written in simple, precise language, and no amateur can excusably misinterpret them. Obey them faithfully and help to keep amateur radio on its present high standard of good sportsmanship.

accordance with instructions to be issued by the Navy Department.

385. Quiet hours.—In the event that the operation of an amateur radio station causes general interference to the reception of broadcast programs with receivers of modern design, that amateur station shall not operate during the hours from 8 o'clock p. m. to 10:30 p. m., local time, and on Sunday from 10:30 a. m. until 1 p. m., local time, upon such frequency or frequencies as cause such interference.

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

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

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

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

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

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

frequency to another amateur band.)

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

g. The message traffic handled. (If record communications are handled in regular message form, a copy of each message sent and received shall be entered in the log or retained on file for at least 1 year.)

387. Portable stations.—Advance notice of all locations in which portable amateur stations will be operated shall be given by the licensee to the inspector in charge of the district in which the station is to be operated. Such notices shall be made by letter or other means prior to any operation contemplated and shall state the station call, name of licensee, the date of proposed operation, and the approximate locations, as by city, town, or county. An amateur station operating under this rule shall not be operated during any period exceeding 30 days without giving further notice to the inspector in charge of the radio inspection district in which the station will be operated. This rule does not apply to the operation of portable or portable-mobile amateur stations on frequencies above 28,000 kc. authorized to be used by amateur stations (see rule 368).

AMATEUR OPERATORS

400. Only amateur operators may operate amateur stations.—An amateur station may be operated only by a person holding a valid amateur operator's license, and then only to the extent provided for by the class of privileges for which the operator's license is endorsed.

401. Validity of operator's license.—Amateur operators' licenses are valid only for the operation of licensed amateur stations, provided; however, any person holding a valid radio operator's license of any class may operate stations in the experimental service licensed for, and operating on, frequencies above 30,000 kilocycles.

402. Proof of use.—Amateur station licenses and/or amateur operator licenses may, upon proper application, be renewed provided: (1) The applicant has used his station to communicate by radio with at least three other amateur stations during the 3-month period prior to the date of submitting the application, or (2) in the case of an applicant possessing only an operator's license, that he has similarly communicated with amateur stations during the same period. Proof of such communication must be included in the application by stating the call letters of the stations with which communication was carried on and the time and date of each communication. Lacking such proof, the applicant will be ineligible for a license for a period of 90 days.

This rule shall not prevent renewal of an amateur station license to an applicant who has recently qualified for license as an amateur operator.

403. Class of operator and privileges.—There shall be but one main class of amateur operator's license, to be known as "amateur class," but each such license shall be limited in scope by the signature of the examining officer opposite the particular class or classes of privileges which apply, as follows:

Class A.—Unlimited privileges.

Class B.—Unlimited radiotelegraph privileges. Limited in the operation of radiotelephone amateur stations to the following bands of frequencies: 1,800 to 2,000 kilocycles; 28,000 to 28,500 kilocycles; 56,000 to 60,000 kilocycles; 400,000 to 401,000 kilocycles.

Class C.—Same as class B privileges, except that the Commission may require the licensee to appear at an examining point for a supervisory written examination and practi-

cal code test during the license term. Failing to appear for examination when directed to do so, or failing to pass the supervisory examination, the license held will be canceled and the holder thereof will not be issued another license for the class C privileges.

404. Scope and places of examinations.—The scope of examinations for amateur operators' licenses shall be based on the class of privileges the applicant desires, as follows:

Class A.—To be eligible for examination for the class A amateur operator's privileges the applicant must have been a licensed amateur operator for at least 1 year and must personally appear at one of the Commission's examining offices, and take the supervisory written examination and code test. Examinations will be conducted at Washington, D. C., on Thursday of each week, and at each radio district office of the Commission on the days designated by the inspector in charge of such office. In addition, examinations will be held quarterly in other examining cities on the dates to be designated by the inspector in charge of the radio district in which the examining city is situated. The examination will include the following:

a. Applicant's ability to send and receive in plain language messages in the Continental Morse Code (5 characters to the word) at a speed of not less than 13 words per minute.

b. Technical knowledge of amateur radio apparatus, both telegraph and telephone.

c. Knowledge of the provisions of the Communications Act of 1934, subsequent acts, treaties, and rules and regulations of the Federal Communications Commission, affecting amateur licensees.

Class B.—The requirements for class B amateur operators' privileges are similar to those for the class A, except that no experience is required and the questions on radiotelephone apparatus are not so comprehensive in scope.

Class C.—The requirements for class C amateur operators' privileges shall be the same as for the class B except the examination will be given by mail. Applicants for class C privileges must reside more than 125 miles airline from the nearest examining point for class B privileges, or in a camp of the Civilian Conservation Corps, or be in the regular military or naval service of the United States at a military post or naval station; or be shown by physician's certificate to be unable to appear for examination due to protracted disability.

405. Recognition of other classes of licenses.—An applicant for any class of amateur operator's privileges who has held a radiotelephone

second-class operator's license or higher, or an equivalent commercial grade license, or who has been accorded unlimited amateur radiotelephone privileges, within 5 years of the date of application may only be required to submit additional proof as to code ability and/or knowledge of the laws, treaties, and regulations affecting amateur licensees.

406. An applicant for the class B or C amateur operator's privileges who has held a radiotelegraph third-class operator's license or higher, or an equivalent commercial grade license, or who has held an amateur extra first-class license within 5 years of the date of application may be accorded a license by passing an examination in laws, treaties, and regulations affecting amateur licensees.

407. Code ability to be certified by licensed operator.—An applicant for the class C amateur operator's privileges must have his application signed in the presence of a person authorized to administer oaths by (1) a licensed radiotelegraph operator other than an amateur operator possessing only the class C privileges or former temporary amateur class license, or (2) by a person who can show evidence of employment as a radiotelegraph operator in the Government service of the United States. In either case the radiotelegraph code examiner shall attest to the applicant's ability to send and receive messages in

plain language in the continental Morse code (5 characters to the word) at a speed of not less than 18 words per minute. The code certification may be omitted if the applicant can show proof of code ability in accordance with the preceding rule.

408. Application forms.—Forms for amateur station and/or operator license shall be obtained by calling or writing to the inspector in charge of the radio inspection district in which the applicant resides. Upon completion of the forms, they shall be sent back to the same office where the final arrangements will be made for the examination: Provided, however, in the case of applicants for the class C amateur operator's privileges, the forms and examination papers when completed shall be mailed direct to the Federal Communications Commission, Washington, D. C.

409. Grading of examinations.—The percentage that must be obtained as a passing mark in each examination is 75 out of a possible 100. No credit will be given in the grading of papers for experience or knowledge of the code. If an applicant answers only the questions relating to laws, treaties, and regulations by reason of his right to omit other subjects because of having held a recognized class of license, a percentage of 75 out of a possible 100 must be obtained on the questions answered.

410. Operator's and station licenses to run concurrently.—An amateur station license shall be issued so as to run concurrently with the amateur operator's license and both licenses shall run for 3 years from the date of issuance. If either the station license or the operator's license is modified during the license term, both licenses shall be reissued for the full 3-year term: Provided, however, if an operator's license is modified only with respect to the class of operator's privileges, the old license may be endorsed, in which case the expiration date will not change.

411. Eligibility for reexamination.—No applicant who fails to qualify for an operator's license will be reexamined within 90 days from the date of the previous examination.

412. Penalty.—Any attempt to obtain an operator's license by fraudulent means, or by attempting to impersonate another, or copying or divulging questions used in examinations, or, if found unqualified or unfit, will constitute a violation of the regulations for which the licensee may suffer suspension of license or be refused a license and/or debarment from further examination for a period not exceeding 2 years at the discretion of the licensing authority.

413. Duplicate licenses.—Any licensee applying for a duplicate license to replace an original which has been lost, mutilated, or destroyed, shall submit an affidavit to the Commission attesting to the facts regarding the manner in which the original was lost. Duplicates will be issued in exact conformity with the original, and will be marked "duplicate" on the face of the license.

414. Oath of secrecy.—Licenses are not valid until the oath of secrecy has been executed and the signature of the licensee affixed thereto.

415. Examination to be written in long-hand.—All examinations, including the code test, must be written in longhand by the applicant.

CHANGES!

The F.C.C. change these regulations from time to time. Before taking these as final, check with your nearest Radio Inspector or the office of the F.C.C. at Washington, D. C.

THANK YOU

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Wholesale Radio Service, Co., Inc., 100--6th Ave., New York



ZEH BOUCK

... THE RED MENACE ...

IT HAPPENS THAT out our way we're registered with the Communist Party—more or less a matter of protest against the inadequacies of the Republicans, Democrats, *et al.* This fact of course is well known in our little community of a hundred souls, and it is vaguely rumored that our cellar is amply stocked with bombs, and that our radio equipment is used for direct communication with the USSR. The town council is closer to the truth in that latter assumption. Anyhow, the theory was beautifully substantiated the other day when we received a QSL card from Operator Cerebin. URS 1390 Moscow!

Needless to say the upright citizens were about ready to run us out of town, when, in the course of our operations with the Army Amateur Radio System, we received a franked envelope from the War Department. Then the rumor went about that at last the G-men were getting wise to the Red, and the army was out after us. The good citizens decided on non-intervention and have merely been waiting around hopefully for the execution.

Unfortunately we let them down terribly by mailing an official communication *ourselves* in a penalty envelope. Now they figure we've even got the government bamboozled. W8QMR

Getting Your Amateur "Ticket"

AMATEUR licensing procedure is a little different now from what it was several years ago. For the benefit of both new "hams" and old ones returning to the game after several years absence, we are offering a few hints as to obtaining "tickets".

There are three classes of operators' licenses. Class A carries unlimited phone and c.w. privileges, and requires that the applicant have at least one year's experience as a licensed operator. A personal examination at a radio inspector's office is necessary. Class B is the general class for new operators. It carries unlimited radiotelegraph privileges, but phone privileges are limited to the 1800-2000, 28,000-28,500 and 56,000-60,000 kilocycle bands and to the fractional meter bands. Applicant must appear for a test. Class C is similar to Class B, but the examination will be given by mail if the applicant lives more than 125 miles airline from Washington, D. C., a radio district office of the F.C.C., or an examining city.

The station and operator licenses are combined on a white piece of paper a little smaller than a postcard. They run concurrently and are good for a period of three years.

Obtain application blanks from the office of the radio inspector covering the territory in which you live. Consult the accompanying list of inspection districts, make sure of your county, and then write to the correct office for information on the next examination dates.

Amateur licenses are issued only to individual citizens of the United States, without regard for age, sex or color. They are not granted to corporation or associations, except in the case of bona fide radio clubs, where a member who is already a licensed operator assumes responsibility for the club station as its trustee.

When in doubt about anything concerning license, don't hesitate to write to your radio inspector. He'll give you authentic information. Address your letter to "The Radio Inspector, Federal Communications Commission."

Boundaries of the F. C. C., U. S. Amateur Districts change slightly from time to time. However, if you will write us direct, we will promptly advise latest boundaries and location of your nearest radio inspector, together with data on days examinations are held. Be sure to mention COUNTY you are in. Address-All-Wave Radio, 16 East 43 Street, New York.

R. S. S. L. NEWS



THE Radio Signal Survey League is a non-professional, non-profit organization of scientifically-inclined radio observers working together for the purpose of improving world radio conditions. Members undertake their appointed tasks with no thought of personal reward other than the satisfaction they derive from the knowledge that they are performing a worthwhile public service. However, the League does give recognition to those members who perform outstanding services.

Aims of League

The primary aim of the R.S.S.L. is to survey radio broadcast and communication bands so that clear channels may be found for international shortwave broadcast stations; to assist any transmitting station in improving its coverage and the character of its emission, to cooperate with any station operating on an experimental basis; to reduce station interference, and to take a hand in the elimination of local noise conditions.

It is likewise an aim of the League to conduct long-range observations on signal propagation and characteristics under varying atmospheric and seasonal conditions for the purpose of learning more regarding the many freak conditions related to radio communication.

It is also an aim of the League to offer the services of its members in cases of emergency when a widespread standby for distress signals or the monitoring of communication bands becomes a matter of great importance.

League Policies

The services of the League are offered free to any commercial, broadcast, or amateur station requesting a signal survey. The League serves no one group and at all times maintains an impartial attitude with regard to such matters as station and noise interference. It is not a policy of the League to assume a dictatorial attitude in such instances, but rather to present the findings of the membership network to offenders with suggestions as to means of correction that would prove mutually beneficial.

It is not a policy of the League to duplicate or otherwise trespass upon the activities of listeners' clubs at present devoted to the collection and compilation of data on DX stations. On the contrary, it is the policy of the League to cooperate with such clubs wherever and whenever it may.

League Functions

The League is composed of a world-wide and ever-growing network of Monitoring Stations maintained and operated by its members, these Monitors being placed at the free disposal of individuals or companies desiring accurate data on

CONCERNING THE R.S.S.L.

A recapitulation of the aims, policies, departmental functions, regulations, and activities of the Radio Signal Survey League is presented here for the benefit of present and future members who will wish to keep this condensed data on file for future reference purposes.

signal transmissions. Such requests, together with frequencies and operating schedules, are published in ALL WAVE RADIO magazine, the official organ of the Radio Signal Survey League. It is the duty, then, of each member to monitor the signals in question in his own locality, prepare a report at the termination of the schedule, and forward said report to the Section Manager in his state, province or territory. For the sake of uniformity, reports should preferably be made on the standard Reception Report Forms, which may be purchased from League Headquarters, but will be satisfactory if made on plain or graph paper and following the general style of the standard Report Form.

League Divisions

There are five League Divisions. A member may serve one or all of the Divisions as he sees fit.

The *Standard Broadcast Division*, under the direction of Ray La Rocque, is given over entirely to the survey of signals in the standard broadcast band.

The *Short-Wave Broadcast Division*, under the direction of J. B. L. Hinds, handles surveys on short-wave broadcast and commercial phone stations.

The *Amateur Phone Division*, directed by Zeh Bouck, covers surveys on amateur phone stations in the 5-, 10-, 20-, 75- and 160-meter bands.

The *Amateur C. W. Division*, under the direction of Willard Bohlen, is set up not only to survey c.w. signals in all the amateur bands, but commercial c.w. stations as well.

The *Noise Survey Division*, under the direction of E. W. Lederman, is set up for the purpose of alleviating conditions of severe man-made electrical interference in local areas. In instances where League members are able to determine the source of such interference and the approximate area it covers, a detailed report to headquarters will be analyzed and the condition brought to the attention of the offender, and

practical suggestions offered as to means, approximate cost, etc., of eliminating the disturbance.

League Set-Up

The supervisory section of the R.S.S.L. is composed of the Headquarters Staff, the Acting Director, the five Divisional Directors named above, and the Sectional Managers who are the League representatives in states, provinces and territories throughout the world.

Members are requested to communicate directly with Divisional Directors on all matters dealing with League regulations, suggestions, reports on unsolicited surveys, new stations heard, etc., directing the communication to the Director of the Division in question. For instance, should you hear a new station in one of the short-wave broadcast bands, or note an unusual fade-out condition, your report should be addressed to Mr. J. B. L. Hinds, Director, Short-Wave Broadcast Division, Radio Signal Survey League, 16 East 43rd St., New York, N. Y. The same address should be employed when communicating with the other League Directors, or directly with Headquarters. Letters, news items and general discussions regarding League activities, for publication in the R.S.S.L. News section of ALL-WAVE RADIO, should be forwarded to M. L. Muhleman, Acting Director, R.S.S.L., at the same address.

All reports and communications regarding official signal surveys, as announced from time to time in ALL-WAVE RADIO, should be sent to the Sectional Manager for your state, province or territory. You will find the name and address of the Sectional Manager for your locality in the accompanying list. If no Sectional Manager has been appointed for your state, province, territory or country, send your reports directly to the Acting Director at League Headquarters.

A better idea of the inter-relations between League Headquarters, Division Directors, Sectional Managers, League Chapters, and Members, can be gained from the block diagram of Fig. 1. This illustrates the complete League set-up, and indicates the "direction of flow" of signal survey reports, etc., from members.

R.S.S.L. Chapters

A minimum of five duly registered R.S.S.L. members is required to form a chapter. The territorial boundary of chapters shall in all cases be set by the Directors and stipulated in the chapter's charter. The Directors reserve the right, however, to modify the chapter's boundary in the event they consider it for the best interests of the R.S.S.L. The nature of the League and the irregular distribution of population reflected in its membership makes it necessary to allow elasticity in ruling on the setting of boundary lines for individual chapters. Certain key cities may rate several chapters within their limits whereas some entire states may be satisfactorily served by but two or three chapters. In addition to the problem of unequal geographical distribution of population, the R.S.S.L.'s growth is so rapid that a single chapter is apt to grow beyond practical size and become unwieldy. A county chapter, for instance, may grow so large that its members might find it convenient to divide it into a number of town or city chapters.

No regular membership dues in any form may be charged members by the chapter for the privilege of joining.

Chapter names should preferably indicate the section which they cover and must clearly state their affiliation with the R.S.S.L.

The Directors of the R.S.S.L. reserve the right to revoke charters of local chapters at any time should they feel that such chapters are not working for the best interests of the R.S.S.L.

Chapters are under the direct supervision of their Sectional Managers. All controversial matters outside the chapter itself should be reported through him to the Chapter Director who in turn will call a meeting of the Directors for a final decision.

A "Survey Supervisor" shall be elected by each chapter to act as the leader of the chapter in all official survey matters as well as chapter activities. Elected by majority vote, his term shall run from January 1st to December 31st for one full year. It is the Survey Supervisors duty to see that all chapter members are informed of forthcoming surveys. On conclusion of each survey he is to be responsible for the collection of the reports from chapter members participating, the proper sorting of such reports, and of forwarding them in collated form to the Sectional Manager.

In addition to the Survey Supervisor, each chapter shall elect by majority vote a Secretary whose duty it shall be to supervise chapter meetings, handle official chapter correspondence and transmit to League Headquarters, each month, news on chapter meetings, activities, new members, etc., the correspondence being addressed to the Chapter Director, R.S.S.L., 16 East 43rd St., New York, N. Y. Such reports should be mailed not later than the 20th of each month.

Applications for Chapter Charter

All duly registered members of the R.S.S.L., with the exception of the Division Directors and Sectional Managers, may join local chapters, though Directors and Sectional Managers may become honorary members of one or more of the chapters in their locality, but under no circumstances may they hold office in any chapter.

A minimum of five R.S.S.L. members are required to form a local chapter. In the event that a group of less than five members experience difficulty in securing the necessary minimum, the Chapter Director will supply the group with the names of other R.S.S.L. members residing in their locality. If there is still difficulty in bringing together five members, it is suggested that the group wishing to form the chapter make a drive in their locality for a sufficient number of new members to meet the charter requirements. Membership Application Blanks can be obtained from Headquarters on request.

In making application for a chapter charter, proceed as follows:

(1) Draw up a petition signed by all interested members, giving their names, addresses and monitoring station identifications, and set forth:

- (a) Proposed name of chapter.
- (b) Suggested geographical boundaries of chapter.
- (c) Names and addresses of Survey Supervisor

and Secretary—both elected by majority vote.

(d) Proposed chapter headquarters and meeting place.

(e) Day of week or month selected for regular meetings.

(2) Submit the petition to the Chapter Director, Radio Signal Survey League, 16 East 43rd St., New York, N. Y.

Official notification of the acceptance of the charter petition will be given by letter and a charter certificate, including name of chapter, will be issued. Only those chapters so notified shall be recognized as being affiliated with the R.S.S.L.

Signal Reporting

The only practical form of signal reporting is one universally used and understood. The measurement of signal input in microvolts is an accurate means of stating the reception conditions, and is clear to any engineer analyzing a summarized report. However, this type of reading is beyond the scope of the average receiver and it is therefore necessary to fall back on the standardized "QSA" and "R" systems which, though having arbitrary values, are sufficiently accurate for the purposes of signal survey work.

The "QSA" reports deal strictly with *signal readability*, and the "R" reports with *signal strength*. When both are given, other factors are indicated, because if signal strength is high but

signal readability low, it is a foregone conclusion that the received signal is not adequately modulated, local interference is high, or another station is interfering with the one being monitored.

The "QSA" or signal-readability scale follows. For the sake of brevity, the "SA" is dropped, and in making reports it is sufficient to refer to signal readability as Q1, Q2, etc.

Q0—Only carrier audible (by means of beat-frequency oscillator)

Q1—Hardly perceptible, unreadable

Q2—Weak, readable now and then

Q3—Fairly good; readable, but with difficulty

Q4—Good, readable

Q5—Very good, perfectly readable.

The complete "R" scale of signal strength follows:

R0—Only carrier audible (by means of beat-frequency oscillator)

R1—Faint signals, just audible

R2—Weak signals, barely audible

R3—Weak signals, copiable in absence of interference

R4—Fair signals, readable

R5—Moderately strong signals

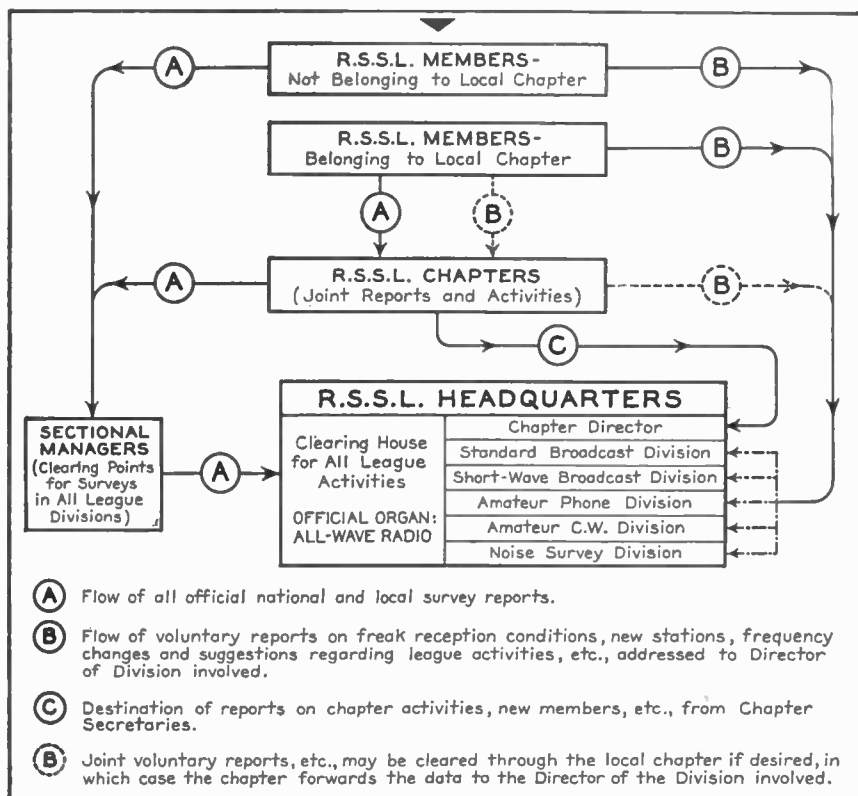
R6—Strong signals

R7—Good strong signals, copiable through interference

R8—Very strong signals

R9—Extremely strong signals

Signal fading is indicated by the letter F, the complete scale following:



Set-up and divisional inter-relationships of the Radio Signal Survey League.

DATE		RECEPTION REPORT FORM		MONITORING STATION				
YEAR 1937	MONTH March			OBSERVER John J. Lee ADDRESS Seaside, N.Y. NEAREST LARGE CITY New York				
FROM 12th	TO 13th							
TYPE ANTENNA Doublet		STATION CALL CQA		FREQUENCY 19250 KC.		COUNTRY U.S.A.		
DIRECTION OF SPAN E-W		DIRECTION FROM MONITORING STATION Due West		TIME ZONE E.S.T.		LOCATION Seaside, N.Y.		
RECEIVER CBS Model 32		AVERAGE INPUT IN MICROVOLTS 8.00		March 12th				
WEATHER		SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
TEMPERATURE °F		Snow 20	Clear 35	Clear 15	Rain-Wind 30	Cloudy 40	Clear 25	Clear 32
SIGNAL STRENGTH & READABILITY	R9							
	R8							
	R7							
	R6							
	Q5 R5							
	Q4 R4							
	Q3 R3							
	Q2 R2							
	Q1 R1							
	Q0 R0							
FADING	F6							
	F5							
	F4							
	F3							
	F2							
	F1							
INTER-FERENCE	I6							
	I5							
	I4							
	I3							
	I2							
	I1							
AVERAGE QUALITY OF SIGNAL		Excellent	Fair	Nil	Poor	Fair	Excellent	Poor
REMARKS: General reception conditions poor throughout week. CQZ has frequency drift. Due to QRM from CQZ.								

Showing method of reporting the characteristics of signals on the new R.S.S.I. forms. The vertical shaded areas represent periods of darkness. Spaces are provided for weather conditions, temperature, signal strength and readability, fading, interference, and average signal quality. The report blanks may be filled in with pencil or ink.

- F1—Bad distortion (selective fading)
- F2—Slight distortion
- F3—Deep, rapid
- F4—Shallow, rapid
- F5—Deep slow
- F6—Negligible

The League has also adopted a scale for indicating the degree of station, static, or man-made noise interference. The letter I is used and this, together with a number, indicates the degree of station interference (QRM). If it is static interference (QRN) the letter I is preceded by the letter X. If noise interference, the letter I is preceded by the letters XM. The complete scale follows:

- I1—Heterodyne (whistle)
- I2—Very bad
- I3—Bad
- I4—Fairly bad
- I5—Just audible
- I6—None

Since it is the aim of the League to provide accurate surveys to stations, it should be evident that had reports are just as valuable as good ones. A report should be made even if the station being surveyed cannot be picked up in your locality. Without such information the station cannot very well improve transmission conditions.

League Membership

Those wishing to become members should send a written request for a Membership Application

Blank to the Radio Signal Survey League, 16 East 43rd St., New York, N. Y. There are no dues, and no obligations other than a sincere effort on the part of each member to assist in the survey work to the best of his ability. No special equipment is necessary.

Each member shall receive a membership card bearing his name and a coded identification number allotted to his Monitoring Station. Each station number carries the international prefix for the country in which the station is located—for instance, W for the United States, LU for Argentina, etc. Members are requested to use their identification number on all survey reports, correspondence, etc.

W. E. Whitham
Acting Director



INDEX

TO THE A-W-R PRACTICAL RADIO MANUAL

A

Aerials, see Antenna	
Amateur Districts of U. S. & Canada (Map)	52
Amateur license, laws and regulations	131, 136
Amateur Operating Procedure, W6JMH	66, 76
Amateur Stations	
Flood Station "AB" 24: W5EMI*	46
Pictures of W5FIY & W8QMR 16: W4DLH	32
Amateur Station, Barb & E. visit	39
Amateur Station, Plans for (Barb & E.)	61
Amateurs, work on Flood Relief	24, 37, 75
Amplifier	49
Amplifier action in Vacuum tube	57
Amplification, Voltage and Power	62
Antenna	83
Antenna, design, length, doublet, etc.	38
Antenna, doublet	128
Antenna, lead-in	130
Antenna, picture of rotary	32
Antenna, tilted	129
Antenna, transmission line	129
Antenna, trouble shooting	10, 51
Antenna, Tuning, lengths, etc.	127
Audio Frequency	27

B

Beat Frequency Oscillator	73
Block Diagrams of Transmitter & receiver	69
of Superhetrodyne	71
Books, elementary radio books	7
Buzzer for learning code	5
By-passing and blocking	49, 50

C

Calls, transmission of	133
Cascade Amplifier	49
Chokes	51
Chokes, R. F.	86
Circuits, Crystal receiver	35
Circuits, Regenerative	63, 64
Circuits, Tuned	47
Parallel and variable tuned	48
Clicks, key, elimination of	65
Code, the Continental	7
Code, learning the	5, 25
Code practice, automatic tape for	15
Code practice schedules	13
Code Practice set	112
Code, rhythm and spacing	6, 8

Coils	33
Coils, primary and secondary	41
Condenser, circuits using	44
Condensers, theory and construction	43
Conventionals, radio	89, 118
Crystal receiver circuit	87
Crystal Control of Transmitter	81, 83
C. W. Kit Transmitter	95
C. W. reception on a super	73

D

Diode Rectifier tube	55
Doublet Antenna	128
Drift, of an oscillator	78
DX-4UCW Transmitter, Construction of	105

E

Electricity, alternating and direct currents	19, 21
Electricity, positive and negative	22
Electricity, theory of	17
Electricity, voltage and current	22
Electron tubes, see Vacuum tubes	
Examination, amateur operator	17, 61, 59

F

Federal Communications Commission, Rules	131
Filter	26
Fixed frequency operation of xmtr	79
Frequency, amateur bands	132
Frequency, changing transmitter	81
Frequency, channels	70
Frequency, Conversion chart, kc-meters	60
Frequency, critical	36
Frequency, definition of	28

G

Grid, function of and theory	56
Grid, voltage	57
Ground Waves	69

H

Ham Lingo, abbreviations, etc.	89
Ham Notes, Discussion of Exam. Questions	59
Ham Notes, Monotony in QSO's	59
Hartley circuit	84, 85

INDEX — (Continued)

I

Image reception	74
Impedance	36
Inductance coils	33

K

Key Clicks	65
Key, How to hold	7
Kit Transmitter	95

L

Lead-in connections of antenna	130
License, amateur requirements	134, 136
Logs, required for amateur stations	133

M

Motorboat radio	82
-----------------	----

O

Ohm's Law	45
Oscillations	28
Oscillator, code practice	112
Oscillator, functioning of	84
Oscillator, self-excited	78

P

Pentode Tubes	59, 62
Portable, Self-Powered Transmitter-Receiver	121
Power supply for a transmitter	117

Q

"Q" conventionals	92, 118
-------------------	---------

R

Radio frequency amplifier circuit	49
Radio frequency, theory	27
Radio Signal Survey League,	
Membership requirements	140
Radio Signal Survey League News	137
Radio waves	69
Reactance	35
Receiving set, a 5 & 10 superhet	119
Receiving set, theory (T. R. F.)	69
Receivers, reception of code on	40
Reception reports, (RSSL)	139, 140
Reception Report, Conventional	92
Rectifier, full wave, etc.	55
Resonance	35
Regenerative circuits	63, 64
Regulations for amateur stations	131
Resistance	35

S

Screen grid tubes	58
Selectivity in Crystal receiver	87
Sets, On choosing a	(poem) 10
Signal report system	92
Sky Wave	71
Spectrum of Radio wavelengths (chart)	28
Story, A good	on Radio Inspector 94
Superhetrodyne Receiver, a 5 & 10 meter	119
Superhetrodyne theory	71

T

Tetrodes	58
Transceiver	113
Transformers and Condensers	39
Transformer, Theory and operation	41, 42, 43
Transformer, Uses for	42
Transmission line, antenna	129
Transmitters,	77
Transmitters, C. W. Kit	95
Transmitters, for 40 and 80 meters	99
Transmitters, changing Frequency of	14
Transmitter-Receiver, portable	113
Transmitters, theory of	68
Transmitters, 1 tube Crystal	83
Transmitters, xtal on 10-20-40-80 m.	105
Triode, see Vacuum tube	
Tuning a Coil	34

V

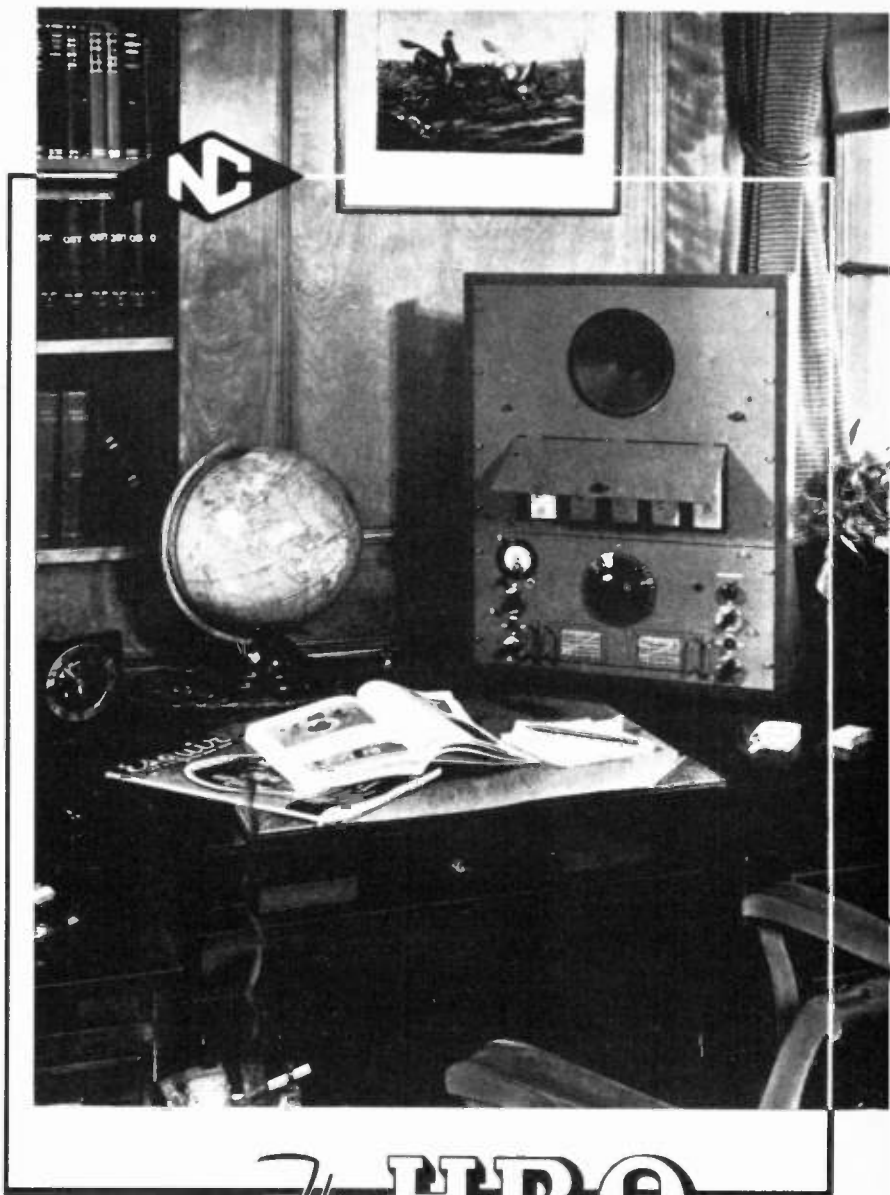
Vacuum tubes, Theory of	53
Vacuum tubes, Diode	54; Triode 56;
Tetrode 58; Pentode 58	
Vacuum tubes, Action in transmitters	63, 64, 68, 85
Vacuum tubes, Action in receivers	63, 64, 69
Vacuum tubes, Action in rectifier	54, 55
Variable Frequency Operation	78
Voltage and Power amplification	62

W

Wavelengths	70
Wavelengths and harmonics	11
Wavelengths, Chart	29, 30

*Correction

The "Typical Amateur Station" WSEMI illustrated on page 46 is actually owned and operated by Mr. Davis Fuller, 604 1/2 Ki Hekah Street Pawhuska, Okla., and not by Mr. Bird as stated.



The **HRO**

IN REPLY to professional demand, a Combination Panel consisting of a spare-coil cabinet, matched speaker and power supply is now offered as an auxiliary to the HRO Receiver. Making a compact well-appointed receiver with its speaker properly segregated to prevent annoying mechanical feed-back. Your choice of finish, either rich grey or black leatherette. Retail prices are: HRO receiver, relay rack type, with coils covering 1.7 to 30 megacycles — \$179.70; Combination Panel type SPC — \$52.50; Table-model Relay Rack type MRR — \$13.50.

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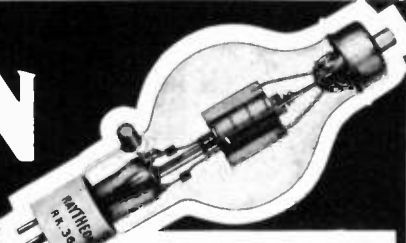
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Amateur tubes



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Type No.	Description	Price	Output
RK-10	Triode Power Amplifier Oscillator	\$ 3.50	25 W*
RK-18	Triode Oscillator R.F. Amplifier Class B Modulator	10.00	50 W 100 W*
RK-19	Full-Wave High Vacuum Rectifier	7.50	
RK-20A	5 V. Heater Peak Current Oscillator R.F. Amplifier Suppressor Modulated Phone Hard Glass Bulb	15.00	600 Ma 80 W 64 W 80 W 18 W
RK-21	Half-Wave Rectifier 2.5 V. Heater Peak Current	5.00	600 Ma
RK-22	Full-Wave Rectifier 2.5 V. Heater Peak Current	7.50	600 Ma
RK-23	R.F. Pentode Oscillator R.F. Amplifier Suppressor Modulated Phone 2.5 V. Heater	4.50	18 W 24 W 5.5 W
RK-24	Triode Power Amplifier (5 meter Oscillator)	2.25	1.2 W
RK-25	R.F. Pentode Characteristics same as RK-23 except 6.3 volt Heater	4.50	
RK-25B	R.F. Pentode Oscillator R.F. Amplifier (Characteristics same as RK-25 Bakelite Base)	3.50	18 W 24 W 5.5 W
RK-26	R.F. Pentode Oscillator—R.F. Amplifier Suppressor Modulated Phone	34.50	160 W 200 W 60 W
RK-30	Triode Power Amplifier	10.00	65 W
RK-31	Zero Bias Class B Modulator	10.00	140 W*
RK-32	Triode Power Amplifier	12.00	65 W
RK-34	Dual Triode Power Amplifier	3.50	14 W
RK-35	Triode (for Ultra High Frequencies)	8.00	75 W
RK-36	High Output Triode	14.50	200 W
RK-37	High Mu Triode	7.75	80 W
RK-38	High Mu Triode	13.50	225 W
RK-39	Beam Power Tetrode 6.3 V. H'r.	3.50	35 W
RK-41	Beam Power Tetrode 2.5 V. H'r.	3.50	35 W
RK-42	Triode Amplifier	1.10	
RK-43	Twin Triode Amplifier	1.50	
RK-44	Coated Cathode Type Amateur Pentode with Ceramic Base 12.6 V. Heater	8.50	28 W
RK-45	Coated Cathode Type Pentode Suppressor grid brought out to a separate base pin 12.6 V. Heater	5.65	24 W
RK-46	Thoriated filament type pentode suppressor grid brought out to a base pin 12.6 V. Fil.	21.75	80 W
RK-47	Beam Power Tetrode. 1.0 Watts Driving Power	17.50	120 W
RK-48	Beam Power Tetrode. 1.2 Watts Driving Power	27.50	250 W
RK-49	Beam Power Type Tetrode with standard 6-prong Isolantite base (Similar in characteristics to 6L6G)	2.10	25 W
841	Triode R.F. Amplifier	3.25	14 W
842	Triode Audio Modulator	3.25	3 W
866	Half-Wave Hot Cathode Mercury Vapor Rectifier	1.50	
866A	Half-Wave Rectifier Mercury Vapor Peak Current	4.00	600 Ma
872A	Half-Way Rectifier Mercury Vapor Peak Current	16.50	2.5 Amp.

*Indicates value for two tubes.

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Raytheon engineers expend all their efforts in building tubes. All their time—all their research—are on tubes alone. That's why Raytheon has always led the way in tube design and manufacture. That's why Raytheon's success was a series of firsts. First to build a tube designed for radio amateurs! First to build an amateur pentode. First to build a zero bias Class B Modulator. And Raytheon is first to introduce the new, exclusive beam power tubes!

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Fil. 6.3 V. Plate 750 V.
\$2.50 55 W
- RK-12—Zero Bias Class B Modulator
Fil. 6.3 V. Plate 750 V.
\$2.50 100 W*
- RK-51—20 Mu Class C Triode
Fil. 7.5 V. Plate 1800 V.
\$8.00 165 W
- RK-52—Zero Bias Class B Modulator
Fil. 7.5 V. Plate 1250 V.
\$8.00 250 W*

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TRANSOIL TRANSMITTING CAPACITORS OIL IMPREGNATED—OIL FILLED



TYPE XL



TYPE XD



TYPE XC



TYPE XT

TYPE XT—TUBULAR Oil Impregnated—Metal Case

Cap. No.	Cap. Mfd.	Operating Volts D.C.	Size Inches	List Price
XT-0005	.0005	1600	$\frac{1}{2}$ x $1\frac{1}{2}$	.50
XT-001	.001	1600	$\frac{1}{2}$ x $1\frac{1}{2}$	.50
XT-002	.002	1600	$\frac{1}{2}$ x $1\frac{1}{2}$	.50
XT-003	.003	1600	$\frac{1}{2}$ x $1\frac{1}{2}$	.50
XT-004	.004	1600	$\frac{1}{2}$ x $1\frac{1}{2}$	.50
XT-005	.005	1600	$\frac{1}{2}$ x $1\frac{1}{2}$	.50
XT-007	.007	1600	$\frac{1}{2}$ x $1\frac{1}{2}$	.50
XT-01	.01	1600	$\frac{3}{4}$ x $2\frac{1}{4}$	.50
XT-02	.02	1600	$\frac{3}{4}$ x $2\frac{1}{4}$	.55
XT-05	.05	1600	$\frac{3}{4}$ x $2\frac{1}{4}$	.65
XT-1	.1	1600	$1\frac{1}{2}$ x $2\frac{1}{4}$	.75
XT-101	.01	1000	$\frac{3}{4}$ x $1\frac{3}{4}$	.40
XT-102	.02	1000	$\frac{3}{4}$ x $1\frac{3}{4}$	.45
XT-105	.05	1000	$\frac{3}{4}$ x $2\frac{1}{4}$	.55
XT-11	.1	1000	$\frac{3}{4}$ x $2\frac{1}{4}$	.65

TYPE XD—DRAWN SHELL CAN Oil Impregnated—Oil Filled

XD-61	.1	600	$1\frac{1}{2}$ x $1\frac{1}{2}$ x $\frac{3}{4}$	1.00
XD-025	.25	600	$1\frac{1}{2}$ x $1\frac{1}{2}$ x $\frac{3}{4}$	1.25
XD-05	.5	600	$2\frac{1}{2}$ x $1\frac{1}{2}$ x $1\frac{1}{2}$	1.50
XD-11	.1	1000	$1\frac{1}{2}$ x $1\frac{1}{2}$ x $\frac{3}{4}$	1.25
XD-125	.25	1000	$2\frac{1}{2}$ x $1\frac{1}{2}$ x $1\frac{1}{2}$	1.00

TYPE XC—ROUND INVERTED AL. CAN Oil Impregnated—Oil Filled

XC-61	1	600	$1\frac{1}{2}$ x 3	2.00
XC-62	2	600	$1\frac{1}{2}$ x 3	2.25
XC-64	4	600	$1\frac{1}{2}$ x $4\frac{3}{4}$	3.00
XC-11	1	1000	$1\frac{1}{2}$ x 3	2.25
XC-12	2	1000	$1\frac{1}{2}$ x $4\frac{3}{4}$	2.75
XC-155	5	1500	$1\frac{1}{2}$ x 3	3.00
XC-151	1	1500	$1\frac{1}{2}$ x $4\frac{3}{4}$	3.50

TYPE XL—RECTANGULAR CANS Oil Impregnated—Oil Filled

Cap. No.	Cap. Mfd.	Size Inches	List Price
800 D.C. Oper. Volts—440 R.M.S. Rect. A.C.			
NL-6-1	1	$2\frac{1}{8}$ x $1\frac{1}{4}$ x $1\frac{1}{4}$	\$2.75
NL-6-2	2	$2\frac{1}{8}$ x $1\frac{1}{4}$ x $1\frac{1}{4}$	3.50
NL-6-4	4	$3\frac{1}{8}$ x $2\frac{1}{2}$ x $1\frac{1}{4}$	4.50
1000 D.C. Oper. Volts—400 R.M.S. Rect. A.C.			
NL-10-05	.5	$2\frac{1}{8}$ x $1\frac{3}{4}$ x $1\frac{1}{4}$	2.80
NL-10-1	1	$2\frac{1}{8}$ x $1\frac{3}{4}$ x $1\frac{1}{4}$	3.00
NL-10-2	2	$4\frac{1}{4}$ x $1\frac{3}{4}$ x $1\frac{1}{4}$	4.50
NL-10-4	4	$4\frac{1}{4}$ x $2\frac{1}{2}$ x $1\frac{1}{4}$	7.00
1500 D.C. Oper. Volts—1000 R.M.S. Rect. A.C.			
NL-15-1	1	$4\frac{1}{4}$ x $1\frac{3}{4}$ x $1\frac{1}{4}$	3.75
NL-15-2	2	$4\frac{1}{4}$ x $2\frac{1}{2}$ x $1\frac{1}{4}$	6.25
NL-15-4	4	$4\frac{1}{4}$ x $3\frac{3}{4}$ x $1\frac{1}{2}$	9.00
2000 D.C. Oper. Volts—1500 R.M.S. Rect. A.C.			
NL-20-01	.1	$2\frac{1}{8}$ x $1\frac{3}{4}$ x $1\frac{1}{4}$	2.50
NL-20-025	.25	$2\frac{1}{8}$ x $1\frac{3}{4}$ x $1\frac{1}{4}$	3.00
NL-20-05	.5	$2\frac{1}{8}$ x $1\frac{3}{4}$ x $1\frac{1}{4}$	3.75
NL-20-1	1	$3\frac{1}{8}$ x $2\frac{1}{2}$ x $1\frac{1}{4}$	5.25
NL-20-2	2	$4\frac{1}{4}$ x $3\frac{3}{4}$ x $1\frac{1}{2}$	8.00
NL-20-4	4	$4\frac{1}{4}$ x $3\frac{3}{4}$ x $2\frac{1}{2}$	11.00
2500 D.C. Oper. Volts—1800 R.M.S. Rect. A.C.			
NL-25-1	1	$4\frac{1}{4}$ x $3\frac{3}{4}$ x $1\frac{1}{4}$	14.00
NL-25-2	2	$4\frac{1}{4}$ x $3\frac{3}{4}$ x $2\frac{1}{4}$	17.00
3000 D.C. Oper. Volts—2200 R.M.S. Rect. A.C.			
NL-30-01	.1	$2\frac{1}{8}$ x $1\frac{3}{4}$ x $1\frac{1}{4}$	4.50
NL-30-025	.25	$3\frac{1}{8}$ x $2\frac{1}{2}$ x $1\frac{1}{4}$	6.00
NL-30-05	.5	$4\frac{1}{4}$ x $3\frac{3}{4}$ x $1\frac{1}{2}$	10.00
NL-30-1	1	$4\frac{1}{4}$ x $3\frac{3}{4}$ x $2\frac{1}{4}$	18.00
NL-30-2	2	$4\frac{1}{4}$ x $3\frac{3}{4}$ x $3\frac{1}{4}$	23.00
4000 D.C. Oper. Volts—2800 R.M.S. Rect. A.C.			
NL-40-01	.1	$3\frac{1}{8}$ x $2\frac{1}{2}$ x $1\frac{1}{4}$	8.00
NL-40-025	.25	$4\frac{1}{4}$ x $3\frac{3}{4}$ x $1\frac{1}{2}$	12.50
NL-40-05	.5	$4\frac{1}{4}$ x $3\frac{3}{4}$ x $2\frac{1}{4}$	23.00
5000 D.C. Oper. Volts—3500 R.M.S. Rect. A.C.			
NL-50-01	.1	$4\frac{1}{4}$ x $2\frac{1}{2}$ x $1\frac{1}{4}$	9.50
NL-50-025	.25	$4\frac{1}{4}$ x $3\frac{3}{4}$ x $1\frac{1}{2}$	13.00
NL-50-05	.5	$4\frac{1}{4}$ x $3\frac{3}{4}$ x $2\frac{1}{4}$	25.00

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THIS CAPACITOR IS GUARANTEED TO BE FREE OF DEFECTS IN WORKMANSHIP AND MATERIALS FOR ONE YEAR. WITHIN THIS PERIOD WE WILL REPLACE, FREE OF CHARGE ANY CAPACITORS WHICH ARE FOUND TO BE DEFECTIVE AND WHICH HAVE NOT BEEN MISUSED.

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SOLAREX TRANSMITTING CAPACITORS

OIL IMPREGNATED
WAX FILLED

TYPE X—RECTANGULAR CANS



Cat. No.	Cap. Mfd.	D.C. Oper. Volts	D.C. Volts Flash Test	Size Inches	List Price
X-101	1	1000	2000	3 x 2 1/2 x 1 1/2	\$1.85
X-102	2	1000	2000	4 5/8 x 2 1/2 x 1 1/2	2.50
X-104	4	1000	2000	4 7/8 x 3 1/2 x 2 1/2	3.35
X-151	1	1500	3000	4 3/4 x 2 1/2 x 1 1/2	2.40
X-152	2	1500	3000	4 7/8 x 3 1/2 x 2 1/2	3.35
X-154	4	1500	3000	4 7/8 x 3 1/2 x 2 1/2	5.40
X-201	1	2000	4000	4 7/8 x 3 1/2 x 2 1/2	2.90
X-202	2	2000	4000	4 7/8 x 3 1/2 x 2 1/2	4.10
X-204	4	2000	4000	6 x 3 1/2 x 2 1/2	7.75
X-301	1	3000	6000	6 x 3 1/2 x 2 1/2	4.15
X-302	2	3000	6000	6 x 4 1/2 x 2 1/2	8.25

TRANSMICA CAPACITORS

MICA DIELECTRIC
PORCELAIN CASE



TYPE XA

High Voltage,
Heavy Current-
Carrying, Mica
Transmitting
Capacitors. Case
size, 2 1/2 x 2 1/2 x
2 1/2 inches.

Cat. No.	Cap. Mfd.	Max. D. C. Volts	A.C. Volts Effective	MAXIMUM AMPERES OPERATING				List Price
				15000 Kc.	7500 Kc.	3750 Kc.	1875 Kc.	
XA-12-45	.00005	12500	10000	3.5	2.5	1.7	1	\$3.75
XA-12-31	.0001	12500	10000	5.5	4.5	3	2	3.75
XA-12-325	.00025	12500	10000	7	8	5	4	3.75
XA-7-35	.0005	7000	6000	8	8	6	4	3.75
XA-12-35	.0005	12500	10000	8	9	7	6	4.25
XA-3-21	.001	3500	3000	7	9	8	6	3.75
XA-7-21	.001	7000	6000	8	9	9	8	4.25
XA-12-21	.001	12500	10000	10	10	11	12	5.00
XA-3-215	.0015	3500	3000	7	8	8	5	4.00
XA-7-215	.0015	7000	6000	8	9	10	8	4.75
XA-12-215	.0015	12500	10000	9	10	11	10	5.50
XA-3-22	.002	3500	3000	7	8	9	7	4.25
XA-7-22	.002	7000	6000	9	9	10	10	5.25
XA-12-22	.002	12500	10000	9	11	12	14	6.50
XA-3-23	.003	3500	3000	8	9	10	8	5.00
XA-7-23	.003	7000	6000	8	9	10	11	6.00
XA-12-23	.003	12500	10000	9	11	12	14	8.00
XA-3-25	.005	3500	3000	10	10	11	9	6.00
XA-7-25	.005	7000	6000	10	12	14	16	7.00
XA-10-25	.005	10000	8000	10	12	14	16	9.50
XA-3-11	.01	3500	3000	10	12	14	16	7.00
XA-7-11	.01	7000	6000	10	12	14	16	9.50
XA-2-12	.02	2000	1600	10	12	14	16	7.00
XA-3-12	.02	3500	3000	12	14	16	18	8.75
XA-3-15	.05	3500	3000	12	14	16	18	11.50
XA-2-01	.1	2000	1600	12	14	16	18	11.00

TYPE XM BAKELITE MOLDED TRANSMITTING CAPACITORS

MICA DIELECTRIC



Size 1 1/2 x 1 1/2 x 1/2 inches except those marked * 1 1/2 x 1 1/2 x 1/2

600 D.C. Operating Volts 1000 D.C. Test Voltage			1200 D.C. Operating Volts 2500 D.C. Test Voltage			2500 D.C. Operating Volts 5000 D.C. Test Voltage		
Cat. No.	Cap. Mfd.	List Price	Cat. No.	Cap. Mfd.	List Price	Cat. No.	Cap. Mfd.	List Price
XM-6-45	.00005	\$.40	XM-12-45	.00005	\$.70	XM-25-45	.00005	\$.90
XM-6-31	.0001	.40	XM-12-31	.0001	.70	XM-25-31	.0001	.90
XM-6-32	.0002	.40	XM-12-32	.0002	.70	XM-25-32	.0002	1.05
XM-6-325	.00025	.40	XM-12-325	.00025	.70	XM-25-325	.00025	1.05
XM-6-35	.0005	.50	XM-12-35	.0005	.70	XM-25-35	.0005	1.25
XM-6-21	.001	.50	XM-12-21	.001	.90	XM-25-21	.001	1.50
XM-6-215	.0015	.50	XM-12-215	.0015	1.15	XM-25-215	.0015	1.95
XM-6-22	.002	.50	XM-12-22	.002	1.35	XM-25-22	.002	2.25
XM-6-225	.0025	.55	XM-12-225	.0025	1.45	XM-25-23	.003	2.75
XM-6-23	.003	.60	XM-12-23	.003	1.55	XM-25-24	.004	3.15
XM-6-24	.004	.60	XM-12-24	.004	1.55	XM-25-25	.005	3.30
XM-6-25	.005	.70	XM-12-25	.005	1.75	XM-25-26	.006	3.50
XM-6-26	.006	.85	XM-12-26	.006	1.75	XM-25-28	.008*	3.80
XM-6-28	.008	1.00	XM-12-28	.008	2.25	XM-25-11	.01*	4.10
XM-6-11	.01	1.15	XM-12-11	.01	2.40	XM-25-115	.015*	4.50
XM-6-115	.015	1.25	XM-12-115	.015	3.35			
XM-6-12	.02	1.85	XM-12-12	.02*	3.95			
XM-6-125	.025	2.30	XM-12-125	.025*	4.40			
XM-6-13	.03	2.50	XM-12-13	.03*	4.60			
XM-6-14	.04*	3.25						
XM-6-15	.05*	3.85						

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RESISTORS - RHEOSTATS - RELAYS



**ADJUSTOHM
RESISTORS**

The adjustable band permits connection to include the number of turns desired to obtain the correct resistance. Simple and convenient. Circular 507 A lists size for 10 to 200 watts with prices.



**FIXED
Wire Wound
RESISTORS**

These resistors are made with the highest grade resistance wire, wound on a special refractory tube, conservatively rated. 10 and 20 watts size up to 100,000 ohms. Circular 507 A.



**HEAVY DUTY
RESISTORS**

Ward Leonard wire wound resistors are known throughout the radio industry for their accuracy, dependability and long life. 25 to 200 watts in various resistance values up to 150,000 ohms. Circular 507 A.



**RING TYPE
RHEOSTATS**

This compact, power ring type rheostat offers a continuous control that is, practically stepless. 1 1/2", 2 1/4", 3" and 4" diameters, giving 30, 50, 100 and 150 watts capacity. Wide range of resistance values up to 10,000 ohms. See 1937 circular 507.

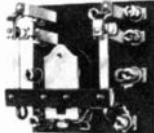
**PLAQUE
RESISTORS**



Non-inductive, non-capacitive. 2", 4" and 5 3/4" giving 20, 40 and 100 watts capacity with resistance values up to 10,000 ohms. Ideal for finely balanced circuits. Circular 507.



**Remote Control
Relay**



**Radio Frequency
Relay**



**Underload
Relay**



**Overload
Relay**



**Time-Delay
Relay**



**Keying
Relay**

SPECIFICATIONS and PRICES of RELAYS

Description	Cat. No.	Poles	Throw	Break	Contacts Normal Position	Volts		Net Price	Approx. Shipping Weight, Oz.
						A.C.	D.C.		
Time Delay, Relay.	507-501	S.P.	S.T.	S.B.	Open	110	.....	\$9.00	13
Remote.....	507-503	D.P.	S.T.	S.B.	Open	6 to 8	.....	4.80	6
Remote.....	507-504	D.P.	S.T.	S.B.	Open	.....	6 to 8	4.80	6
Remote.....	507-505	D.P.	D.T.	S.B.	.....	6 to 8	.....	5.40	7
Remote.....	507-506	D.P.	D.T.	S.B.	.....	.....	6 to 8	5.40	7
Keying.....	507-507	S.P.	S.T.	D.B.	Open	7.5	2.5	4.20	5
.....	507-508	S.P.	S.T.	D.B.	Open	.....	6 to 8	4.20	5
Crystal Oven.....	507-509	S.P.	S.T.	D.B.	Open	.....	110	4.20	6
Remote.....	507-510	S.P.	S.T.	D.B.	Open	110	.....	4.20	6
Remote.....	507-511	D.P.	D.T.	S.B.	.....	110	.....	5.40	7
Overload Relay.....	507-512	S.P.	S.T.	D.B.	N.C.	.....	.....	5.10	6
Overload Relay.....	507-513	S.P.	S.T.	D.B.	N.C.	.....	.....	5.10	6
Underload Relay.....	507-514	S.P.	S.T.	D.B.	N.O.	.....	.....	6.00	10
Underload Relay.....	507-515	S.P.	S.T.	D.B.	N.O.	.....	.....	6.00	10
R. F. Relay.....	*507-521	D.P.	D.T.	S.B.	Open	110	.....	15.00	10
R. F. Relay.....	*507-522	D.P.	D.T.	S.B.	Open	220	.....	15.00	10
R. F. Relay.....	*507-523	D.P.	D.T.	S.B.	Open	.....	6	15.00	10
R. F. Relay.....	507-531	D.P.	D.T.	S.B.	Open	.....	6	6.00	7
R. F. Relay.....	507-532	D.P.	D.T.	S.B.	Open	110		6.00	7

*For additional S.P.N.O. contact add \$1.50

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MOUNT VERNON, NEW YORK

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and Get

"More Watts Per Dollar"



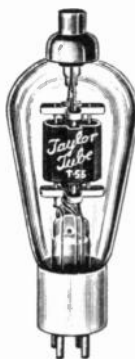
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\$1.00



866
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T-20 TZ-20
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T-55
\$7.00



203Z
\$8.00



T-125
\$13.50

PEAK performance at big price savings. That is the reward for using Taylor Tubes. There are Taylor Tubes for every transmitting purpose. You get quality and performance at prices you can afford to pay. Build your rig around Taylor Tubes and get your share of DX. Insist on Taylor Tubes.

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Taylor — HEAVY — **CUSTOM BUILT** — DUTY — **Tubes**

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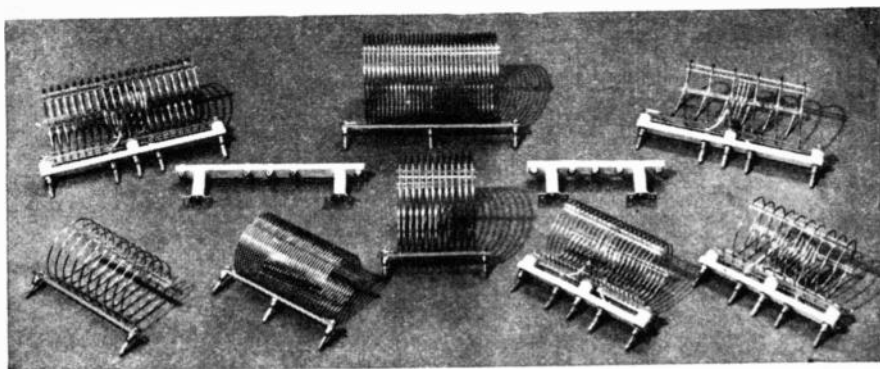
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Coto
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1917

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Dependable and efficient communication is of vital importance to any expedition. That is why the MacGregor and MacDonald polar expeditions wisely chose COTO products. You too can have this reliability when you select COTO.

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If you plan to build a new rig, remodel your present one or if you are just window shopping, by all means meet the COTO inductor family at your jobber.

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* 1st to use *Alsimag 196 material!*
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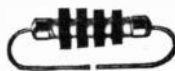
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NEW CONDENSERS *by Johnson*

Smaller Models, with Big Condenser Performance

★ You've wanted smaller condensers that could really take a beating — real small-size transmitting condensers with "big condenser" performance. Now you can have them — with all the advantages of famous Johnson design and construction — in models suitable for every low and medium-power transmitter application — at surprisingly low cost.

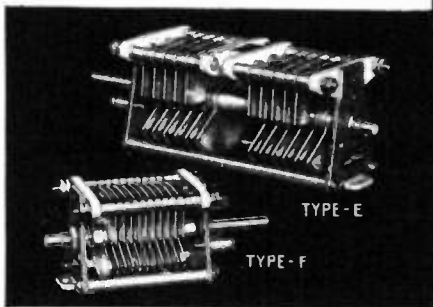
TYPES "E" AND "F"

The new types "E" and "F" condensers, though small and compact, are *not* redesigned receiving condensers. They are really new advanced models designed and built for highest efficiency and dependability in transmitting circuits, and have many important features formerly found only in larger condensers.

Small Size: Panel space for type "F" only 2" square; for type "E", $2\frac{5}{8}$ " square.

High Ratings: Voltage ratings to 4,500. Plate spacings: .045", .075" and .125"

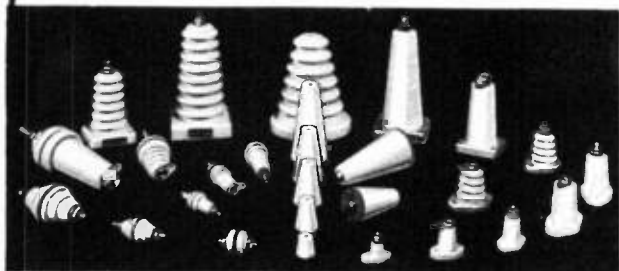
Insulation: Ultra low-loss Alsimag 196*



Precision Construction: Sturdy, rigid, yet light, aluminum frames. Positive wiping spring-contact rotor brushes. Rounded-edge polished plates. Chassis or panel mounting. Stator placed above for minimum capacity to chassis. Shaft extensions front and rear for ganging.

You'll be surprised at the extremely low cost of types "E" and "F" condensers!

A JOHNSON INSULATOR for EVERY PURPOSE



The Johnson line of Stand-Off and Thru-Panel Insulators originated more than ten years ago with a single unit, No. 20, still one of the most popular numbers. In ten years this line has grown until it now includes 45 different insulators, 27 of which are illustrated.

Johnson porcelain insulators have long been accepted for the superior quality of material used. Now many types are available in genuine *Alsimag 196 Steatite*, a material possessing unusual qualities for high frequency use, including a loss factor of one-third that of similar materials.

Discriminating radio men have standardized on Johnson Insulators . . .

BECAUSE . . . there is a better Johnson insulator for every application

BECAUSE . . . Johnson Insulators combine effective insulation with high mechanical strength, without excess bulk

BECAUSE . . . exclusive Johnson features offer the most in utility and convenience

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was made on
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GO WRONG
WHEN YOU
CAN SEE
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ARE DOING!

THERE IS ONLY ONE WAY TO LEARN TO RECEIVE THE CODE SIGNALS AND THAT IS BY LISTENING TO THE SIGNALS. THERE IS ONLY ONE WAY TO LEARN TO SEND THE SIGNALS PROPERLY AND THAT IS BY BEING ABLE TO SEE AND HEAR YOUR OWN SIGNALS.

WITH MASTER TELEPLEX YOU LEARN THE CODE IN THE NATURAL, EASY, FASCINATING WAY. THERE IS NO GUESSWORK BECAUSE YOU CAN SEE AND HEAR WHAT YOU ARE DOING!

Learning to send PROPERLY is more difficult than learning to receive. Most people think sending is easy. Well, just ask the fellow who tries to receive it!

BOUQUET...from E. W. ROWLAND

"It is our experience that if it had not been for your machine it would have been practically impossible for us to learn to transmit correctly or receive correctly."

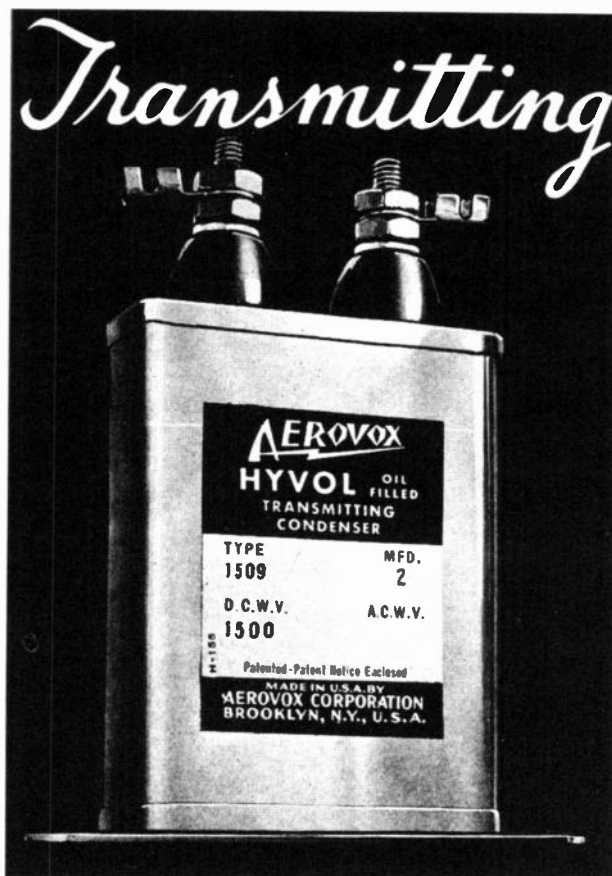
— E. W. Rowland

CATALOGUE EXPLAINS FULLY THE MANY INTERESTING AND FASCINATING FEATURES OF MASTER TELEPLEX. It also lists three other Code Teachers. It is free. Just send a post card asking for catalogue "E"

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AEROVOX prefers to speak in terms of *actual performance* rather than glowing claims. There are millions of AEROVOX condensers or capacitors in daily use. Let those units *you* come across *tell their own story* of dependable, economical, care-free service.

Meanwhile, consider these new HYVOL oil-filled capacitors for transmitting and other high-voltage applications. Using an exclusive super-dielectric oil. Fine linen paper. Selected foil. Properly tensioned windings. High-tension pillar terminals. Heavy welded steel rectangular cases. Quality—at mass-production prices. 600 to 3000 v. D.C. working. .1 to 4 mfd.

CONDENSERS AND RESISTORS

● HYVOL capacitors are also offered in round-can ring-mounted type. Aluminum container. High-tension pillar terminals. 1 to 4 mfd. 1000 to 2000 v. D.C. working.



● HYVOL unit. Same size as usual Popular inverted - mounting electrolytic. Grounded can may be insulated with insulator washer. 600 to 1500 v. D.C. working. .5 to 4 mfd.

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The radio amateur's handbook

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RADIO COMMUNICATION



PRICE

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—Including Complete Questions
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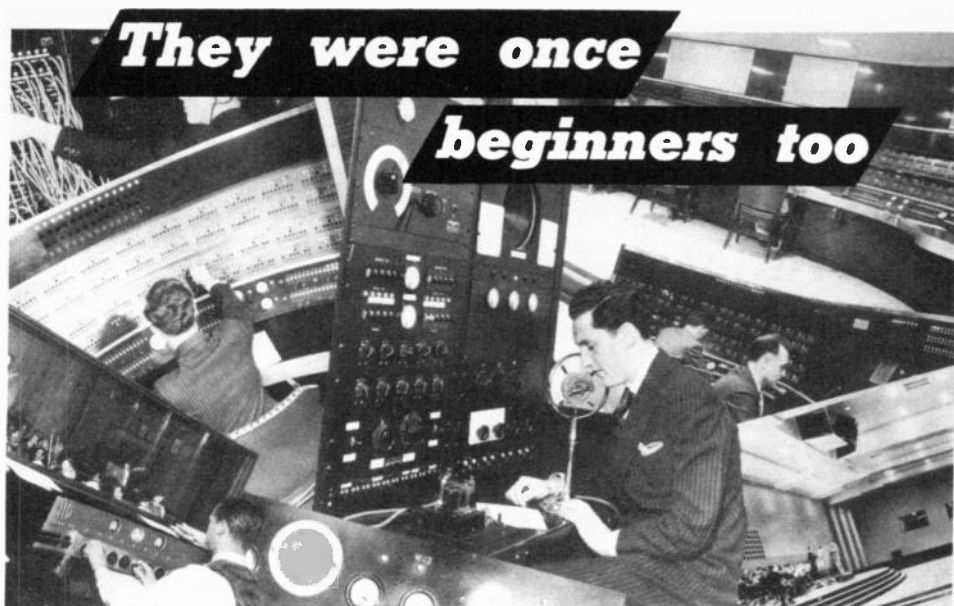
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CARDWELL



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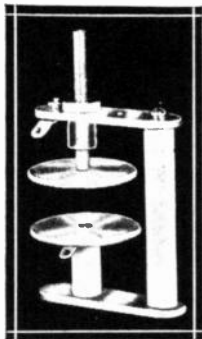
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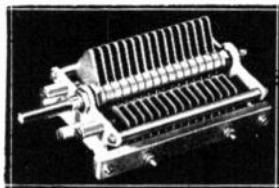
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for LOW CAPACITY TUBES**



Such as T-80, T-55,
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pillars, metal parts are
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extra long bearing with
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eliminate wobble. "Easy
to get at" double lugs of
husky proportions and
knurled thumb nut for
easy locking.



MT-150-GS

★ SINGLE TRANSMITTING MIDWAYS

Type	Max. Cap.	Min. Cap.	Nr. Plates	Air Gap	Depth Back Panel	List Price	Deal- ers Price
MT-20-GS	20	5	5	.070"	2 17/32"	\$3.25	\$1.95
MT-35-GS	35	6	7	.070"	2 17/32"	3.50	2.10
MT-50-GS	50	8	11	.070"	2 17/32"	3.90	2.34
MT-70-GS	70	10	15	.070"	3 17/32"	4.45	2.67
MT-100-GS	100	12	21	.070"	3 17/32"	4.90	2.94
MT-150-GS	150	16	31	.070"	4 15/32"	6.00	3.60
MG-35-NS	35	12	15	.171"	4 15/32"	6.00	3.60

★ DUAL MIDWAY CONDENSERS

Type	Max. Cap.	Min. Cap.	Nr. Plates	Air Gap	Depth Back Panel	List Price	Deal- ers Price
MR-25-BD	25	5	3	.030"	2 17/32"	\$4.35	\$2.61
MR-50-BD	50	6	5	.030"	3 17/32"	4.70	2.82
MR-70-BD	70	7	7	.030"	3 17/32"	4.90	2.94
MR-100-BD	100	8	11	.030"	3 17/32"	5.10	3.06
MR-150-BD	150	9	15	.030"	3 17/32"	5.30	3.18
MR-260-BD	260	11	25	.030"	4 15/32"	5.50	3.30
MO-180-BD	180	15	29	.050"	6 5/32"	8.00	4.80
MT-20-GD	20	6	5	.070"	3 17/32"	5.55	3.33
MT-35-GD	35	7	7	.070"	3 17/32"	6.00	3.60
MT-50-GD	50	9	11	.070"	3 17/32"	6.35	3.81
MT-70-GD	70	10	15	.070"	4 15/32"	7.00	4.20
MT-100-GD	100	13	21	.070"	6 5/32"	8.00	4.80

NOTE—Capacities and number plates are per section.

NET PRICE **\$1.80** TO AMATEURS

CARDWELL FLEXIBLE COUPLING



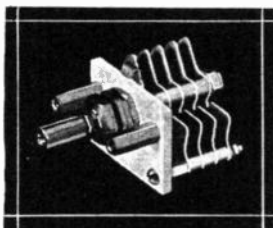
TYPE A—Fits all 1/4" shafts.
Has Isolantite insulation with
new type nickel plated phos-
phor bronze springs and re-
versed brass hubs. Minimum
space required. Maximum flex-
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real improvement over exist-
ing types. Overall diameter
1 1/2". Overall width outside
hub-to-hub 1/2". Packed in
standard cartons of one dozen.
List price \$.60 each
Dealers' Price \$.36 each

"TRIM-AIR" MIDGET CONDENSERS

Type	Max. Cap.	Min. Cap.	Nr. Plates	Air Gap	Depth Back Panel	List Price	Deal- ers Price
ZU-75-AS	75	2.7	15	.020"	1 5/16"	\$1.70	\$1.02
ZU-100AS	100	3	19	.020"	1 7/16"	1.75	1.05
ZU-140-AS	140	5	27	.020"	1 5/16"	3.15	1.80
ZR-10-AS	10	1.2	3	.030"	15/16"	1.25	.75
ZR-15-AS	15	1.5	5	.030"	15/16"	1.25	.75
ZR-25-AS	25	2	7	.030"	1"	1.40	.84
ZR-35-AS	35	2.5	11	.030"	1 5/16"	1.50	.90
ZR-50-AS	50	2.8	13	.030"	1 5/16"	1.60	.96
ZV-6-TS†	5	1.8	3	.061"	15/16"	1.25	.75
ZT-15-AS	15	3	9	.070"	1 7/16"	1.55	.93
ZT-30-AS	30	4	17	.070"	2 1/8"	1.85	1.11
ZS-4-SS	4	1.5	5	.140"	1 5/16"	1.85	1.11

* Double bearing; two end plates.

† Supplied with 2 segment sector for 5 meter circuits. Extra
pfl. also supplied; easily installed; makes it 3 plates as listed.



ZT-15-AS

45/64" x 1 13/32" condenser open. All Duals double bear-
ing, shaft extended at rear for coupling and have remov-
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types. All Trim-Airs have Isolantite insulation. 1/4" nickel
plated brass shaft; aluminum plates. All Trim-Air Acces-
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FOR BROADCASTING, DIATHERMY, PHYSIOTHERAPY, AMATEUR AND INDUSTRIAL APPLICATIONS

Even cursory inspection will show how AMPEREX tubes differ from the mere adaptations of conventional tube types . . . Exclusive engineering developments and radical design refinements are incorporated in the structure of these tubes and reflected in their superior performance.

So universal has been the recognition of the merits and efficiency of these tubes that now more than 70% of all diathermy ultra short wave generators are equipped with AMPEREX tubes and thousands more are in operation in almost every country in the world . . . in broadcast, communication, amateur and industrial apparatus where they have replaced more costly or less efficient tubes.

HF-100



An ultra-high, normal R. F. power amplifier and oscillator and class B audio amplifier or modulator.

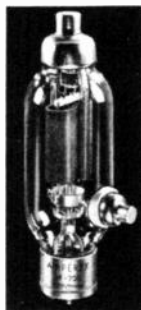
The HF-100 is one of a distinctive group of low voltage high current tubes, an original development of the AMPEREX ENGINEERING LABORATORIES. It is in addition characterized by an extraordinary high ratio of transconductance to interelectrode capacitance, a characteristic which is responsible for its outstanding efficiency in ultra-high frequency circuits.

GENERAL CHARACTERISTICS

Filament: Voltage	10-10.5
Current	2 amperes
Amplification Factor	23
Grid to Plate Transconductance @ 100 ma.	4200
Direct Interelectrode Capacitances:	
Grid to Plate	4.5 uuf
Grid to Filament	3.5 uuf
Plate to Filament	1.4 uuf

Net Price **\$12.50**

HF-200



High and normal R. F. power amplifier, oscillator class B modulator.

The HF-200 is another of the highly prolific ultra-high frequency generators of original AMPEREX design and development. The outstanding features of low voltage high current and a high ratio of transconductance to interelectrode capacitance are also properties of this tube.

GENERAL CHARACTERISTICS

Filament: Voltage	10-11 volts
Current	3.4 amperes
Amplification Factor	18
Grid to Plate Transconductance @ Plate Current of 150 ma.	5000 micromhos
Direct Interelectrode Capacitances:	
Grid to Plate	5.8 uuf
Grid to Filament	5.2 uuf
Plate to Filament	1.2 uuf

Net Price **\$24.50**

R. F. power amplifier, oscillator, class B modulator.

The HF-300 has found favor with many broadcasters and transmitter designers as a substitute for the 204A. A study of the operational data will disclose its superiority, in many classes of service, to the latter tube. It also, like the HF-100 and HF-200, is an efficient ultra-high frequency generator and possesses the characteristic common to AMPEREX designed tubes, of a high ratio of transconductance to interelectrode capacitance.

GENERAL CHARACTERISTICS

Filament: Voltage	11-12 volts
Current	4 amperes
Amplification Factor	23
Grid to Plate Transconductance @ 150 ma.	5600 micromhos
Direct Interelectrode Capacitances (App.):	
Grid to Plate	6.5 uuf
Grid to Filament	6.0 uuf
Plate to Filament	1.4 uuf

Net Price **\$35.00**

HF-300



Low Distortion zero-bias class B amplifier and modulator, high efficiency R. F. frequency multiplying power amplifier, conventional R. F. power amplifier. The ZB-120 is an exclusive AMPEREX development. In common with other tubes of original AMPEREX design it is a low voltage high current type and possesses a high ratio of transconductance to interelectrode capacitance. Although it approaches nearer the ideal in a zero-bias class B tube it is also a highly efficient performer in many other classes of service.

GENERAL CHARACTERISTICS

Filament: Voltage	10-10.5 volts
Current	A.C. or D.C. 2 amperes
Amplification Factor	90
Grid to Plate Transconductance @ 120 ma.	5000 micromhos
Direct Interelectrode Capacitances:	
Grid to Plate	5.2 uuf
Grid to Filament	5.3 uuf
Plate to Filament	3.2 uuf

Net Price **\$10.00**

ZB-120



AMPEREX ELECTRONIC PRODUCTS, Inc.

79 WASHINGTON STREET

BROOKLYN, NEW YORK

Audio and Power equipment for medium and low power rigs

HANDSOME, STURDY CONSTRUCTION ★ GOOD REGULATION

★ PRICED FOR THE MODERATE POCKET-BOOK ★

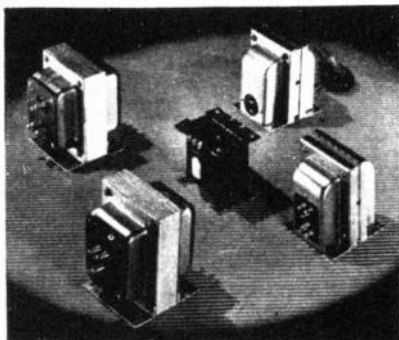


PLATE TRANSFORMERS

CS-200 450 each side of center at 150 MA.; 5V-3A; 2½ V-10A. CV mtg. Net to Amateurs.....	\$3.90
CS-201 500 each side of center at 200 MA.; 2½ V.C.T. 14 A; 5 V.C.T. 3 A; CD mtg. Net to Amateurs.....	\$4.80
CS-202 600 each side of center at 200 MA.; 2½ V-10A; 7½ V-3A; 5V-3A. CD mtg. Net to Amateurs.....	\$6.00
CS-203 800 each side of center at 150 MA.; 600 V. D.C. CD mtg. Net to Amateurs.....	\$4.50
CS-204 800 each side of center at 250 MA.; 650 V. D.C. CD mtg. Net to Amateurs.....	\$6.60

FILAMENT TRANSFORMERS

LM-1 2½ V.C.T. 20 A; 2500 V. insulation. OT mtg. Net to Amateurs.....	\$1.80
LM-2 7½ V.C.T. 6.5 A; 2500 V. insulation. OT mtg. Net to Amateurs.....	\$2.10
LM-3 10 V.C.T. 6½ A; 2500 V. insulation. OT mtg. Net to Amateurs.....	\$2.40
LM-4 6.3 V.C.T. 5 A; 5 V.C.T. 6 A; 2500 V. insulation. OT mtg. Net to Amateurs.....	\$2.40
LM-5 2½ V.C.T. 12 A; 5000 V. insulation. OT mtg. Net to Amateurs.....	\$2.10
LM-6 5 V.C.T. 3 A; 5 V.C.T. 3 A; 5 V.C.T. 6A; 2500 V. insulation. OT mtg. Net to Amateurs.....	\$2.40
LM-7 Three 7½ V.C.T. 2½ ampere windings; 2500 V. insulation. OT mtg. Net to Amateurs.....	\$2.40
LM-8 2½ V.C.T. 5A; 2½ V.C.T. 5A; 5 V.C.T. 3A; 2500 V. insulation. OT mtg. Net to Amateurs.....	\$2.10
LM-9 2½ V.C.T. 5A; 5 V.C.T. 3A; 7½ V.C.T. 3A; 2500 V. insulation. OT mtg. Net to Amateurs.....	\$2.40
LM-10 2½ V.C.T. 5A; 7½ V.C.T. 3A; 7½ V.C.T. 3A; 2500 V. insulation. OT mtg. Net to Amateurs.....	\$2.40
LM-11 5 V.C.T. 3A; 7½ V.C.T. 3A; 7½ V.C.T. 3A; 2500 V. insulation. OT mtg. Net to Amateurs.....	\$2.40
LM-12 2½ V.C.T. 5A; 5 V.C.T. 3A; 6.3 V.C.T. 3A; 2500 V. insulation. OT mtg. Net to Amateurs.....	\$2.40
LM-13 6.3 V.C.T. 3A; 7.5 V.C.T. 4A; 5 V.C.T. 3A; 2500 V. insulation. OT mtg. Net to Amateurs.....	\$2.40
LM-14 6.3 V.C.T. 3A; 7.5 V.C.T. 6.5 A; 2500 V. insulation. OT mtg. Net to Amateurs.....	\$2.40

Gleaming chromium plate! Welded cases! Vacuum treated and humidity proof. Transformers fully clamped internally. All outputs with a variety of impedances! Trim professional units all physically symmetrical and with uniform mounting arrangements.

The new chromshield VARIMATCH modulation transformer incorporates a modified VARIMATCH coil structure making possible universal matching from all the popular modulator tubes to a 5,000 or 3,500 ohm rf load. It will handle 20 watts of audio.

A PRIME AND CLASS B OUTPUT TRANSFORMERS

CS-R designed for class A, AB and B tubes like the 45, 50, 2A3, 42, 59, 46, 47, 2A5, 6F6, 6V6, 6B5, 6A6, 53, 79 and similar tubes to an rf load of 5000 and 3500 ohms. C-4 case. Net to Amateurs **\$2.10**

CS-L will match same tubes as above but to a 500, 15, 8, 4 or 2 ohm line. C-4 case. Net to Amateurs **\$2.25**

CS-V will match same tubes as CS-R but to a 15, 8, 4 and 2 ohm line. C-4 case. Net to Amateurs **\$1.95**

A PRIME AND CLASS B INPUT TRANSFORMERS

CS-29 Driver plate to 53, 6A6, 49, 79 or 89 grids. C-4 mtg. Net to Amateurs.... **\$1.65**

CS-30 Driver 46 or 59 plate to 46 or 59 grids. C-4 mtg. Net to Amateurs..... **\$1.65**

CS-291 Single 2A3, 45, 42, 2A5, 6F6, 6D5 triode plate to push pull A prime 2A3, 45, 42, 2A5, 6F6, 6D5 grids. C-3 mtg. Net to Amateurs..... **\$2.25**

CS-292 Push pull 53 or 6A6 triode plates to two or four class B 53 or 6A6 grids. C-3 mtg. Net to Amateurs..... **\$1.95**

CS-293 Push pull triode 56, 37, 57, 77, 6C6, 6C5 plates to two or four A prime 45, 2A3, 42, 2A5, 6F6, 6D5, 6L6 grids. C-3 mtg. Net to Amateurs..... **\$2.10**



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NEW YORK, N. Y.

EXPORT DIVISION 100 VARICK STREET NEW YORK, N. Y. CABLES: "ARLAB"

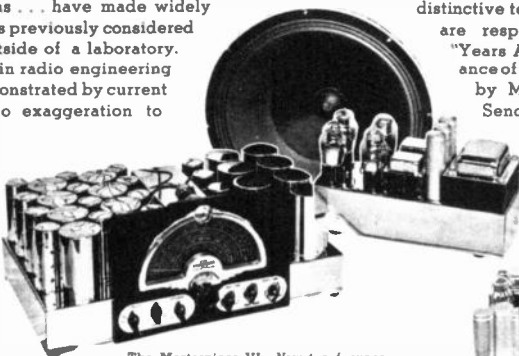
Still "Years Ahead"

RADIO BY McMURDO SILVER

STARTLING radio engineering achievements have characterized the work of McMurdo Silver for a quarter of a century. Year after year his radio receivers have won the acclaim of technical schools, engineering laboratories, radio distance receiving champions, leaders of scientific expeditions, and internationally famous musicians . . . have made widely accessible results previously considered unobtainable outside of a laboratory. This leadership in radio engineering is strikingly demonstrated by current models. It is no exaggeration to

say that no real conception of what radio offers today is possible until you have tested the 1938 masterpieces of this master engineer. Here is radio which, with uncanny "reach" goes to the earth's four corners to snare unique and unusual programs . . . music, sports, news, ships' messages. Thirty-six distinctive technical features are responsible for the "Years Ahead" performance of tomorrow's radio by McMurdo Silver. Send for details.

The 14-15—Super-sharp communication receiver of 14 tubes (15 with larger speaker) with tuned and stabilized regenerative r. f. amplification on all wave bands.



The Masterpiece V1—New t. r. f. super-heterodyne and exclusive Multi-Band Circuit, employing 21 tubes on two 31/32-in. chromium plated steel chassis.

The 15-17—Advanced 15 tube super-heterodyne circuit delivering functional efficiency of 17 tubes. Every coil and circuit individually shielded and chassis chrome plated throughout.



Type 1B Pre-Amplifier Mixer —



This pre-amplifier and electronic mixer (self powered, universal a.c.—d.c.) features two channels into the two triode sections of a 6F8, the two capable of being mixed and fed together by individual gain controls. The first with a 6J7 pentode yields 56 db. voltage gain with an input of 2 megohms permitting use of crystal or other low-level microphone plugged in directly through standard shielded jack and plug. The second channel serves for high-level microphone and phono-pick-up or radio receiver input and gives a voltage gain of 20 db. Operation is from any 105 to 125 volt, 25 to 60 cycle a.c. or d.c. power line. Hum is unmeasurable and the 1B may be used to drive following power amplifiers with no trouble on this score, with 20 to 50 foot separation through single conductor shielded microphone cable. Substantial steel shielding cases 7" long, 6" high and 3-1/2" deep. Shipped complete with 1 each tested Raytheon 6J7, 6F8 and 6J5 it will turn any good receiver into a complete P. A. System.

New and Sensitive Dynamic Microphone



In America's best and most highly developed broadcasting stations, the dynamic microphone reigns practically supreme as the acme of microphone quality. So, in offering a microphone comparable in quality to McMurdo Silver receivers, we naturally selected the dynamic principle as the sound basis upon which to start development.

We are proud to offer at one and the same time not only a microphone directly comparable in quality to the costly units used in the finest broadcasts, but to provide through recent research greatly increased sensitivity, a combination of directional or non-directional characteristics in one single unit—and to be able to establish what is an extraordinarily low price for such a remarkable instrument.

The new McMurdo Silver 4A Dynamic Microphone is shown mounted upon its 7" high, no-tip-over steel desk stand, together with the shielded plug which terminates at the microphone, the 25-foot rubber-covered shielded microphone cable with which it is equipped. Both stand and cable plug unscrew for convenience. The stand thread is standard, so that the microphone itself may be quickly transferred to different stands as may be desired.

This superb microphone is only 3-13/16" long and 2-1/4" in diameter, and weighing but 1-1/2 lbs. has a frequency characteristic flat to 3 db. from 50 to 10,000 cycles—the full range of the best broadcast stations. Its "level" is unusually high, being only—52 db. and its output impedance is 50,000 ohms and materially reduces a.c. hum pick-up by the microphone or its cable and permits quite long microphone to amplifier cables—even up to a couple of hundred feet when necessary.

New Selective-Directional Antenna



The SELECTIVE-DIRECTIONAL 9 is a positive means of boosting weak signal strength and reducing noise and interference. It provides an extraordinary amount of local noise reduction—dependent wholly upon how far away from and high above local electrical noise sources one can erect its "X" flat-tops.

The SELECTIVE-DIRECTIONAL 9 gives nine different choices of directional doublet, single wire and V-aerials. One may select at the turn of the knob an East-West or North-South doublet, an East, West, or South single wire "Y" antenna, or a South-East, South-West, North-West or North-East "V" aerial.

All are coupled to the receiver through a noise rejecting transmission line and perfected automatically self-selecting long and short wave antenna and set couplers.

All soldered and ready to put up, erection requires only two crossing 60-foot spans in approximate "X" form on house top, open lot, or anywhere such spans can be conveniently found.

Kit includes 4 antenna and insulators, 4 stand-off insulators, lead-in insulator tube and 50-ft. of weather-proof lead-in cable.

McMURDO SILVER

2900-L SOUTH MICHIGAN AVENUE, CHICAGO, ILLINOIS



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for **QUALITY** products, reliably priced,
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Nor need you have an inferiority complex if
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Our new line of Trimmer Condensers has met an immediate response wherever the call is for extremely stable units with excellent power factor at radio frequencies. No possibility of "drifting" capacity ratings.

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NEW! THE ONLY UNCASED CONDENSERS — FULLY SEALED



Whether you're an amateur interested in Condensers that are unexcelled as low cost transmitting units, or a serviceman replacing an old condenser block, you'll be more

than pleased with these new and vastly improved paper sections.

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If you haven't already received one, we'd like to send you FREE our new complete catalog. This includes listings of the full Sprague Condenser line for every need PLUS a wealth of valuable condenser facts and information.



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Nothing is more essential to your Transmitting Condensers than the right oil. On this oil depends their ability to dissipate heat, resist moisture, perform satisfactorily over a long period of time.

Thus, in analyzing oils of many types for Sprague Transmitting Condensers, we paid special attention to the oil used to impregnate the transatlantic cables. Here, there could be no failure. Here, none but the very best would do . . . As a result, we used this same identical oil for our Condensers. We demanded the best—and got it! This Sprague oil has no trick name—but it is the best oil for the purpose BAR NONE.

Use Spragues—and note the difference!

• UNCONDITIONALLY GUARANTEED •

Sprague Transmitting Condensers are oil-filled, oil-impregnated, cylindrically wound and constructed with ample safety factor. They are unconditionally guaranteed against breakdown when used as specified.

ROUND
OR RECTANGULAR
... At the
same Low Prices



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TRANSMITTING CONDENSERS

SUN RADIO

OFFERS

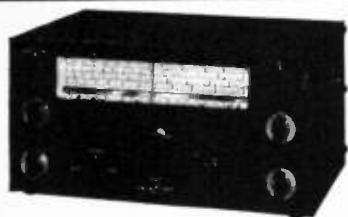
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TO

AMATEURS

AND

BEGINNERS



NATIONAL NC-80X and 81X \$88
 COMPLETE WITH SPEAKER AND TUBES. NET
 We also have in stock for immediate delivery: National HRO, NC100, NC101X and HRO Jr.

— SPECIAL —

RCA TMV 135 "V" Cut, Complete with holder, 3500 Kc to 4000 Kc Only. Limited quantity. Special at..... **\$3.95**

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1938 SUPER-SKYRIDER
 Complete \$123.00 net.

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 With self contained Power Supply, 12 to 200 meters, complete with tubes.
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FOR DOUBLE MIKE **\$159**
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NC-800 Condenser

A high voltage neutralizing condenser. Suitable for use with the RCA-800. Insulation is Isolantite. For capacity-air gap relation see Figure 8.

Our Price
\$180

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● NATIONAL ● HALLCRAFTERS
 ● HAMMARLUND ● RME ● RCA, Etc

Tubes

● TAYLOR ● RCA ● RAYTHEON ● EIMAC
 ● AMPEREX, Etc.

TYPE "400" 1" CRYSTAL AND HOLDER

A small, compact, inexpensive precision holder and quartz crystal. Frequency stamped on name plate is accurate to within 500 cycles or better. Body diam., 1 3/8"; height 1 3/4" height over base pine 13/16"

PRICE **\$480**

SPEEDX

"300"



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Our Price **88c**

NEW "HAM" MAC KEY

The ham's delight! Same base and parts as the deluxe model but priced for the gang. Black wrinkle finish and nickel plated parts. Swedish blue steel springs. Mac patented "Dot Stabilizer"; NINE adjustments; Bakelite paddle and knob; rubber feet. Less switch.

Your Cost **\$6.91**

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15 Henries
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AMPEREX Tubes

ZB120 **\$10.00**
 HF100 **12.50**
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RCA - ACR - 155

COMMUNICATION RECEIVER

This Receiver Is of Superhet Type and Consists of Many Features That Make it Outstanding.

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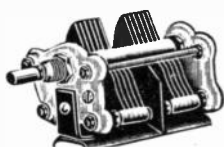


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Numerous back copies of **All-Wave Radio** are still available at the price of 15c. per copy, postpaid (8 for \$1.00). If you do not find the exact type of transmitter or receiver you wish to build described in this volume, tell us your requirements and it is a good bet that one or more back issues have just what you have been looking for. Back issues also contain lists of police calls; world short wave C. W. and phone stations; and other helpful information. Also lots more dope on 5 meter transmitters and transreceivers, wide range music reception, arm chair control, high power ham transmitters, and other phases of amateur radio. See list elsewhere of particular issues and contents. For more information, address Circulation Manager,

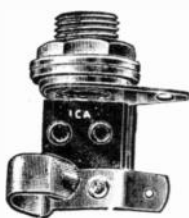
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Amateurs RATE BIRNBACH PRODUCTS AT 100%

XMITTING SOCKETS

Featuring side wiping contacts. Brass, nickel plated shell. Highly vitrified, low absorption base. All brass hardware. Low prices.
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Feature large contact area.



Cat. No.	Description	List Price
395	Giant Jack $\frac{3}{8}$ " Mtg. Hole	\$0.25
396	Giant Plug 10/32 threaded hole	.25
397	Giant Plug $\frac{1}{4}$ " 28 threaded hole	.25
398	Giant Plug $\frac{1}{4}$ " 28 threaded shank	.25
399	Giant Jack $\frac{1}{4}$ " mounting hole	.25
400	Plug 6/32 threaded shank $\frac{1}{4}$ " long	.06
401	Plug 6/32 threaded hole	.07
403	Jack $\frac{1}{4}$ " mounting hole	.06

COPPERWELD ANTENNA WIRE

Stretchless Has steel core covered with copper and heavily enameled. Low R.F. resistance.



Gauge	List Price
10 List per 100 ft.	\$2.60
12 List per 100 ft.	1.80
14 List per 100 ft.	1.25
Special prices in 250, 500, 1000, 2500 ft. lengths.	

NO. 412



New BIRNBACH Items

Insulated Scrulok Pin Tip

No. 412. Small compact yet has all the features of old styles. Handle of phenolic resin. Black, red, green, yellow. 1 5/16" overall. List price each. .12c

No. 408. Bakelite Pencil Type Test Leads, needlepoint prod and phone tip with Scrulok. List each. \$1.50

Banana Type Insulated Plug No. 404. Features the Scrulok solderless connection and non-collapsible Birnbach plug. Black, red, green, yellow. Overall 1 3/4". List each. .15c

Test Prod Handles

No. 417. Features needlepoint tips. Solderless phenolic resin handle. Famous Birnbach Scrulok principle. Red and black only. 4" long. List each. .20c

No. 418. Same as above only 5" long. List each. .25c

No. 411. Bakelite pencil type test prod, Scrulok, 6" long. List each. .50c



NO. 404

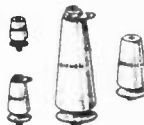


NO. 417

CONE STANDOFF INSULATORS

Of improved physical and electrical qualities. Complete range of heights.

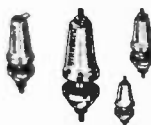
Cat. No.	Height	List Price
430	$\frac{1}{8}$ "	\$0.10
431	1"	.15
431J	1"	.20
432	1 1/4"	.20 1/2
432J	1 1/4"	.25
433	2 1/4"	.25
433J	2 1/4"	.50



FEEDTHRU STANDOFF INSULATORS

An original Birnbach development. Two pieces. Designed and proportioned for maximum strength. Brass nickel plated hardware supplied.

Cat. No.	Height	List Price
458	$\frac{1}{8}$ "	\$0.12
478	1"	.20
478J	1"	.25
4125	1 1/4"	.25
4125J	1 1/4"	.30
4234	2 1/4"	.50
4234J	2 1/4"	.80



BIRNBACH STANDOFF INSULATORS

Come in fine, properly graduated heights to cover every need. Highly vitrified, low absorption porcelain used throughout.

Cat. No.	Height	List Price
405	$\frac{1}{8}$ "	\$0.065
966	1"	.075
966J	1"	.10
866	1 1/4"	.12
866J	1 1/4"	.15
866SJ	1 1/4"	.35
4275	2 1/4"	.30
4275J	2 1/4"	.55
4450	4 1/4"	.50
4450J	4 1/4"	.75



X'MTR LEAD IN INSULATORS

Made of highly vitrified glazed porcelain. Feature low absorption.



Cat. No.	List Price
4235 10 inch rod	\$0.90
4236 15 inch rod	1.00
4237 10 inch rod with bushings	1.20
4240 Bushing 1" long 3/4" dia.	.05
4241 Bushing 1/2" long 3/4" dia.	.05
4242 Bushing 3/4" long 3/4" dia.	.05

E01 TRANSMISSION CABLE

Surge impedance 72 ohms. Can use up to 1000 ft. with negligible loss. Immune to the elements.



No. 953 1000 ft. coll. List \$100.00
No. 955 250 ft. reel List 25.00
Also available in 100 and 500 ft. lengths.

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RADIO CO. INC.

NEW YORK, N. Y.



"No one can prophesy its future"

—LEE DE FOREST

• NEW developments and new adaptations of the radio principle have crowded on each others' heels. For the engineer, the manufacturer, the distributor and service expert there are opportunities that were undreamed of yesterday. And tomorrow—no one knows what it will bring forth. Radio is no longer a plaything—something to tinker with—it is a profession, and those who take up radio work with serious minds will find it rich in rewards.

"I saw the handwriting on the wall," says Victor S. Gitters of the Philco organization. "I was working in the Philadelphia service station of the Philco. My job was mainly changing batteries in automobiles and, afterwards, repairing socket powers. I saw the handwriting on the wall. Radio was coming and coming strong. If I ever expected to do something better than changing those batteries, and jobs of that kind, I had to get busy. So I enrolled for your Radio Course. After starting the study I was transferred to work in the laboratories. I am now in charge of the up-keep of the sales acceptance equipment. Since starting study with you, my salary has reached 125 per cent above the wages I received in those days."

All told, there are more than 200 Philco employees who have studied with the I.C.S. "The I.C.S. will help you get

whatever kind of success you're after," says Arthur Nickel, Philco's Foreman of Final Testers.

•
"With such a leader as Mr. Crosley, eager to welcome men who are trying to mount the ladder, and with sound spare-time study facilities such as the I.C.S. plan affords, there is no excuse in these days for men remaining in ruts of thought and action."

This is the opinion of J. D. Park of the Crosley Radio Corporation—a man who has himself studied three I.C.S. courses.

Radio is going ahead. The I.C.S. course with all its modern advantages provides the way to go ahead with it. The handwriting is clearly on the wall. There is no excuse these days for men remaining in the ruts. A great profession needs trained men—it needs *you*.

•
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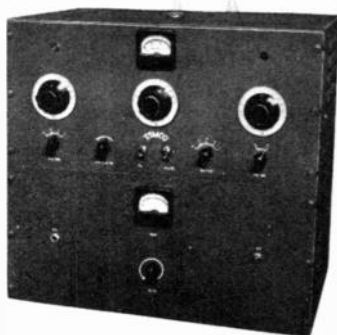
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