FEBRUARY, 1925 25 CENTS

RADIO

COTTON—QUALITY SUPER-HETERODYNE

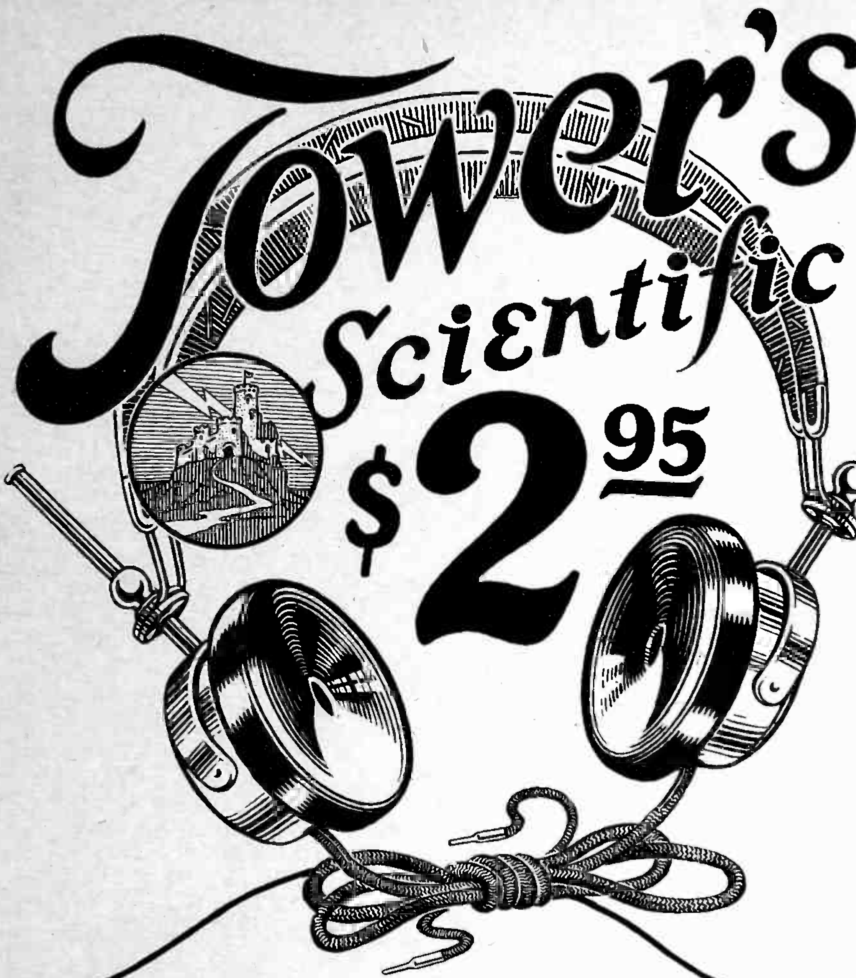
MATHISON—300 TO 30,000 METER RECEIVER

SHORT WAVE ANTENNAS

HAYNES—DE LUXE SUPER-HETERODYNE

McNAMEE—MULTI-SPEAKER AMPLIFIER

CONSTANT FREQUENCY TRANSMITTERS



Two Towers

As the Eiffel Tower stands as a monument to skilled engineering construction so TOWER'S Scientific phones stand as a monument to supreme radio achievement.

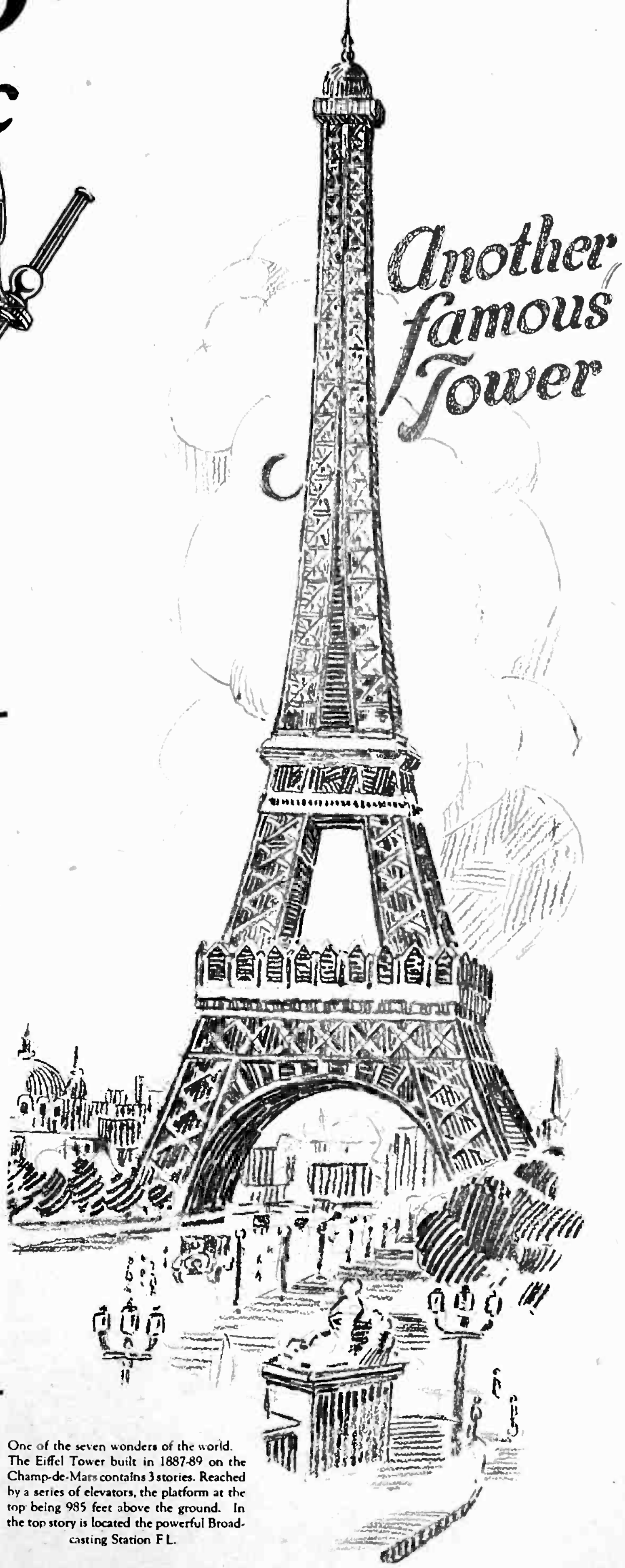
¶ Each phone is carefully tested and approved before it leaves the factory by a Government Licensed Radio Operator thus guaranteeing perfection in tone quality with a positive uniformity of volume.

¶ Lightest of all in weight (only 8¾ oz.) they do not catch in the hair and are unusually easy to adjust conforming gracefully to the head.

TOWER'S Scientific Headsets are guaranteed to be made of the best materials money can buy—highest test enamel, insulated magnet wire, best grade five-foot tinsel cord, unbreakable caps, polished aluminum cases—using the famous scientific head-band constructed for maximum comfort. Now on sale from coast to coast. Look for the purple and yellow carton.

If your dealer cannot supply you, order direct, we will ship immediately Parcel Post C.O.D.

THE TOWER MFG. CORPORATION
98 BROOKLINE AVE. Dept. E BOSTON, MASS.



One of the seven wonders of the world. The Eiffel Tower built in 1887-89 on the Champ-de-Mars contains 3 stories. Reached by a series of elevators, the platform at the top being 985 feet above the ground. In the top story is located the powerful Broadcasting Station F L.

The World's Greatest Headset Value

RADIO

Established 1917

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VOLUME VII. FEBRUARY, 1925 NUMBER 2

CONTENTS

Forecast of Contributions for March Issue

Due to a hurried trip to Washington Prof. Jansky's contribution for February was delayed, but will appear in the March issue. It deals with radio frequency amplification.

The Canadian National Railways are operating a chain of nine powerful stations whose interesting features are illustrated and described in a special article. Details are also given of the receiving equipment used on the trains.

A unique form of loop antenna, especially applicable to the Rounds No. 16 circuit, is described by A. H. Vance.

Brainard Foote describes the construction of "A Self-Contained Portable Receiver" employing a four-tube reflex circuit.

"Tales of the Tube Wreckers," by Volney G. Mathison, graphically tells of the abuses to which vacuum tubes are put by some users.

Lewis R. Freeman relates some interesting experiences with a radio set in the ice fields of the Canadian Rockies, illustrating his story with some remarkable pictures.

Harry A. Nickerson presents some interesting and unusual data on "Experimenting With a Loop."

E. C. Nichols tells how to add a second step of radio frequency amplification to the two-tube reflex.

An inexpensive high-speed chemical code recorder is illustrated and described by Harry W. Minnerman.

Gaston B. Ashe gives some unusually complete information on "Short Wave Counterpoises," supplementing his first article on short wave antennas.

Jack Bront has two contributions, a serious account of "Automatic Radio Telegraph Relaying" and the other a humorous "Radio Glossary."

Chas. F. Felstead gives some pointers on "Eliminating the C. W.-Phone Switch."

L. R. Felder discusses "Radiophone Modulation Circuits" for the radio novice.

Richard F. Shea presents an unusually simple and complete "Analysis of Vacuum Tube Detection."

Frank C. Jones has an article on "Measurement of Ultra-Radio Frequencies" wherein he describes an oscillator that works down to two meters with high efficiency.

G. F. Lampkin describes the construction of a low-loss, low-wave helix.

The fiction feature is "A Kiss in the Dark," by Oliver B. Scott.

Case, Cells and Handles moulded in one piece

THERE are no separate jars in the new Exide 6-Volt "A" Battery. Compartments holding the plates are moulded in one piece with the composition case.

Not only is this battery simple and sturdy, but it is handsome enough to take its place openly in any room. The surface is beautifully stippled and finished in glossy black.

You will find many other refinements in this new battery, but one thing has not been changed—it has the same old dependable power that made the former Exide "A" Battery famous. The flow of current is uniform through a long period of discharge. The life is notably long.

The New Exide 6-volt "A" Battery

This new 6-volt battery is made in five sizes—50, 75, 100, 125, and 150 ampere hour capacity.

Two other "A's" and a new "B"

For low-voltage tubes there are the Exide 2-volt and 4-volt "A" batteries, weighing only five and six pounds. They are midgets in size but giants in power.

The new "B" battery has 6000 milliampere hours capacity. It is assembled in glass jars, thus adding visibility to capacity. You will find this splendid battery full of silent, rugged, long-lasting power. It can be recharged at home most economically with the new Exide Rectifier.

Ask to see the complete Exide line at any Exide Service Station or Radio Dealer's. We shall be glad to mail you descriptive booklets on request.

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia

In Canada: Exide Batteries of Canada, Limited, 153 Dufferin St., Toronto

Exide

RADIO BATTERIES

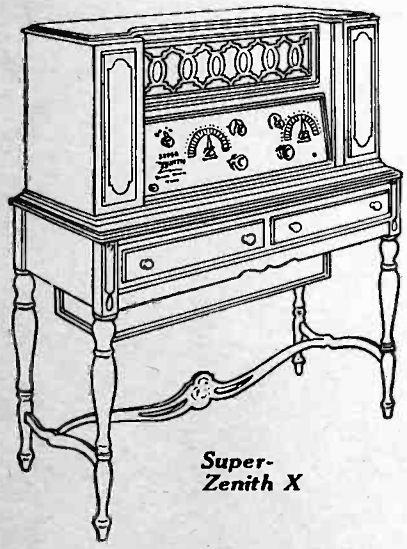
For better radio reception use storage batteries

ZENITH RADIO

TRADE MARK REG.

Super-Zenith VII—
the ideal radio set
for the fine home

They Cost More
But They Do More



Super-
Zenith X

Fulfills your utmost desire, in beauty and performance

The new Super-Zenith is beautiful to look at—lends an atmosphere of dignity and worth to library or drawing room.

Naturally you expect unusual performance from so beautiful a radio set. And—unusual performance is exactly what you ***get.***

Tuning, for example, is controlled by ***two dials only***—so perfectly adjusted that each station comes in always at the same dial settings. ***It never varies.*** Powerful locals may be on full blast, yet you can tune them out completely and bring in distant stations. Tone reproduction is always clear and true; the volume always adequate.

Before you make your choice, be sure to see and try the new Super-Zenith. A fifteen-minute test will give you a new standard of radio values, as applied to beauty of construction—and—***performance.***

Dealers and Jobbers: Write or wire for our exclusive territorial franchise

ZENITH RADIO CORPORATION
332 South Michigan Avenue, Chicago

ZENITH—the exclusive choice of MacMillan for his North Pole Expedition
Holder of the Berengaria Record

THE complete Zenith line includes seven models, ranging in price from $95 to $550.

With either Zenith 3R or Zenith 4R, satisfactory reception over distances of 2,000 to 3,000 miles is readily accomplished, ***using any ordinary loud speaker.*** Models 3R and 4R licensed under Armstrong U.S. Pat. No. 1,113,149.

The new Super-Zenith is a six-tube set with a new, unique, and really different patented circuit, controlled exclusively by the Zenith Radio Corporation. It is NOT regenerative.

SUPER-ZENITH VII—Six tubes—2 stages tuned frequency amplification—detector and 3 stages audio frequency amplification. Installed in a beautifully finished cabinet of solid mahogany—44⅞ inches long, 16¾ inches wide, 10⅝ inches high. Compartments at either end for dry batteries. Price (exclusive of tubes and batteries) $230

SUPER-ZENITH VIII—Same as VII except—console type. Price (exclusive of tubes and batteries) $250

SUPER-ZENITH IX—Console model with additional compartments containing built-in Zenith loud speaker and generous storage battery space. Price (exclusive of tubes and batteries) . . $350

SUPER-ZENITH X—Contains two new features superseding all receivers. 1st—Built in, patented, Super-Zenith Duo-Loud Speakers (harmonically synchronized ***twin*** speakers and horns), designed to reproduce both high and low pitch tones otherwise impossible with single-unit speakers. 2nd—Zenith Battery Eliminator, distinctly a Zenith achievement. Requires no A or B batteries
Price (exclusive of tubes) $550
Price (without battery eliminator) $450
All Prices F. O. B. Factory.

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Gentlemen: Please send me illustrated literature giving full details of the Super-Zenith.

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Address ....

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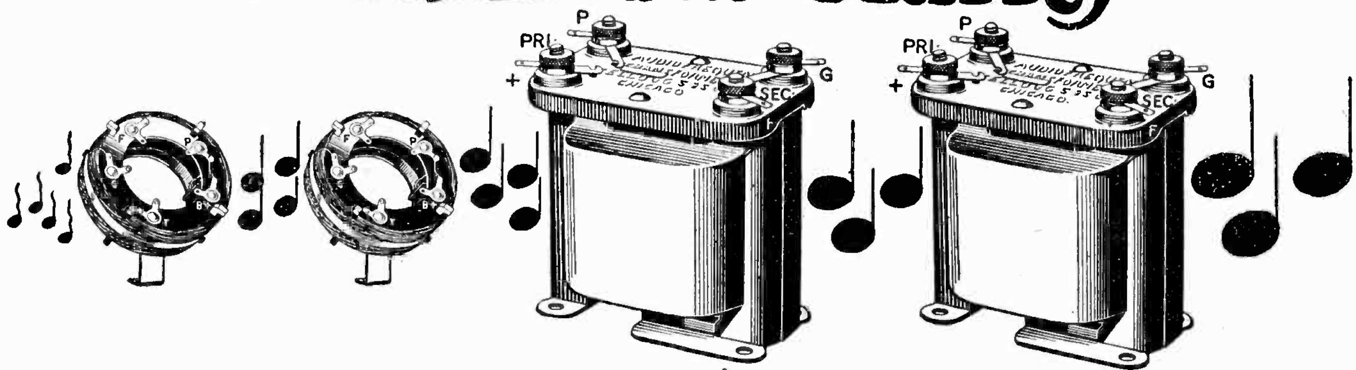
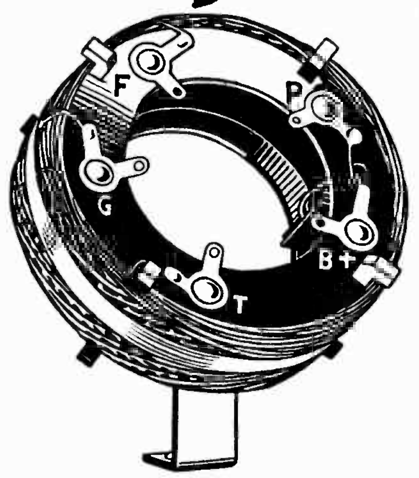
Volume and Clarity



with Kellogg Transformers



Radio Frequency Transformer

A Radio Frequency Transformer of the aperiodic type suitable for all sets with which tuned radio frequency is desired. Also used for one stage of radio frequency amplification ahead of regenerative sets to prevent re-radiation.

Consider these points of superiority:

- No dope to hold windings in place.
- Soldered connections.
- Mounting bracket holds coil at correct angle.
- Minimum rubber used in form.
- Lowest possible loss, with greatest transfer of energy.
- Works with any .0005 condenser.
- Secondary arranged with suitable taps for biasing features.

This transformer makes the construction of a radio frequency set an easy matter, assuring best possible reception with widely varying types of circuits, including reflex.

Built and guaranteed by Kellogg Switchboard and Supply Co.

No. 602 Radio Frequency Transformer
at your dealers for $2.35 each.

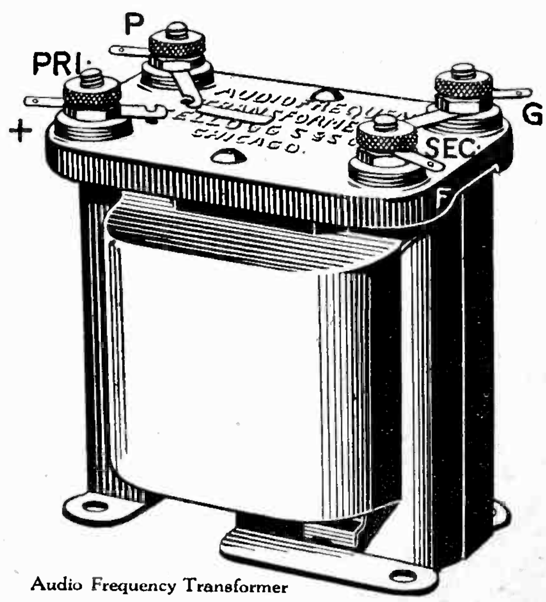
Kellogg Audio Frequency Transformers are the "stepping stones" of modern amplification.

Clear, accurate reproduction assured over the entire range of the musical scale.

Plainly marked, accessible terminals.

It is acclaimed by test to be the best.

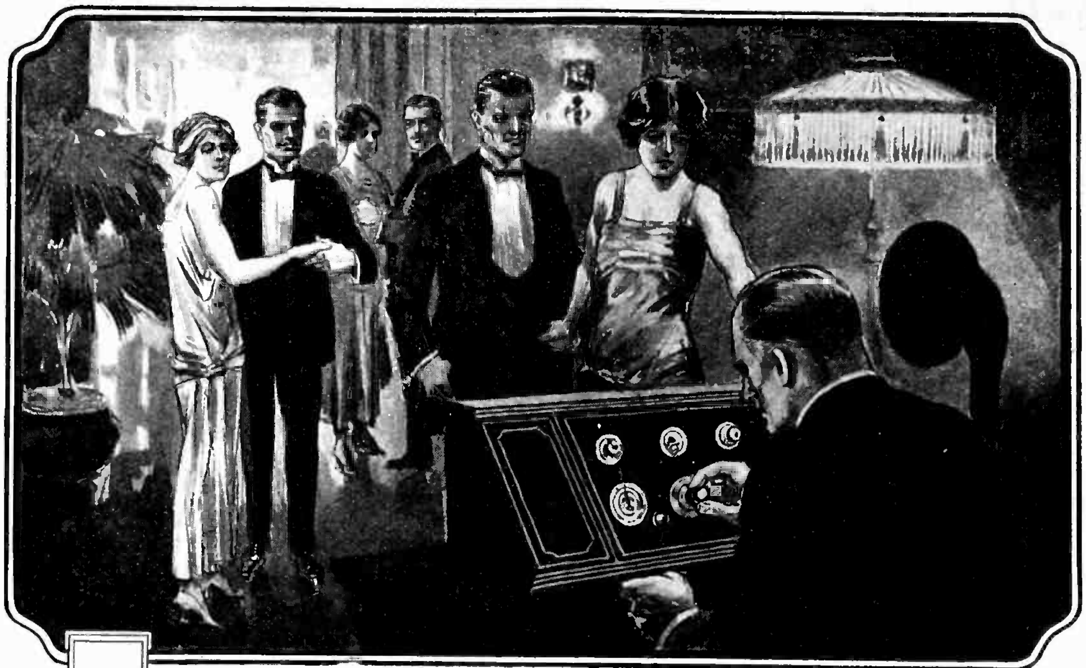
No. 501 Audio Frequency Transformer
Ratio 4½ to 1—
No. 502 Audio Frequency Transformer
Ratio 3 to 1—
$4.50 each



Audio Frequency Transformer

KELLOGG SWITCHBOARD & SUPPLY CO.

1066 WEST ADAMS STREET, CHICAGO



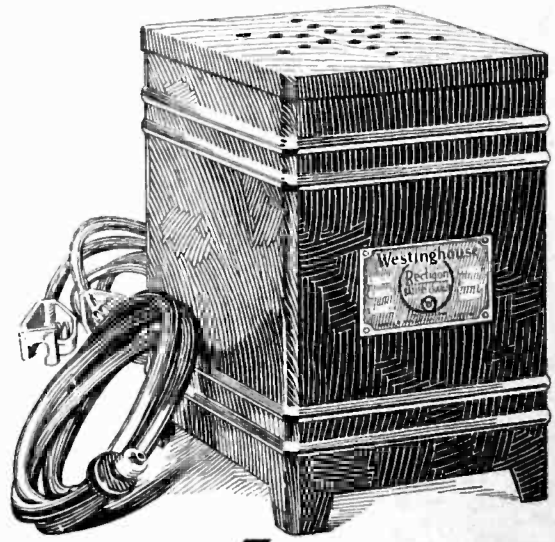
Are you ready to TUNE IN that DISTANT STATION ?

NOTHING is more discouraging to a radio fan than to find his batteries down on a good night—too weak for distant reception.

A weak battery is a noisy battery and, further, current flow is irregular—the reception comes and goes.

A great many pleasant evenings have been spoiled by weak batteries. Hours have been wasted tinkering—when a weak battery was the cause of all the trouble.

The Westinghouse Rectigon Battery Charger is the friend of every radio fan. It will charge your battery over night.



The Rectigon will enhance many fold the pleasures of radio reception. It can be obtained at a small cost.

Make a Rectigon a part of your equipment and forget battery troubles.

See our nearest dealer.

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RADIO

Established 1917

Volume VII FEBRUARY, 1925 Number 2

Radiotorial Comment

ONE of the most vexing features of any radio magazine to the reader, and likewise to the editor, is an author's definite specification of some specific make of part to be used in the construction of a receiving set. Even when the reader knows that there are probably a dozen other makes that will fill the purpose as well, it is natural to try to get the part specified. And there's the rub. For often it is not in the dealer's stock either because his jobbers can not or will not get it for him.

Thus the author's effort to assist the reader by providing detailed panel and baseboard layouts is frustrated and the reader's constructional effort is postponed or abandoned.

There is probably no specified part of any home-built radio set for which some acceptable substitute cannot be found. The only changes necessary are in the drilling directions or the set dimensions. Any reputable dealer can suggest equipment that will suffice and thus avoid delay.

The ultimate and inevitable answer to this problem is such standardization of dimensions that one make may be interchanged for another make without changes in panel layout. Manufacturers might agree upon a standard template for mounting variable condensers, for instance. Other parts could likewise be standardized in external dimensions without increase in cost or change in internal characteristics.

Such action would not only assist the builders of sets and the radio dealers but would eventually benefit the manufacturers by reducing production costs. The great success of American manufacturers in other lines of industry has been largely due to production of standard sizes in large quantities. One reason for the relatively high cost of radio equipment is the dearth of uniform standards. Competition has prevented co-operation.

The specification of something special, when that which is standard might be used, shows inferior rather than superior designing ability. It takes a real radio engineer to design a receiving set whose component parts consist of standard apparatus. Good design seeks to adapt specifications so as to utilize what is available on the market instead of calling for special new parts.

This is perhaps an ideal not yet attainable in radio. due to the fact that the art is progressing so rapidly. But it is fully in accord with the general trend of all industrial progress toward standardization. Older industries, such as the electrical, have found that it pays in dollars and cents and radio must do likewise.

The first efforts in standardization were toward dimensions. In the twelfth century King Henry of England specified that the ell, the ancient yard, should be the exact length of his royal arm. Later more rational standards were found and developed by such commendable work as is now being done by the United States Bureau of Standards.

After dimensions have become standardized the next step will probably be toward the more uniform and definite specification as to the electrical constants of parts It is already recognized that the turns-ratio of a transformer or the number of plates in a condenser are inadequate to foretell performance. Some day it will be possible to match tubes of low internal capacity from the labels, and some day fixed condensers may be depended upon within five per cent of their rating. These advances will greatly assist the designer and builder who is now largely dependent upon the cut-and-try method.

While the Bureau of Standards is ready to co-operate with the radio manufacturers in bringing about these desired ends, the initiative must come from the manufacturers. Those who first awake to the necessity for standardization and who recognize the advantages will earn a good-will and a patronage that will compensate for many times the initial expense. Here's hoping!

A MUCH-MOOTED question, which bids fair to be the storm center of discussion this year, is the proposed sales tax on radio apparatus to provide better radiocasting. Assuming that the tax can be imposed and collected, notwithstanding the natural opposition of some of those taxed, the controversy will then focus on the purposes for which the money should be spent, whether it should go to the general support of stations or to the artists who appear before the microphone. Inasmuch as there are more stations than room it is apparent that the owners are satisfied with the returns on their investment. This leaves as the dissatisfied party the artists whose services are given without compensation. It would therefore seem not only just but also conducive to better programs that the first proceeds of the fund should be devoted to the payment of talent. This argument, however, is predicated upon the popular pastime of spending your money before you get it.

Constructing A Quality Super-Heterodyne

Directions For Building a 60,000 Cycle (5,000 meter) Set Using Eight "A" Tubes and Potentiometer Control

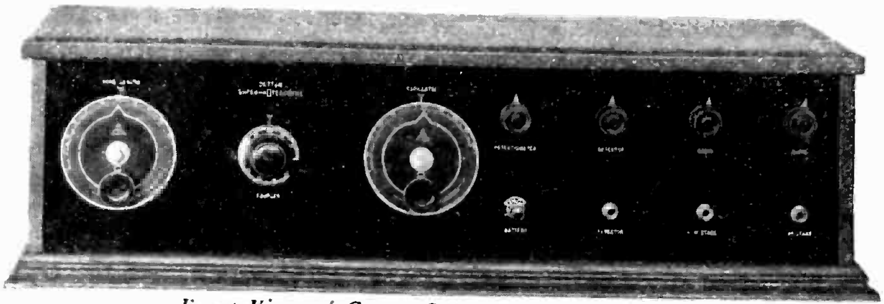
By R. W. Cotton

THERE have been many articles written on the construction of various super-heterodyne receivers and there is probably no receiving system which is more talked about by the radio fan today. The average constructor sometimes reports that he is not pleased with the results obtained. Why? Either because he has expected altogether too much from the set, or he has used parts which are not the best suited for their particular work.

On the other hand a person who owns and operates a *good* super-heterodyne cannot be pursuaded that there is any other receiving set which will equal his and, to my mind, he is right in making such a statement. It is a well recognized fact by authorities on radio that there is no set available today which will out-perform a good super-heterodyne, one whose every separate part is theoretically and practically proven the best available for its particular purpose.

As a starting point why not investigate the facts regarding reception and see if we cannot correct the erroneous impressions regarding receiving range, etc., which are all too commonly created by salesmen? The range of a receiving set is not altogether governed by the circuit used or the number of tubes employed but is limited by three factors: (1), the power of the transmitting station, (2), the static level and (3), the sensitivity of the set.

For example, the transmitting station sends forth a certain signal which at some place in its course becomes so weak that the static strength or noise is equal to it. It is obvious that when static and signal strength are equal or when the static level is higher, no receiving set, be it the humble single circuit "blooper" or super- heterodyne of twenty-four tube capacity, is capable of receiving the transmitting station signal. Hence, any receiving set which is capable at all times of receiving down to



Front View of Cotton Super-Heterodyne Receiver

the static level is the most efficient receiver and no other set is capable of doing more than this. This last sentence is a definition of what a good "super" will do.

An owner of a "super" has the satisfaction of knowing that, on a given night in a certain location with the same conditions, no other set can acomplish more than his. It should not be any cause for pique if some neighbor operating a single tube set receives the same distant station that you, operating a super-heterodyne, receive. A rough simile may be drawn as follows. The much talked about Ford automobile will take you to the same place as a Rolls-Royce. It is simply a matter of how you arrive and with what comfort and enjoyment.

The author has reached the point in radio where he does not demand as the outstanding feature of his set the ability to obtain distance, but puts quality of reception and selectivity ahead of DX ability. A good super-heterodyne is paramount in all these phases.

An item of interest is the fact that in the recent trans-atlantic tests, a set similar to that pictured in this article was used in competition with other sets at an official listening post near New York and was the only set there to receive foreign stations on a loud speaker. This reception was accomplished on a loop alone against competitive sets operating on antennas and ground.

BEFORE beginning the constructional data on the set described herein, it might be well to state that the author is not in the employ of any of the firms whose products are listed herein and has, to the best of his knowledge and experience, picked out those parts which he believes function the best. By this I do not mean to infer that parts of other manfacturers are not as good, but that I have merely specified those which I have found to be satisfactory as based on engineering tests. The parts necessary are not as many or as expensive as the general public has been led to believe. There is one fact which cannot be over emphasized, "the best is the cheapest in the long run." Below is given the quantity and list of the parts used:

- 8 No. 8645 Benjamin sockets.
- 1 No. 850 Chelton midget condenser.
- 2 No. 301 General Radio 30-ohm rheostats.
- 1 No. 301 General Radio 10-ohm rheostat.
- 1 No. 301 General Radio 200-ohm potentiometer.
- 2 No. 11 Bruno condensers, .0005.
- 1 Carter "Imp" battery switch.
- 2 No. 104 Carter Hold-Tite jacks.
- 1 No. 101 Carter Hold-Tite jack.
- 1 Samson Super-Kit, including 1 No. 29 Samson oscillator coupler, 1 HW-RI 5,000 meter filter, 3 HW-RI 5,000 meter intermediate frequency transformers.
- 2 Apex vernier dials for condensers.
- 1 2 in. Carter dial with ¼ in. shaft for coupler.

Rear View of Cotton Super-Heterodyne Receiver

9 Eby binding posts, (3 loop; 1 A—; 1 A+B—; 1 B+Det.; 1 B+Amp; 1 C—; 1 C+).
1 HW-A2 6:1 ratio Samson audio transformer.
1 HW-A2 3:1 ratio Samson audio transformer.
5 No. 601 Micadon fixed condensers (1-.005 mfd.; 2-.0005 mfd.; 2-.001 mfd.)
2 1mfd. bypass condensers.
3 Daven grid leaks with No. 51 mountings. Resistance: 1-.05 meg.; 2-5. meg.
1 Front panel, 7 in. by 28 in. by 3/16 in.
1 Base panel, 8 in. by 27 in. by 3/16 in.
3 Brass brackets, 1/8 by 3/8 by 5 in.
Bus bar, spaghetti, soldering lugs, solder, etc.

It is recommended that the base panel be made of bakelite or hard rubber as wood which has not been seasoned has caused trouble,—particularly if bare wires are led through the board and come in contact with the wood.

In choosing variable condensers for this set, it is well to purchase one of the so-called "low loss" type with a grounded rotor. There are many of these on the market, which are very good. Be sure in buying this, that the minimum capacity is low—at least not more than .00002 mfd., this reading to be taken when the rotor plates are entirely removed from those of the stator. A small variable feed back condenser of approximately .000045 mfd. maximum capacity is required to cause regeneration in the first detector.

Referring to the schematic diagram of this set, it will be noted that the grid condensers of the first and second detectors are in the usual position, and that the grid leaks are connected from the grids to the positive ends of the filament. With the grid leaks connected as shown, it makes no difference to which side of the filament the grid return is connected, since there is no direct current in the grid return, owing to the presence of the grid condenser.

In the oscillator circuit you will note also a grid leak and grid condenser. This is essential for satisfactory operation of the oscillator over the entire range. Without the grid leak and condenser, a large amount of energy is lost in the grid circuit when the oscillator is in operation, since for a part of the time during each cycle the grid is quite positive.

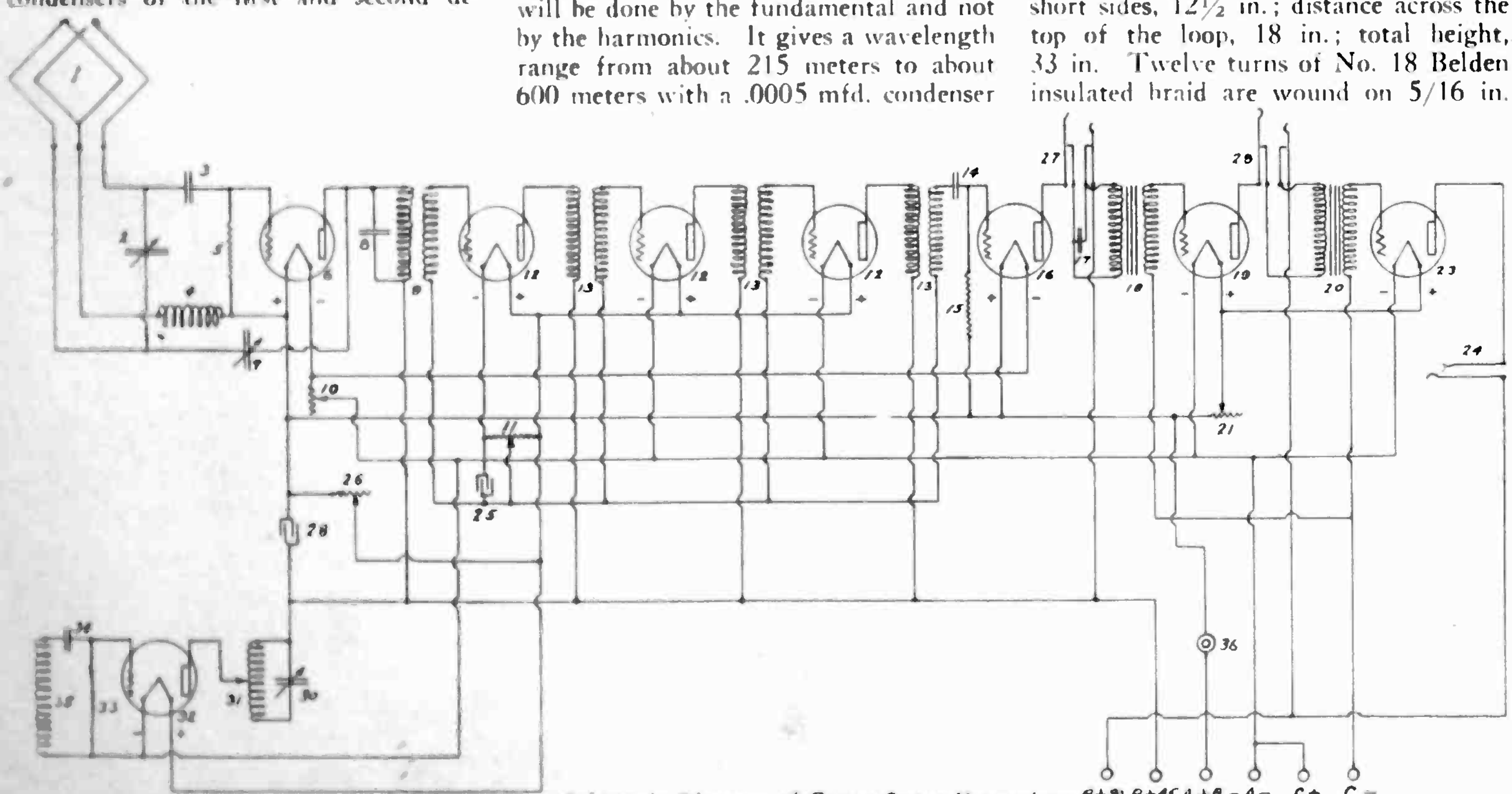
A UV201A or C-301A tube will operate best as an oscillator with a grid leak of about 30,000 ohms, although this value is not critical. A grid leak of 50,000 ohms or .05 meg-ohms will work satisfactorily. The grid oscillator condenser only acts as a by-pass for the alternating current and need only be large enough to serve this purpose. For the oscillator in question, a value of about .005 mfd. will be good, although a .004 mfd. or a .006 mfd. will do as well.

The Samson oscillator coupler has been designed to give the necessary variations in frequency over the range of the 5,000 meter intermediate frequency transformers so that the heterodyning will be done by the fundamental and not by the harmonics. It gives a wavelength range from about 215 meters to about 600 meters with a .0005 mfd. condenser having a zero capacity of about .000015 mfd. An extra tap is taken from the oscillator coil for the plate lead so as to increase the stability of high frequency oscillations and yet allow sufficient coupling between the oscillator and grid coils to produce strong oscillation at the lower frequencies.

The author has tried out numerous intermediate frequency transformers ranging from 2,000 to 10,000 meters in wavelength and of both iron core and air core construction. He finds that the 5,000 meter band seems to offer the advantages of both the higher and lower wavelengths without some of their disadvantages. He also accepts the general opinion that properly constructed air core transformers, properly matched, are the best. An air core is also used in the in-put or filter transformer in conjunction with a tested .001 mfd. fixed condenser across its primary, this being sufficiently sharp to eliminate interference and yet broad enough to pass the side bands necessary to give good quality of reproduction.

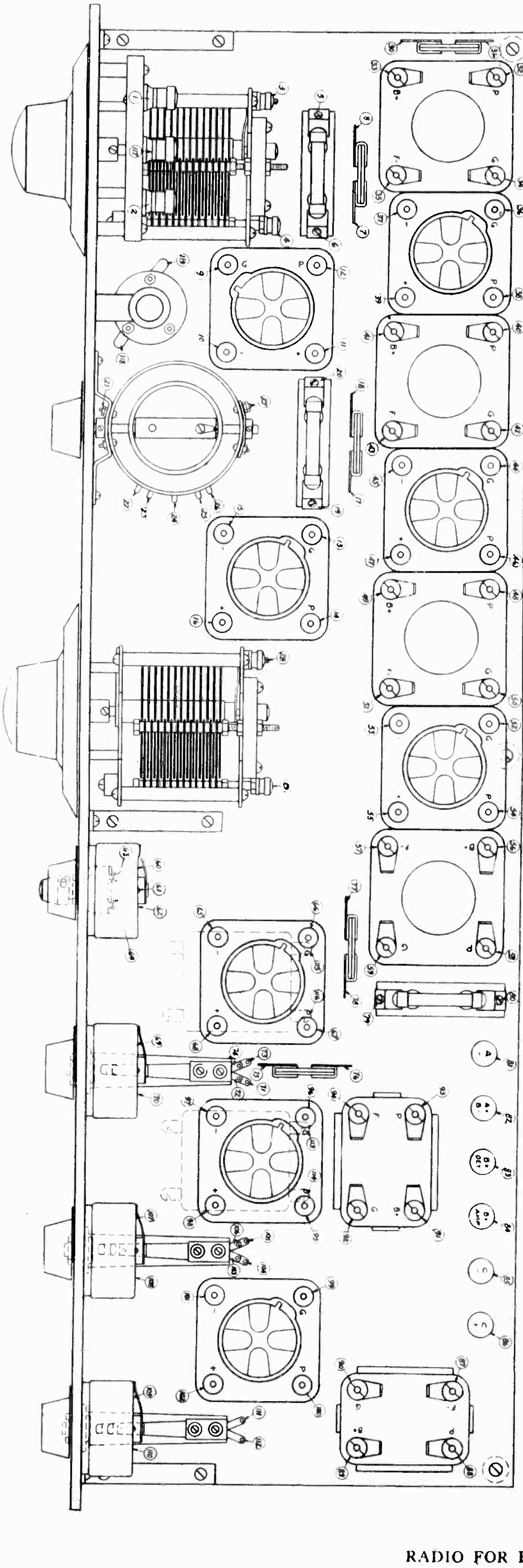
Regeneration in the first detector is secured by the use of a three-tap loop and a small feed back condenser. This makes the loop more directional, makes tuning sharper and increases a tube's sensitivity as well as making its neutralization possible.

The specifications of a loop which is suited to this receiver are as follows: Length of long sides, 25 in.; length of short sides, 12½ in.; distance across the top of the loop, 18 in.; total height, 33 in. Twelve turns of No. 18 Belden insulated braid are wound on 5/16 in.

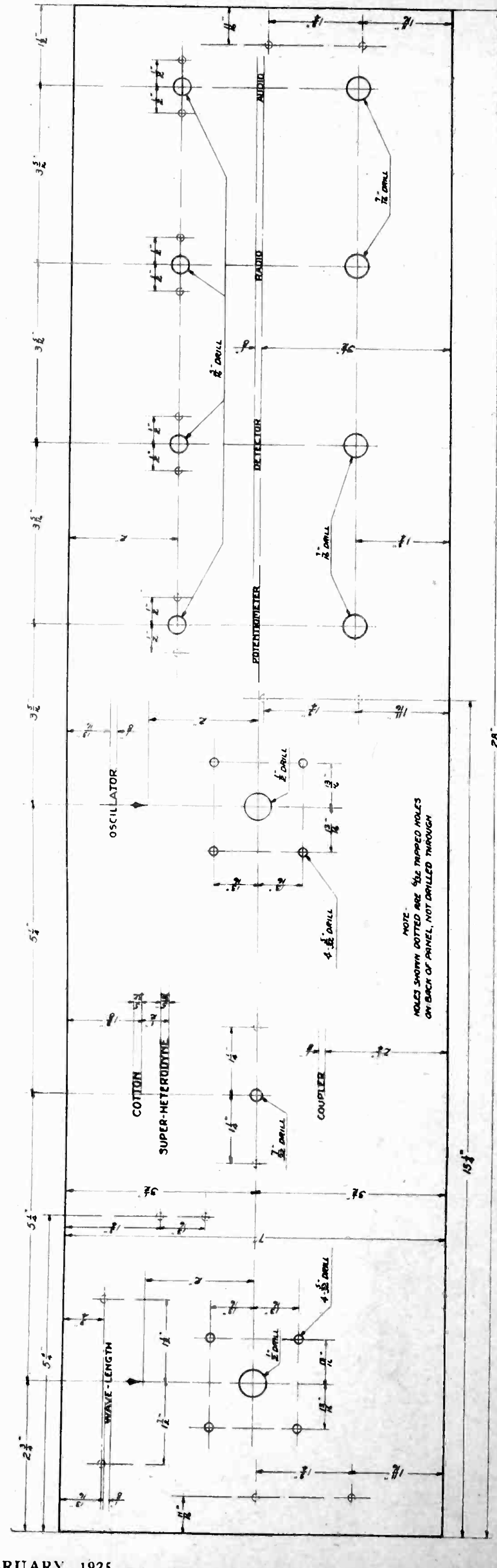


Schematic Diagram of Cotton Super-Heterodyne

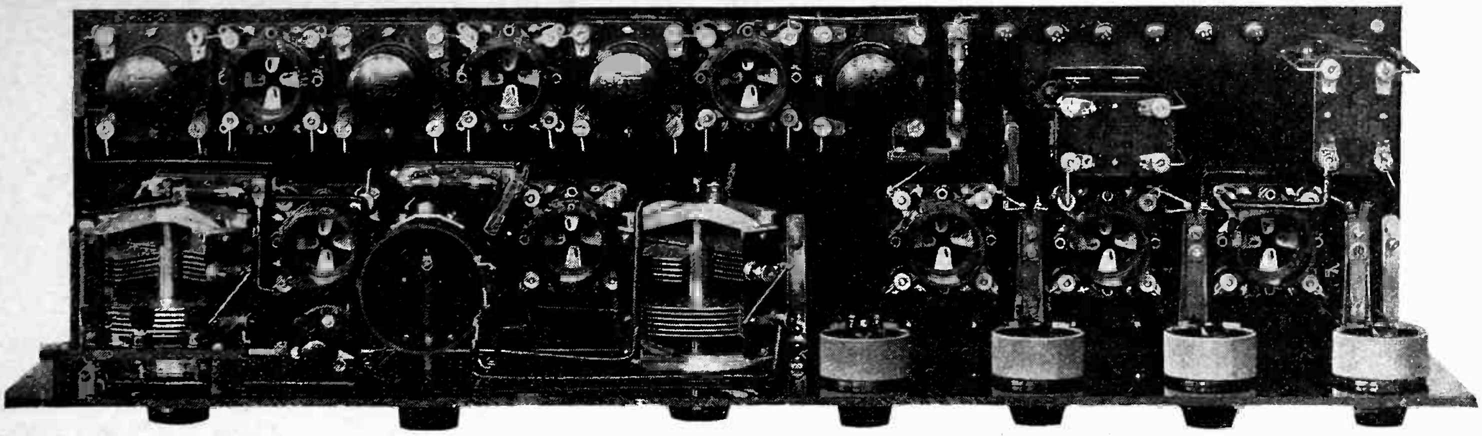
1 Center tap loop
2 Loop condenser, .0005 mfd.
3 1st Det. grid condenser, .0005 mfd.
4 Oscillator pick-up coil
5 1st Det. grid leak, 3-5 meg.
6 1st Det. tube
7 Feed-back condenser, .000045 mfd.
8 Filter condenser, .001 mfd.
9 Samson HW-R1 Filter, 60 kc.
10 Detector Rheostat, 15 ohms.
11 Potentiometer, 200 ohms.
12 Radio frequency tubes
13 Samson HW-R1 transformers, 60 kc.
14 2nd Det. grid condenser, .0005 mfd.
15 2nd Det. grid leak, 3-5 meg.
16 2nd Det. tube.
17 Phone condenser, .001 mfd.
18 Samson HW-A2 transformer, 6-1 ratio.
19 1st audio tube
20 Samson HW-A2 transformer, 3-1 ratio.
21 Audio rheostat, 15 ohms.
22 "C" Battery, 4.5 volts.
23 2nd audio tube.
24 Output Jack.
25 Pot. by-pass condenser, 1 mfd.
26 Radio rheostat, 5 omhs.
27 Detector Jack.
28 "B" Battery by-pass condenser, 1 mfd.
29 1st Audio Jack.
30 Oscillator condenser, .0005 mfd.
31 Oscillator plate coil.
32 Oscillator tube.
33 Oscillator grid leak, .05 meg.
34 Oscillator grid condenser, .005 mfd.
35 Oscillator grid coil.
36 "A" Battery switch.



Parts Assembly for Cotton Super-Heterodyne



Panel Layout for Cotton Super-Heterodyne



Top View of Cotton Super-Heterodyne Receiver

centers, with a tap taken off at the exact center of the wire. The pieces of wood which support the wire are 4 by ¼ by 1½ in. with notches cut in one side 1/8 in. deep and 5/16 in. on centers, to accommodate the wire. The frame should be made of any good dry 1 in. square wood. It is recommended that the constructor purchase a ready-made loop with mid-tap.

An antenna and ground may be used with this set by connecting the antenna wire to the ground wire with 4 or 5 ft. of stranded insulated wire turned once around the outside of the loop.

Small tinned copper wire or insulated wire is the best material to use in construction. Wire smaller than No. 14 is not recommended for use in the filament circuit, but smaller wire may be used elsewhere in the set. Rosin core solder should be used, or plain solder with a mixture of rosin and alcohol as a flux. Never use paste or acid core solder, as this has a tendency to create trouble.

It is generally recommended that eight tubes of the C301-A or UV-201-A type be used throughout. The writer recently had the pleasure of using the Magnavox tubes which proved very satisfactory. In case the experimenter wishes to use D21 Sodion tubes as detectors the only necessary change is that the grid return be made negative instead of positive. The 199 type of tubes can be used with adapters. The results will be approximately 65 per cent of what can be expected from the use of larger tubes.

To obtain the best results with the super-heterodyne vernier dials are a necessity and should be used on both condensers.

THE author feels it needless to go into a long description as to how to construct this set. The picture layout and wiring diagram are sufficient means for the average person to accomplish this work satisfactorily. A few general ideas, however, may be helpful:

The first thing is to fasten the instruments to the base panel and to the front panel. Do not, however, put these panels together. Wire all that can be done on the front panel. and then wire all that can be accomplished on the base panel.

When these are finished, attach the front panel to the base by brackets and finish the wiring from panel to base. Make all the joints rigid enough so that it is possible to slide the set on your table by the joint which has just been made. This will save you the trouble of broken connections at some later date.

It is best to do all of the filament wiring first. Then follow with the wiring of the *B* battery connections; this in turn, may be followed with the wiring of the loop tuning circuit and the oscillator circuit.

To test the correctness of the wiring, connect your *A* battery to the *A* battery binding posts, taking one tube and inserting it in each successive socket with the filament switch on the rheostat controlling the particular tube socket in which you have the tube about half way on. If the tube lights in each place controlled by the rheostat corresponding to the socket in which the tube is inserted, you may be reasonably certain that the filament wiring is correct.

Then connect the *A* battery to the detector *B* battery terminals, taking one tube and inserting it in each socket as before. If the tube does not light this wiring is correct. Do the same thing with the *A* battery connected to the amplifier *B*+ terminals.

Next connect the *B* battery to the *B* battery binding posts and insert the telephone plug in the detector jack. This should give you a click showing that the *B* battery circuit is correct. Now insert one tube in each socket successively with the filament current on, and if nothing happens, the *B* battery connections are not shorted with that of the *A* battery. Now put all tubes in their respective sockets and connect the three tap loop to the three binding posts. The center tap of the loop must by all means be connected to the center binding post.

Turn on the detector tubes to approximately normal brilliancy, which will be about three-quarters of the rheostat. Follow this by turning on the intermediate frequency amplifiers and the oscillator by means of the rheostat which controls them, to their normal brilliancy. Be sure that the Chelton midget condenser is at its minimum capacity. When listening to a low wavelength station, 1,000 or more miles away, move the Chelton midget condenser up to the point where the greatest signal strength is obtained without distortion. In some cases it may be possible to throw the first detector tube into oscillation by means of this small condenser, and of course it would be set just beneath this point. Now that this condenser is set, it will not have to be varied.

On a station of at least 1,000 miles away, make the adjustment of the oscillator rotor to the minimum coupling position that it is possible to attain without decreasing signal strength. This may be accompanied by a small change in the oscillator condenser dial. Now that this adjustment is fixed, it need not be changed, except when a new oscillator tube may be inserted in the oscillator socket.

Try out the different tubes in different positions throughout the set, as some act in one capacity better than others. Now place the potentiometer about midway of its arc; by turning this to the right you should notice a decided click. This shows that the radio frequency tubes have gone into oscillation.

Leaving the radio frequency tubes in this manner, slowly rotate the oscillator dial. If whistles are heard, it shows that the oscillator is performing its function. Now turn the potentiometer to the left until there is a click, showing that the radio frequency amplifier has gone out of oscillation. Now rotate the oscillator condenser dial slowly together with that of the loop tuning dial. These will run fairly uniform, not more than ten degrees apart.

This testing should occur when local radiocast stations are known to be in operation, and as the oscillator dial is turned, the stations will be heard to come in.

Now turn the loop tuning dial to the point at which the music or speech comes in the best. Also do this with the oscillator dial. Then move the potentiometer on to the right within a short

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The "Multi-Speaker" Amplifier

A Simple and Effective Means for Connecting Several Loud Speakers To A Single Receiving Set

By B. F. McNamee

INQUIRIES often reach the radio man regarding the installation of radio equipment in apartment houses, hospitals and club buildings. Generally the idea is to install a single master receiving set with loud speaker equipment at various points in the building or in various rooms, all the loud speakers being wired to the one receiving set.

A problem is involved in connecting more than two or three loud speakers to a single receiving set. Connecting them in parallel is not to be considered, as the volume is rapidly cut down. It has been found fairly satisfactory to connect two, or sometimes even three, speakers in series without cutting down very greatly on the volume. When, however, four or five or more loud speakers are connected in series, the output impedance is so great that even with increased *B* battery voltage the volume is greatly diminished. The difficulty is not solved by adding more steps of audio frequency amplification. The trouble lies in the fact that the last tube is not capable of delivering sufficient energy to operate all the loud speakers, unless, of course, a power tube and power equipment are used. Such power equipment is not feasible in this class of installation.

Fig. 1 shows an amplifier which works satisfactorily under such conditions without greatly increasing the equipment. The plug shown at the left is plugged into the output jack of an ordinary radiocast receiver. *P* and *S* are the primary and secondary of a low ratio amplifying transformer. A 2 to 1 ratio works out very satisfactorily. The filaments on the three tubes are connected as usual, in parallel, and may be fed from the some storage battery that is used for the receiving set. The grids of these three tubes are all connected together to the outer end of the secondary winding of the transformer. Each plate circuit is connected through two or three loud speakers to the positive of the *B* battery. Ordinary A tubes may be used. In this way one transformer controls the three tubes but the plate circuits are separate.

The idea may, of course, be extended by adding further tubes, still connecting all the grids and filaments in parallel. Increasing the number of tubes will not increase the tendency to howl that they would have if connected in the usual cascade arrangement. In this way any number of loud speakers may be taken care of without cutting down on the volume. If one tube is removed the only loud speakers that will be affected are those connected in its plate circuit. The others will still work without increase or decrease in volume.

The writer made up such an amplifier by re-wiring a Western Electric Type 10A power amplifier. The change in wiring is simple and only the input transformer is used. The grids of the second and third tubes are disconnected from the push-pull transformer, and connected to the grid of the first tube. The plates are all disconnected and brought out to three terminals for three loud speaker circuits.

Fig. 2 shows a system for wiring up the loud speakers so that they may be disconnected at will without interfering with the other loud speakers. *C* and *D* are jacks of the closed circuit type. The loud speakers are equipped with standard plugs. Another scheme would be to wire the loud speakers into the circuit permanently with any simple form of single-pole, single-throw switch for short-circuiting it when desired. A small push-pull switch, such as is often used on filament circuits will be convenient.

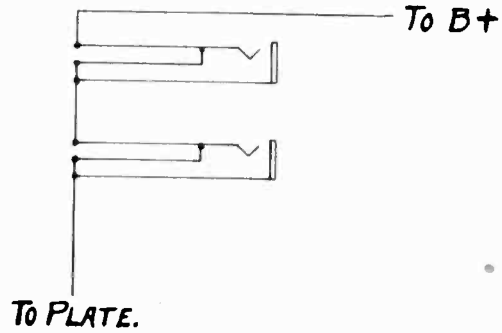

Fig. 2. Wiring Method for Cut-out

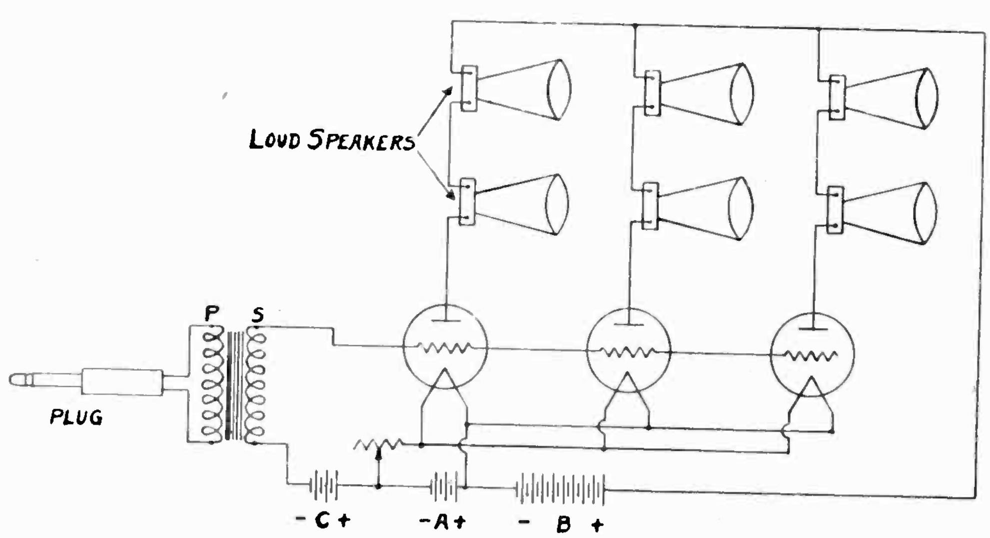

Fig. 1. The Multi-Speaker Amplifier

ARE THE SHORT WAVES NEW?

By Howard F. Mason

Almost everyone interested in radio has heard reports of the wonderful and unusual results obtained by stations transmitting on short wavelengths. By short wavelengths is meant from 100 meters or so down to even 2 or 3 meters. Ten years ago these wavelengths were regarded as useless for practical communication. Five years ago there was a mild interest in short waves but no one to start the ball a rolling. Today there exists what almost amounts to a mad scramble on the part of commercial companies, the navy, the amateur experimenters, to perfect apparatus for use on these short waves.

Some of the stations to be heard transmitting signals of short wavelength are WGY, KDKA, KFKX, NKF, NFV, and WGH. POZ, the big station at Nauen, Germany, which boasts the largest antenna in the world, has had a short wave transmitter operating in the vicinity of 88 meters for several months. UFT and LPZ, two more foreign transoceanic stations, are also investigating short wavelength work. Marconi, the man who really made radio commercially practical in the first place, did phenomenal work on short waves recently by transmitting a signal from England to Australia on a 100-meter wavelength with quite low power.

There is a queer bit of history behind this recent interest in short wave transmission and reception. It was these same short wavelengths, only shorter, that were used 37 years ago by Heinrich

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A De-Luxe Super-Heterodyne

Incorporating One Stage of Tuned R. F. Ahead of Super to Increase Sensitivity and Selectivity

By A. J. Haynes

IN designing receiving equipment there are two ideals for which we aim.—taking for granted that good quality of reproduction in the audio amplification end of the receiver is always maintained. One of these desirable conditions is to have the receiving set extremly sensitive, i. e., to attain a large degree of radio frequency amplification. The other ideal is extreme selectivity or sharp tuning, whereby we may be able to receive the one station which we desire and eliminate all else.

Both of these conditions for which we strive have practical limitations. The sensitivity should not be so great that the noise of static and irregular filament emission drowns out the faint signals of distant stations. Tuning should not be so sharp as to exclude the side-bands as otherwise some of the overtones and harmonies will be pinched and distorted.

The super-heterodyne is capable of admirably fulfilling these two ideals. The set I describe approaches these conditions more nearly than any receiver I have ever operated. Of course the ideal set would perhaps accomplish the same thing with greater simplicity and fewer tuning controls and no doubt such a receiver will be developed some day, as simplicity should be the aim of all engineering and design work. While it is true that there are three tuning controls, at the same time this is not going to be easily reduced without sacrificing something and it has been my ambition in designing this set not to make sacrifices.

I will say frankly, that this set is not one for the novice to tackle. He would undoubtedly get better results and surer success from a straight super-heterodyne, but for the amateur or set-builder who has already had success with the super-heterodyne, who appreciates and perhaps understands some of the workings of this remarkable circuit, the set should offer few difficulties.

This receiver is extremely flexible. It can be made to tune beyond the limit of selectivity, in other words, if it is so desired, the signal may be actually distorted, which allows the operator to carry sharp tuning to its limit at all times. Also on a medium size loop its amplification is such that it will get down to the noise level under practically any conditions. Thus the only thing that limits its range is its location and the amount of atmospheric disturbance present.

A switch is provided whereby the first stage of tuned radio frequency, which precedes the super-heterodyne proper may be cut out and the set operated as a straight superheterodyne with its two tuning controls, namely, the loop and oscillator tuning condensers. Throwing in the stage of tuned radio frequency ahead of the set has no effect on the oscillator tuning, but requires a slight readjustment of the loop condenser. The set is designed to operate from a six-volt storage battery and from 90 to 130 volts *B* battery. The current consumption is very small for this type of set, the filament consumption with all tubes in use being slightly less than one ampere and the *B* battery consumption approximately 18 miliamperes.

UV-199 or C-299 tubes are used up to the final detector, as they handle the radio frequency current admirably. The larger one-fourth amp. tubes are used for the final detector and the audio frequency amplifiers where tubes of greater capacity are desirable for perfect reproduction with good volume.

The rheostat controls only the small tubes and a filament volt meter is included in the circuit across their filaments in order that they may always be kept at, or below, their proper voltage point. Automatic filament control is provided for the larger tubes where a critical adjustment or rheostat is of no benefit.

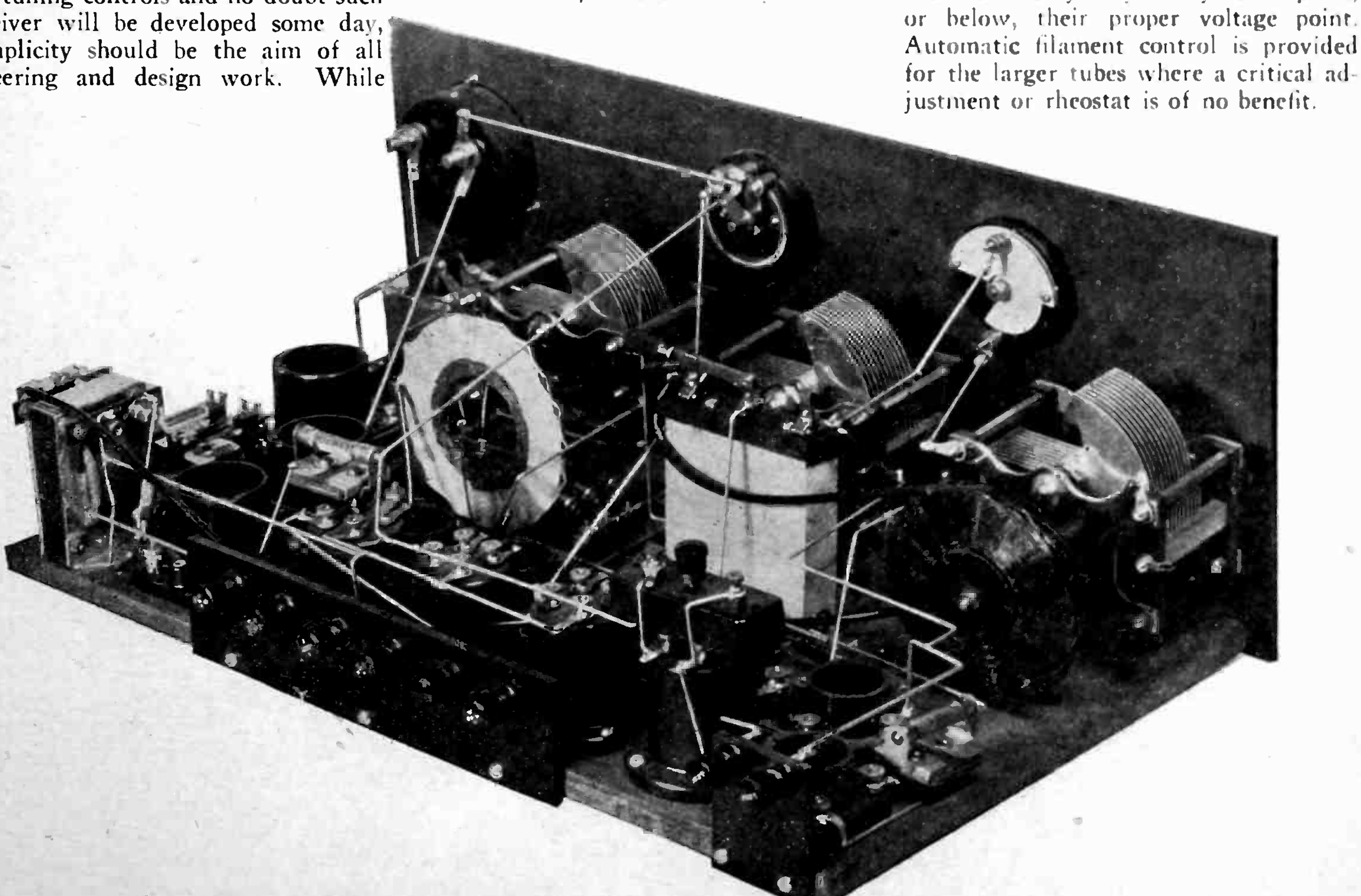

Fig. 1. Rear Panel View of De Luxe Super-Heterodyne

THE following is a list of the material used in the construction of this set. Other good parts may be substituted but the particular parts specified are adapted to the panel layout and have given satisfactory operation.

- 3 Haynes-Griffin Geared Vernier Condensers.
- 1 Rathbun 3-plate Condenser.
- 1 200-400 ohm Potentiometer.
- 1 20 ohm Rheostat.
- 3 Standard Base Benjamin Sockets.
- 5 199 type Hoosic Falls Sockets.
- 1 Haynes-Griffin Audio Transformer No. 91.
- 1 Resistor Coupler (Daven).
- 1 Special Oscillation Coupler.
- 1 Special R. F. Transformer.
- 1 Set H-G Matched R. F. Transformers.
- 1 Type H-G 2 Input Condenser.
- 2 .00025 mfd. Dubilier Condenser with grid-lead mountings.
- 1 .006 mfd. Dubilier Condenser.
- 2 .5 mfd. Dubilier Condenser.
- 2 .002 mfd. Dubilier Condenser.
- 2 .1 meg Resistances (Daven).
- 2 meg Resistances (H-G).
- 1 1 meg Resistances (H-G).
- 3 Amperites with mountings.
- 8 Binding Posts (Eby).
- 1 0-10 Volt-meter (Jewel).
- 1 7 in. by 18 in. hard rubber Drilled Panel.
- 1 Cutler-Hammer Battery Switch.
- 1 Double Circuit Jack (H-G).
- 1 Single Circuit Jack (H-G).
- 1 Marco S.P.D.T.
- 1 Baseboard 17 in. by 9½ in.

Fig. 1 shows a rear panel view of the set. The three large dials from left to right are the radio frequency tuning condenser, loop tuning condenser and oscillator condenser. The small dial at the top between the two left-hand condensers is the compensating condenser for the tuned radio frequency. The small knob at the top center is the potentiometer controlling the intermediate amplifier and the small knob in the lower right hand corner, the rheostat for the small tubes. A meter and filament switch which cuts off the entire set are also mounted on the panel. All battery connections are mounted on the binding post strip in the rear of the baseboard.

The oscillator coupler employes diamond winding, which combines efficiency with compactness. A winding form must first be made from a circular wooden disc 1½ in. in diameter, around the circumference of which 15 holes are drilled, equally spaced, each hole being in the center of the outer edge and drilled ½ in. straight toward the center of the disc. In each hole insert a pin made from a 2½ in. length of ⅛ in. brass rod or a wire nail of approximately the same diameter, first removing the head.

In winding the coil No. 26 double silk or No. 28 cotton and silk insulated wire may be used. The winding should be started by taking a turn around one of the pins and then winding around and around the circumference of the disc back and forth between the pins, but skipping two pins each time. After winding 20 turns for the pick-up coil make a loop which is brought out and may later be cut to form two leads. Then the winding is continued in the same direction for 25 more turns, when another loop is brought out, this middle section forming the plate coil. Then the winding is continued for 55 more turns and an end wire brought out for a few inches, this outside section forming the grid of the oscillator coupler.

To hold the winding in place, a heavy thread or string may be woven in and out through the diamonds on the outer edges. To do this, slip the pins out of the center core without pulling them out of the winding and slide the coil off the core. After the coil is held rigidly by the sewing process, the pins themselves may be removed. Another method of fastening the coil is to cover it with collodion, the pins being removed and the core slipped out after the collodion is dry.

The radio frequency transformer consists of two diamond windings, spaced ¼ in. apart. The same form may be used for winding these two coils with No. 24 S.C.S.S. For the primary coil wind on 60 turns with a tap brought out at the 20th. For the secondary coil wind 70 turns of the same wire.

A schematic wiring diagram of the circuit is given in Fig. 4. In connecting up the oscillator coupler, the two loops which were brought out should be cut so that we have three separate windings, that is six separate leads. On the outside section, which is the grid coil, the outer end should be connected to the stator of the oscillator condenser and also to the grid of the oscillator tube. The inner lead of the grid coil is connected to the rotor of the same condenser and the negative filament lead. The outer end of the center or plate coil should be connected to the plus 45 volt *B* battery tap, while the inner end is connected directly to the plate of the oscillator tube. The pick-up coil is connected in the plate circuit of the first detector tube, one end going directly to the plate and the other to the plus 45 volt *B* battery line. As a rule it makes no difference which of these two leads is brought to the plate or the battery, but it is well to try both ways.

In connecting the radio frequency amplifier into the circuit, the outside terminal on the secondary goes to one contact of the S.P.D.T. switch, while the inside connection is attached to the plus *A* battery line. On the primary the outside lead goes to the stator of the first tuning condenser and to the plate of the radio frequency tube, while the inside lead connects to the rotor of the same condenser and the rotor of the small compensating condenser. The tap on the primary winding goes to the *B* battery as indicated on the diagram.

If the builder winds his own coils, it is simplest to leave long leads which may be connected directly to the proper points by merely covering with spaghetti, rather than using bus-wire. However,

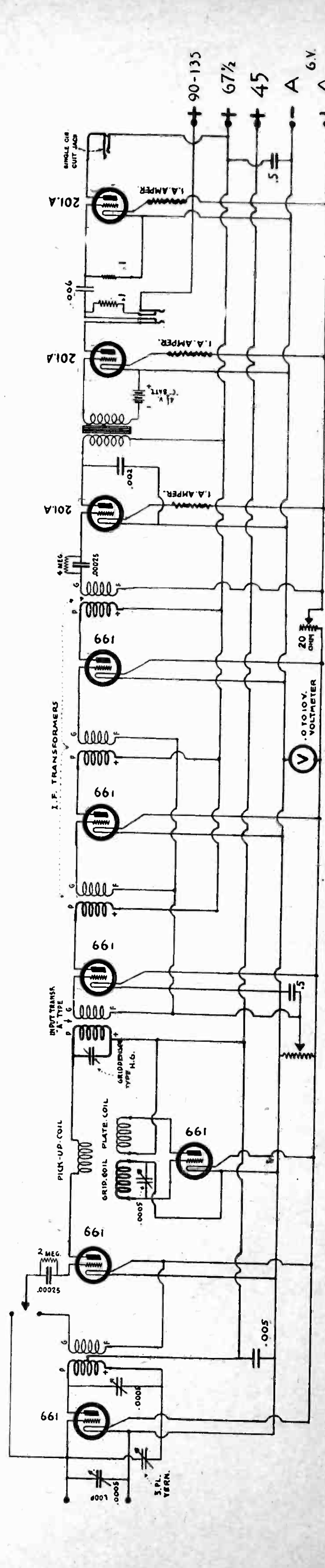

Fig. 4. Schematic Wiring Diagram of De Luxe Super-Heterodyne

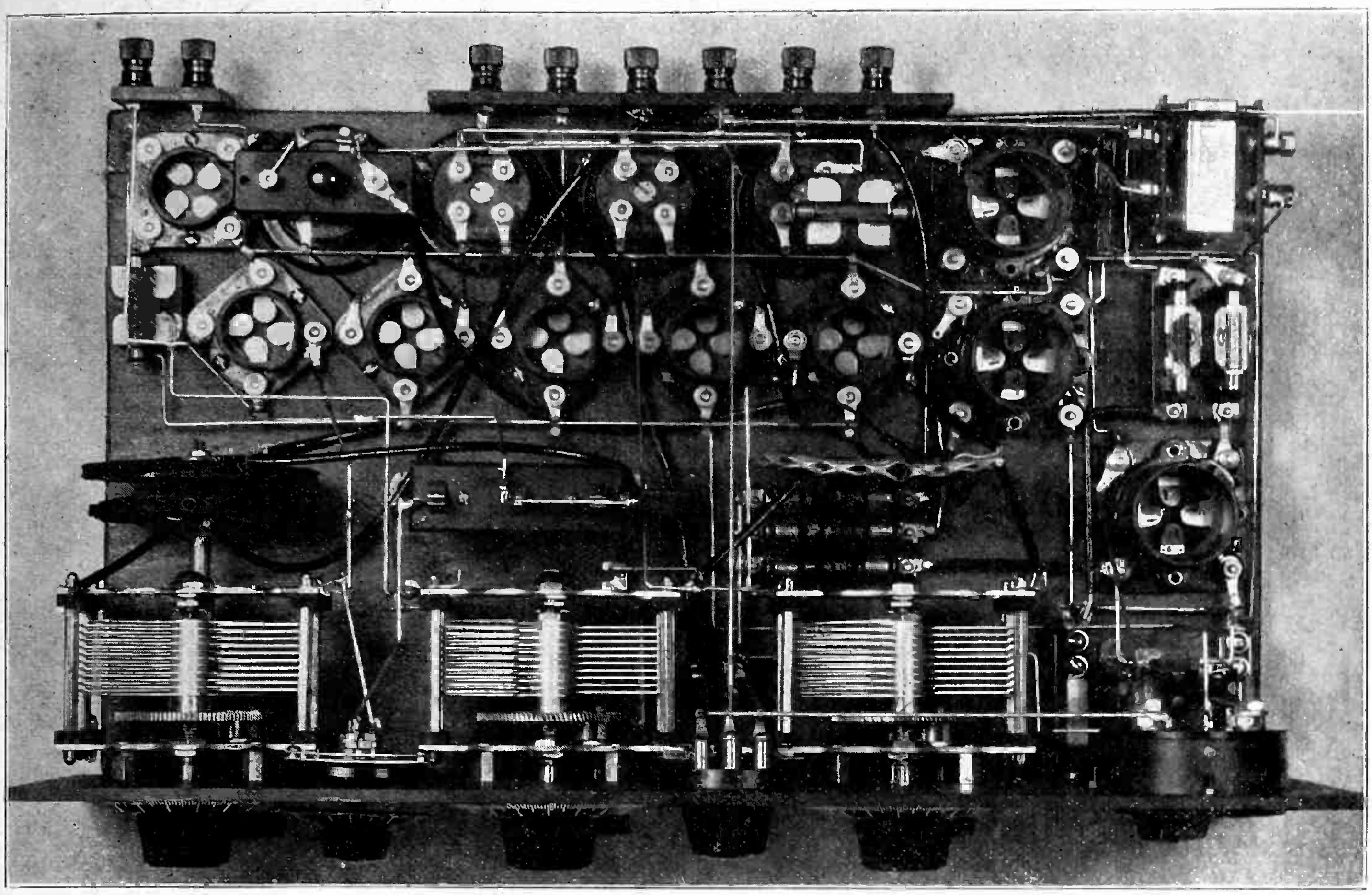

Fig. 2. Baseboard View of De Luxe Super-Heterodyne

bus wiring is recommended in general for the rest of the set, particularly the low voltage leads, due to the fact that it is somewhat easier to handle and makes a neater job.

The single step of radio frequency ahead of the super can be thrown in or out by means of the S.P.T.D. switch mounted on the block of the sub-base. When the radio frequency stage is not in use it is well to keep its tuning condenser at zero, that is with the plates entirely out of mesh. The set should first be tuned in this manner until the operator becomes accustomed to handling it as a straight super-heterodyne.

The proper operating point for the small tube filaments is 3 volts or slightly below. If the filaments are not high enough the set will be found unstable and hard to control.

The potentiometer which controls the intermediate amplifier should be carried well over toward the negative side at a point just before the tubes go into oscillation. If the set is functioning properly, when the potentiometer is advanced beyond this point the tubes in the intermediate amplifier will oscillate, then if the oscillator dial is rotated a series of whistles or heterodyne notes may be heard, but no stations will come through with the amplifier in this condition. The potentiometer must be brought back until the intermediate frequency amplifier ceases to oscillate. Usually a slight rushing sound can be heard when it is in its most sensitive position.

The stage of tuned r. f., when thrown in ahead of the super, gives a surprising increase in volume on weak signals and it also serves to sharpen the tuning considerably. In fact if it is left in, the three dials will operate exactly as the ordinary tuned r. f. or Neutrodyne set, and there will be no second point of resonance on the oscillator dial. This is because by the time this second point is reached, both the loop and the tuned r. f. are so far out of resonance with the signal that it cannot force its way through, the tuned r. f. acting as a filter circuit.

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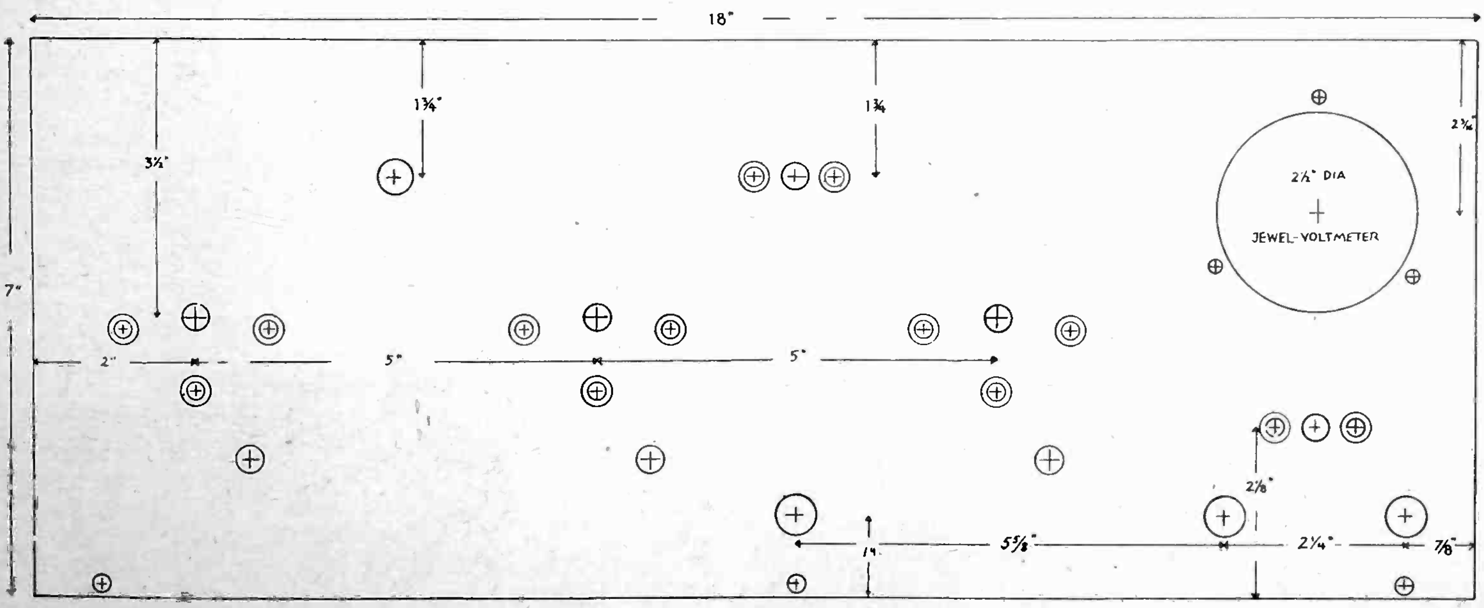

Fig. 3. Panel Layout

Reactance, Capacity and Phase Angle

A Discussion of the Meaning of These Terms and Their Application to Condenser Specifications

By E. F. Kiernan

REACTANCE is of two kinds; capacitive, and inductive. Capacitive reactance is simply a term to signify the retarding effect of a condenser on an a. c. current; likewise, inductive reactance is the retarding effect of an inductance coil.

In a d. c. circuit, a condenser acts as an open circuit, but in an a. c. circuit the condenser passes current in proportion to its frequency, the capacitive reactance varying inversely as the frequency. If an inductance replace the capacity, the current grows less as the frequency increases, i. e., inductive reactance varies directly as the frequency.

By inserting the correct amount of each kind of reactance in an a. c. circuit with an impressed voltage having a given frequency, the two reactances cancel, and the resulting condition is known as resonance. The resulting current flow will be limited, theoretically, by a single factor; namely, the ohmic resistance of the circuit. Since it is practical to reduce this resistance to a comparatively small value, the applied e.m.f. (electromotive force) need not be very great to produce a perceptible current flow.

The effect of the applied e.m.f. on a resonant circuit may be likened to the properly timed strokes of a hammer on a pendulum. In the case of the pendulum, its oscillations increase in swing until the work done against gravity just equals that supplied by the hammer. In the resonant circuit, the current increases until the losses (heat, radiation, etc.) in the circuit reach an equilibrium with energy supplied to it.

A resonant circuit is made up principally of inductances and capacities which introduce new losses. Capacity effects have a disconcerting way of creeping unwanted into various places in a circuit. If a record be made of the behavior of a given inductance under changes in frequency of the applied e.m.f, it will be found that, above a certain frequency, the inductance of the coil becomes insignificant compared to its distributed capacity. This is equivalent to saying that the coil has, to all practical purposes, become a condenser. Even two parallel wires, in close proximity, become effective condensers at high frequencies.

In the condenser proper, problems no less vexing occur. Since a condenser, if poorly built, may contain a large percentage of the total losses in a circuit, it will be well to examine said losses in more detail. To enumerate the losses; first, losses in the dielectric material; second, losses due to leakage between the two sets of plates, either through or around the dielectric; and third, corona losses. To these three might be added power losses in the conducting plates.

In any condenser, there will be found two main classes of material; the one acting as a conductor to distribute the electrostatic pressure over the second (dielectric) which is stressed thereby and stores the charge. The duty of the one material has been stated, the duties of the other material are three in number; to store the charge, to insulate the two sets of plates from each other, and to maintain a rigid mechanical relationship of the condenser parts. Of course one kind of dielectric material may perform two of the above duties while a second dielectric material performs the other. It is practically impossible to combine efficiently, all three duties in one material. Air is the ideal dielectric, from the efficiency standpoint, but its specific inductive capacity (its energy storing power) is small. Many of the synthetic resinol compounds have the necessary insulative and mechanical strength.

It would seem then, that an ideal condenser could be made with an active air dielectric and a synthetic resin as an insulator and mechanical binder. A majority of the variable condensers on the market today are built according to the above, yet they contain losses, and, in many instances, large losses.

To go back to condenser construction; the material used to insulate the two sets of plates may or may not serve as the active dielectric, (the active dielectric insulates too of course). It is, however, subject to the stresses imposed by the electrostatic field of the conducting plates. These stresses cause an atomic displacement in the dielectric, represented as stored energy. If the dielectric, as such, was 100 per cent efficient, all the stored energy would be given up upon the removal of the stress. This does not happen for the following reason; the work done in storing up energy is partially utilized in overcoming molecular friction in the dielectric, and is evidenced as heat. This heat is dead loss, and, if generated in excessive quantities, is harmful in a more serious way. The heat causes disintegration and chemical change in the dielectric with a corresponding increase in the amount generated. The process is accumulative and ends in the disruptive failure of the condenser. Failure is, of course, the extreme case, and in cases below this extreme point, the entailed losses are the center of interest.

To discuss dielectric losses quantitatively, power factor, together with phase angle, must be considered for a moment. Power factor might be called 'efficiency factor,' as it is a direct statement of the amount of available power that is being utilized in a given apparatus, (motor, condenser, etc.) By definition, power factor is the quotient obtained by dividing the product of the readings of an a. c. voltmeter and an a. c. ammeter (apparent power), by the reading of a wattmeter (true power) in the same circuit.

Mathematically, power factor is the cosine of the angle of phase difference (phase angle) between the current and the impressed e. m. f. of an a. c. circuit. Since the power factor is a measure of the efficiency and has a mathematical relationship to the phase angle, the latter may be also used to express efficiency. Many manufacturers use the term, phase angle, when giving data on dielectric materials. In radio condensers, the phase angle should never be in excess of .2°. Greater angles are indicative of prohibitive losses.

In point of efficiency, quartz and porcelain head the list of solid dielectrics. They have one drawback; they are hard to work with ordinary tools. The U. S. Bureau of Standards has used quartz for some time in its standard variable condensers.

The foregoing discussion has covered more or less thoroughly, condenser loss number one; losses two and three will be given a word or two.

Leakage around or through the dielectric can be minimized, in modern condensers, by making the leakage path as long and narrow as possible. This is effective because the voltages in current radio circuits are nearly always moderate. Corona losses appear at high voltages only, and it is therefore needless to discuss them here.

The Experimenter's Short-Wave Low-Loss Tuner

A Quick-Change Set for Amateur and Radiocast Wavelengths Using Various Coils Whose Construction is Described

By Carlos S. Mundt

A RECEIVER especially well adapted to waves below 100 meters can easily be made from the circuit diagram of Fig. 1. This is a Hartley oscillator with antenna circuit loosely coupled and fixed in tune so as to minimize radiation. Its especial feature is the provision made for easy and rapid coil changes, thus giving great flexibility in covering all wavelengths.

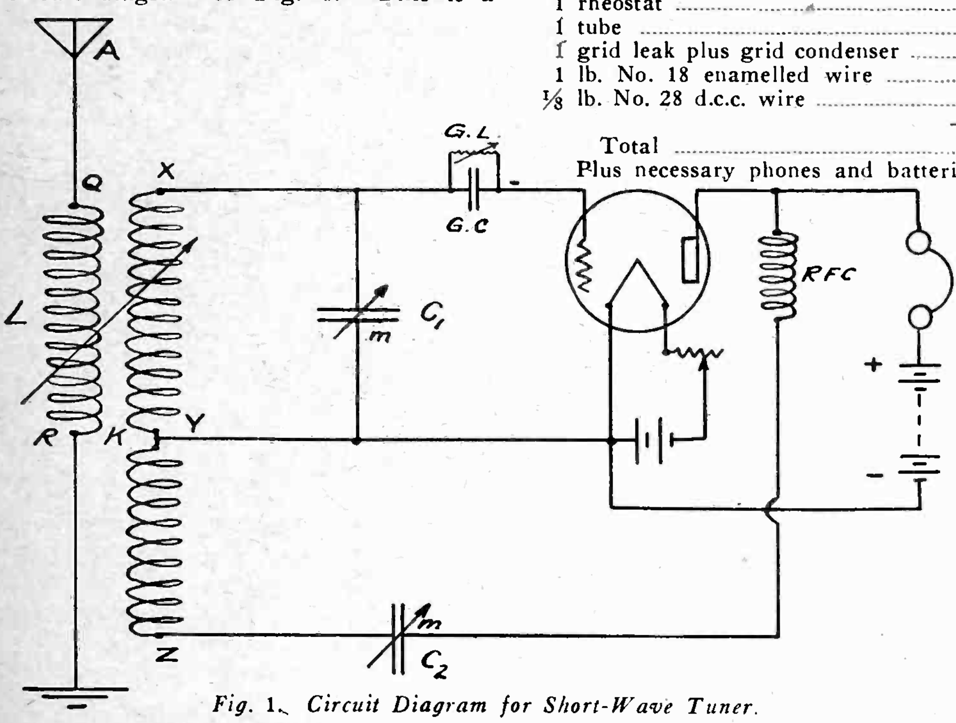

Fig. 1. Circuit Diagram for Short-Wave Tuner.

This quick change is accomplished by means of small battery clips whereby different coils may be attached at *X, Y, Z, Q,* and *R*. Best results are secured with a 2 in. separation of coils *L* and *K*. Complicated coupling arrangements are obviated by using variable condenser C_2 to control the feedback.

A simple panel arrangement for tuner and detector is shown in Fig. 2. This may be modified for adding one stage of audio frequency by mounting one rheostat above the left hand dial and one above the right hand dial.

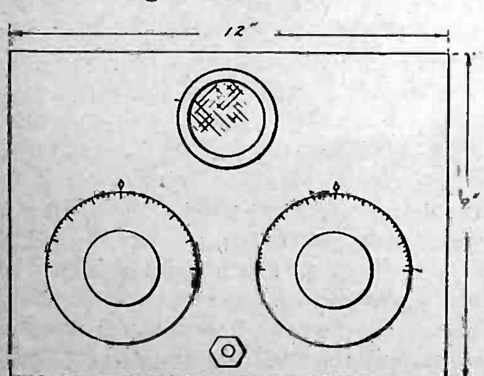

Fig. 2. Suggested Panel Layout

The apparatus and cost follows:

1	7x12x⅛-in. panel	$ 1.25
2	good low-loss variable condensers	10.00
1	socket	1.00
1	rheostat	1.75
1	tube	4.00
1	grid leak plus grid condenser	1.00
1	lb. No. 18 enamelled wire	0.60
⅛	lb. No. 28 d.c.c. wire	0.15
	Total	$19.75

Plus necessary phones and batteries.

The coils may be chosen from the four kinds described below. Look over your facilities and pick out those which are best suited to your available material.

Coil 1 (Fig. 3a) is wound on an ordinary spiderweb form. Thread the wire in and out over each arm (see figure) or, as an optional method, over two arms and under two arms. Assuming an inside diameter of 2½ in., wire 24 turns of the No. 18 enameled, stop and make a bared twist for connection *Y*, then add 16 turns to constitute the plate coil.

Coil 2 (Fig 3b) is wound on a 3 in. bakelite cylinder arranged for low loss by glueing eight strips of bakelite (or better yet, hard rubber) lengthwise around the circumference at equal distances. The object of this arrangement is to keep as much of the winding in air is possible. Six strips may be used in place of eight if desired. Number of turns: 20 for *XY*, bared twist, and then 14 for *YZ*.

Coil 3 (Fig. 3c), is a "diamond weave." On a disc of 3 in. dowel or window pole ½ in. wide make 15 equally spaced marks (lay your watch on the face of the disc and mark off every four minutes). Drive 15 2 in. nails normal to the surface, and about ⅜ in. away drive a similar line (see figure). Wind over one nail, cross and under next, or, as option you may wind over two, cross and under two, thus making the "duolateral." when finished tie with thread, pull out nails and clip coil off form, which may be used again. Turns as before.

Coil 4 (Fig. 3d) is the so-called "basket weave." On a flat board about ½ in. thick draw a 3 in. circle. Lay out by protracter or watch 15 equally spaced points on this circle. Drill ¼ in. holes at these points and insert 2 in. lengths of dowel in each. Wind in and out or, as option, over two and under two. Tie with thread, remove dowels with a twisting motion and coil is made. Number of turns as for coil 2.

Coil *L* is of five turns No. 18 enamelled. For coils 2 and 4 it may be made circular, though it is best to make it exactly like them. For coils 1 and 3 inductance *L* should match exactly. Clips at *Q* and *R* provide for changes.

Choke *CH* is made of 100 turns No. 28 d.c.c. "jumble wound" on a 2 in. tube.

In this set the exact number of turns

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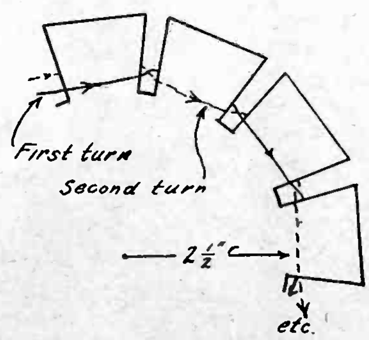


Fig. 3a. Coil I

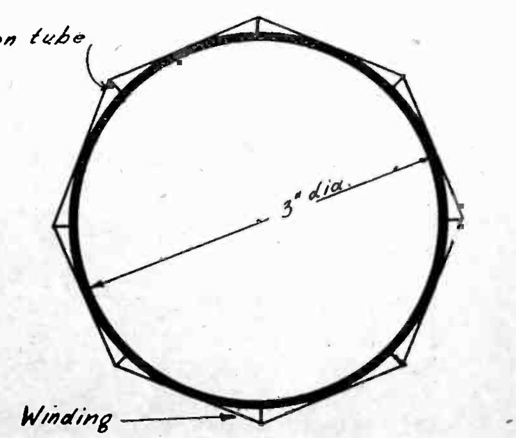


Fig. 3b. Coil 2

300 to 30,000 Meters on One Receiver

Complete Details for the Design, Construction and Operation of a Set Guaranteed To Efficiently Cover This Tremendous Range

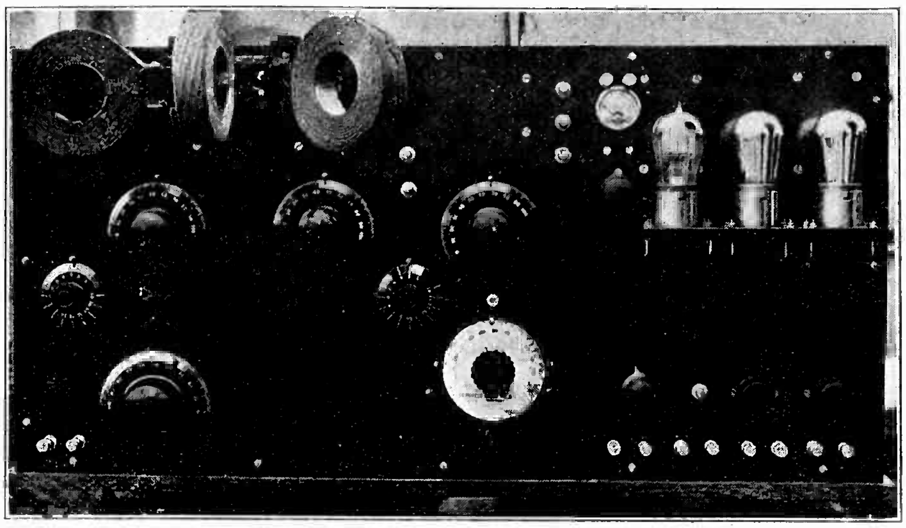
By Volney G. Mathison

TO THE radiocast listeners, and many amateurs, the radio wave bands above 800 meters are an unknown wilderness. The region over 10,000 meters is a particularly mysterious jungle, rumored to be frequented by certain leviathanic beasts such as 1,000-KW Poulsen arcs and Alexandersons, and other monsters that bellow across oceans and continents, with a contemptful disregard for static and daylight and summer conditions.

Occasionally the experimenter, reading of the opening of a new transoceanic unit, or seeing a close-range photograph of one of the huge long-wave brutes in his Sunday illustrated, is inspired to go and buy himself a wheelbarrowful of magnet-wire and construct various and sundry coils as lumpy, bumpy, and solid as the newlyweds' doughnuts, with which objects (the coils, not the doughnuts) he essays to eavesdrop on the new radio monster in his native haunts, "up on 20,000."

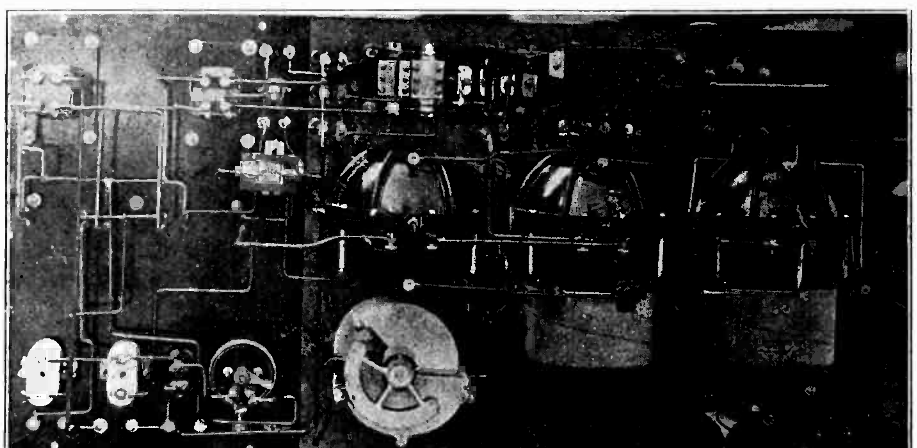
The general result is often a gloomy silence, broken only by faint crackles of static that seem as far away as Mars and turn out to be only the fizzlings of the old *B* battery at the experimenter's elbow. Then impatient attempts to rouse the game may cause the set to break into an uproar of howls, squeals, beats, and whistles that sound as if all the earth-girdling radio monsters were stampeding and rioting about the ether, spitting juice from every lofty aerial cable-end. The amateur learns that most of those big fellows are as wary as they are mighty.

It is indeed interesting to operate a receiver that will go from the music bands up through the commercial ship waves, radio compas, radio beacons, intermediate naval waves, army waves and air-mail, intermediate commercial, and long wave navy and international commercial, finally arriving at the silent places up above 28,000 meters. A receiver that will successfully do this is shown in the accompanying pictures and diagrams.



Panel View of All-Wave Receiver

In designing a set to cover this tremendous range of wavelengths from 300 to 30,000 meters, one of the most difficult problems is to select and combine standard apparatus so as to get the receiver to oscillate smoothly and quietly over the entire tuning range. This was finally accomplished by combining variocouplers for short waves with bank-wound inductances and honeycomb coils for long waves. There are no coils to be shifted or pulled out. The large honeycombs seen on the front of the panel are left on the set at all wavelengths; variations of primary and secondary inductance being accomplished by means of back-mounted multi-point panel switches.



Rear View of All-Wave Receiver

The Primary Circuit

THE primary or antenna-tuning system is confined to the left-hand end of the panel front. It consists of the stator winding of the first variocoupler, the bank-wound inductance of 300 turns of No. 22 d. c. c. wire attached to the lower part of the coupler, the 600-turn tapped honeycomb-coil mounted on a fixed plug above the coupler, and the large 1500-turn honeycomb-coil in the left-hand movable mounting on the front of the panel. The total primary inductance is about equal to one 1500-turn honeycomb-coil and one 1,000-turn honeycomb in series. The variable condenser under the bank-wound inductance is in series with the primary tuning-system and the ground. It is of .001 mfd. capacity.

Various sections of primary inductance are cut in and out by means of a 15-point back-mounted switch, shown beside the bank-wound inductance. Only nine points of this switch are actually used. The first switch-tap cuts in one-half of the stator winding on the variocoupler. This is the minimum amount of inductance obtainable in the primary system. The second switch-point cuts in the entire variocoupler stator winding. The third, fourth, fifth and sixth taps each cut in 75 turns of the 300-turn bank-winding attached to the coupler. The seventh tap cuts in 300 turns of the honeycomb-coil above the coupler; the eighth tap cuts in the entire coil of 600 turns; and the ninth tap adds the 1500-turn coil on the front of the panel. These allotments of inductance provide overlapping wave-bands on the primary condenser, with no holes at any point.

In order to assure sharp tuning, the primary condenser is kept in series with the primary inductance on all waves. On wavelengths above 20,000 meters, using a small aerial, it may be found necessary to shunt the antenna and ground connections with a fixed condenser of .001 or ,002 mfd. capacity. If used, this condenser must be arranged with a switch to enable cutting out on shorter waves.

It will be observed that a large amount of dead-end inductance is left in the circuit when the receiver is adjusted for short waves. Long dead-ends are generally objectionable in secondary circuits; but in the primary circuit, at least in the case of this receiver, repeated experiments with dead-end switches have convinced me that they are not worth the cost of installation. Cutting off the unused primary inductance causes no change in signal strength or sharpness of tuning. The careful shielding employed perhaps has something to do with this.

The Secondary Circuit

THE secondary circuit is coupled to the primary by means of the rotor winding in the first variocoupler. One end of the rotor winding is taken directly to the positive terminal of the *A* battery. The other end of the coupling coil is connected in series with the stator of the second or middle variocoupler; to this is added a 300-turn bank-wound inductance, corresponding to that used in the primary, a 600-turn honeycomb-coil mounted above the variocoupler, also corresponding to the primary, and a 1250-turn honeycomb on the front of the panel—the middle coil. This inductance system is tapped to a secondary switch, using ten points, taken off as follows:

The first switch-tap cuts in only the rotor or coupling-coil in the primary variocoupler, all loading inductance in the secondary system therefore being cut out. This is the minimum inductance obtainable in the secondary circuit. With the secondary variable condenser at or near zero, the wavelength is considerably below 300 meters, nearer 250; with full secondary condenser (capacity .001 M. F.) it is about 700 meters.

It is important to note that the rotor winding used as a coupling-coil has only 60 turns of wire. The variocoupler, as originally purchased, had 120 turns; but one-half of them were removed. If this were not done, the receiver with the average variocoupler would not tune low enough, owing to the distance at which the secondary condenser is mounted from the coupling-coil. It should also be noted that the "variocouplers" used on this set are really variometers, but with the rotors employed as coupling coils and having no electrical connection whatever with the stator windings. These instruments are used instead of the ordinary variocouplers because the latter do not usually have as close clearance between moving and stationary windings and will not give as strong coupling as a converted variometer.

The second tap of the secondary inductance-switch cuts in one-half of the stator winding on the middle variocoupler. This loading inductance raises the secondary wavelength to 400-1000 meters. The third tap cuts in all the stator winding and brings the wavelength up to 500-1250 meters. The fourth tap cuts in the stator winding of the third vario-coupler and 75 turns of the secondary bank-wound inductance. The next three taps each cut in 75 turns of the bank-winding, and brings the wavelength up to about 4800 meters.

The eighth tap cuts in 300 turns of the honeycomb-coil over the middle variocoupler, and the ninth tap cuts in the entire coil of 600 turns, raising the maximum wavelength to over 12,000 meters. To this already-long-wave circuit, the tenth tap cuts in the 1250-turn honeycomb-coil on the front of the panel and raises the wave-band to a minimum of 10,000 and a maximum that is "over everything."

In the secondary tuning circuit, the dead-end effects of this large amount of inductance were found serious on some of the short waves. A simple sixty-cent push-pull radio switch was inserted in the circuit between the bank-wound inductance and the loading honeycomb-coils to break the secondary loading inductance into two sections. Below 4,800 meters, this switch is open, above 4,800 it must be closed. This arrangement has been found adequate for this receiver.

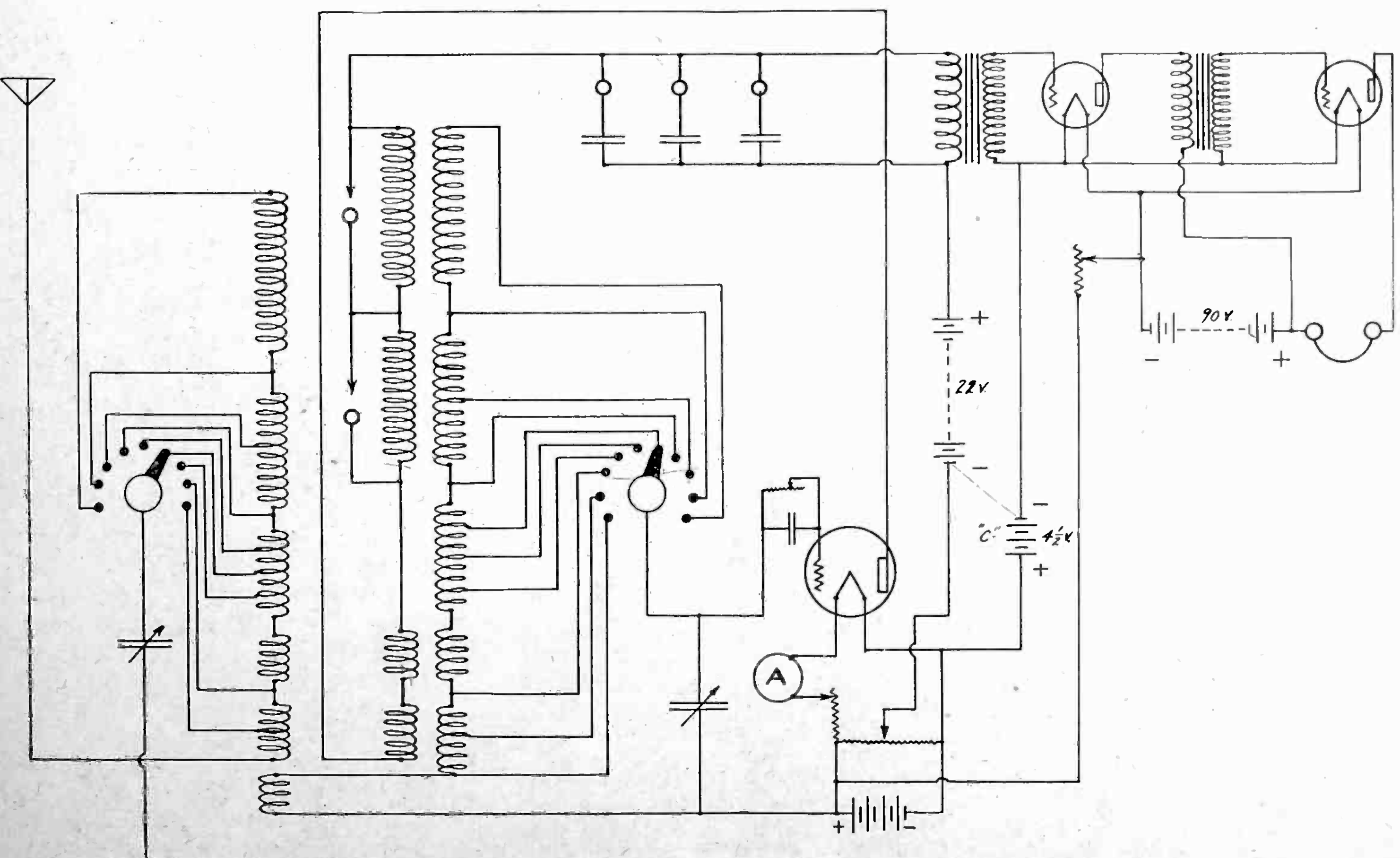


Fig. 1. Schematic Diagram of Connections of All-Wave Receiver.

The Plate Circuit

ONE of the most important parts of this instrument and one which was found most difficult to get right, is the plate circuit. As originally designed, the set had only two variocouplers, the rotor of the second variocoupler (now the middle one) being used as a tickler coil, or regenerative feed-back coupling.

This feed-back was sufficient to cause the circuits to oscillate from the shortest waves up to about 2800 meters; above that point it was impossible to get the circuit to oscillate, regardless of the values of bridging-condenser used across the primary of the first audio-frequency transformer. Using a VT-1 tube as a detector, this was not the case, but I was aiming to construct a set that would operate with the popular types of tubes. Various expedients were tried, such as cutting out the grid condenser and grid-leak and supplying a *C* battery in the detector circuit. Both 200 and 201-A tubes were tried as detectors with *C* battery and various values of *B* battery, but the results were unsatisfactory. I should state here that even when a successful plate-circuit was eventually arranged I found that a *C* battery detector-circuit was much inferior, in this receiver, to a grid-condenser and *variable* grid-leak. Also, a type 200 or 300 detector tube must be used.

Finding the regeneration insufficient with one variocoupler rotor used as a feed-back winding, I took a third variocoupler, connected its stator winding in series with the secondary loading inductance and its rotor winding into the plate-circuit. This variocoupler is connected in between the secondary loading variocoupler and the secondary bank inductance. In this manner I placed two movable tickler coils into inductive relation with the secondary windings.

This arrangement improved the set remarkably and caused it to oscillate on wavelengths up to about 6,000 meters. On waves above 10,000 meters, oscillations were sustained by cutting in a 1,000 turn honeycomb tickler-coil into the plate circuit—the third coil on the front of the panel. This left a "hole" of about 4,000 meters, between 6,000 and 10,000, where the receiver still refused to oscillate with any adjustment.

A honeycomb of 300 turns was then placed directly on top of the 600-turn secondary loading coil mounted over the middle variocoupler. This 300-turn coil was also cut into the plate circuit in series with the two variocoupler feed-back rotors. Results were not very good until this coil was reduced to about 150 turns. Here a balance was finally struck whereby sufficient feed-back was obtained to produce smooth oscillation on all waves up to 24,000 meters. For waves longer than this it is necessary with some tubes to cut in the additional tickler coil of 1,000 turns shown on the front of the panel. With a good detector tube, this coil is not necessary. A simple radio switch on the panel is used to short out this coil. Another radio switch is used to short out the 150-turn honeycomb in the plate circuit. With some tubes, this coil must be shorted out in order to get smooth oscillation on short wavelengths.

The presence of these short-circuited inductances in the plate circuit is theoretically bad engineering; but experiments at all wavelengths show that they cause no perceptible energy losses and that their total disconnection from the circuit, instead of mere short-circuiting, does not improve the operation of the receiver in any way.

The bridging condenser in the plate circuit is controlled by three radio switches. The upper switch cuts in .001 mfd., the second switch, .002, and the lower one, .004. Adjustable capacities are thereby obtainable from .001 to .007 mfd. in steps of .001 mfd. The entire capacity of .007 mfd. is used on all waves above 2,000 meters, and on many of the shortwave adjustments. A fixed combination of .007 mfd. without switches would be quite satisfactory.

Other General Details

THE following remarks particularly refer, of course, to the foregoing receiver, but some of the suggestions given may be of interest to those about to build any kind of receiving set.

It will be observed that a variable grid-leak has been used. This is an essential unit; good results on the long waves are not obtainable without it. The grid condenser is of the usual .0025 capacity. Another inexpensive and important device, in order to get efficient results on all waves with a type 200 or 300 detector tube, is the 300-ohm potentiometer connected across the *A* battery, the movable arm of which is connected to the minus side of the detector *B* battery. This gives precise adjustment of the detector plate voltage. Note that a radio switch is used to cut off the *A* battery when the set is not in use. Without this switch, the *A* battery would leak through the 300-ohm potentiometer while the receiver is standing idle.

The two audio-frequency transformers are of 3-1 ratio. No higher ratio is desirable if the set is to be used for music reception. For straight telegraph work, the first transformer could be a 6-1 if desired, but the second transformer should not have a ratio of more than 3-1 in any case, or the receiver will have a tendency to howl on long waves. Higher ratios seem only to distort without any worth-while gain in signal strength.

It will be noted that no telephone jacks are fitted onto this set. If signals are too strong, they may be reduced by detuning, loosening the coupling, or by cutting down filament current on the amplifier tubes. A pair of binding posts have been mounted on the panel (just above the filament ammeter whereby the headphones may be connected directly into the detector-tube plate circuit, in shunt with the primary of the first audio-frequency transformer, for testing or other purposes. A jack could easily be installed here, if desired.

Two separate *B* batteries are used for detector and amplifier. This enables batteries to be replaced independently when they become exhausted or noisy, without scrapping portions not worn out. The batteries last much longer and the set works better than when a single battery is used. A tapped 22-volt battery

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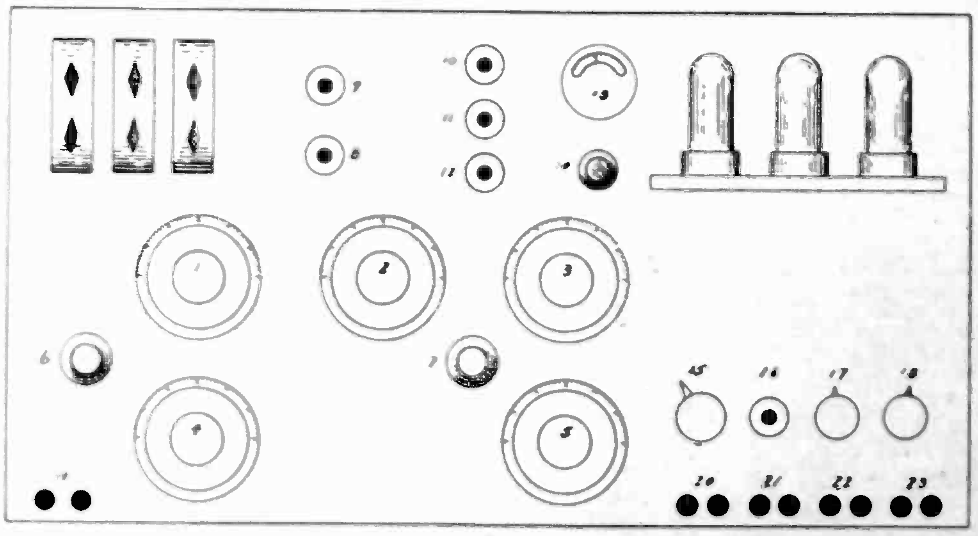

Fig. 2. Panel Arrangement of All-Wave Receiver.

(1) Coupling Control. (2) First Tickler. (3) Second Tickler. (4) Pri. Series Condenser. (5) Sec. Series Condenser. (6) Pri. Inductance Switch. (7) Sec. Inductance Switch. (8) Long-Wave Tickler Shorting Switch. (9) Intermediate Wave Tickler Shorting Switch. (10) Dead-end Switch (open on waves below 4800 meters; closed on waves above 4800). (11 and 12) Bridging Condenser Switches. (13) Filament Ammeter. (14) Variable Grid-Leak. (15) Detector Potentiometer. (16) A-Battery Switch. (17) Detector Rheostat. (18) Amplifier Tubes Rheostat. (19) Aerial and Ground. (20) Detector 22-v B-Battery. (21) A-Battery. (22) Amplifiers 90-v B-Battery. (23) Phones.

"Cq" Watts—Bum!

By Earle Ennis

THE fast freight makes no stops at Babcock, flagpoint on the Western Division, but speeds through Pablo gorge, with a flirt of crimson markers by night and a flap of "Irish linen" by day. Consequently when Pokerchip Watts detrained from No. 6 at Babcock on a late September day, Sheriff Mike Donovan was somewhat surprised.

There was no ceremony about Pokerchip's disembarkment. A brakeman kicked, and Pokerchip ducked and jumped. The freight was making forty-five miles an hour at the time. Pokerchip described a neat parabola, spread out his arms gracefully, zoomed downward, and winged to earth as light and airy as a ten-ton safe.

The sheriff, with one leg hooked over the horn of his saddle, chewed a quill toothpick reflectively as Pokerchip came up spitting and clawing like a wildcat, a few feet distant.

"Bud," he said pleasantly, "you sure got that down fine. I ain't never seen anybody get off a train any fancier."

Pokerchip wiped the grit from his eyes with the back of his sleeve, and peered through the dust cloud of his own landing at the lank, grinning figure with the tarnished star. His own freckles crinkled suddenly.

"You'd ought to see me do it in a plug hat and a yellow vest," he said—and fainted dead away.

The sheriff looked down at the crumpled figure and something gleamed back in the depths of his eyes.

"Well, yuh derned nervy little maverick," he said in admiration, and slid from his "paint" to kneel beside the other.

In such manner did Pokerchip Watts, ex-radio operator and soldier of fortune, come to Babcock, Pablo gorge and the Sawtooth country. It was an hour later that, washed, fed and equipped with a cigarette, he leaned on the "chow board" at the Pablo construction camp and grinned across the table at Sheriff Donovan. The jar of his jump had not hurt him, and the skin he had lost would grow again. Just at present he felt comfortable, friendly and at peace with the world.

"If anybody had of told me I would pass out from not eatin' I'd have said they were full of hop," he volunteered.

The sheriff nodded.

"When'd yuh have the nose bag on last?" he asked.

Pokerchip squinted.

"Les' see—what day is this?"

The sheriff chuckled.

"All right, bud; let it go. Now go on and talk. I want to know how come yuh picked on a bumless country to be a bum in. 'Taint healthy for your kind up here."

Pokerchip's eyes narrowed.

"My kind is your kind and every other white man's kind," he said shortly. "I'm no bum—not by a damned sight. I'm a radio operator by profesh, answering to the name of 'Sparks'! I was chief on the S. S. Berimudia, out of N'Orleans until me and the captain had a few words. I popped him in the eye and told him where to go. He sent the mate after me, and I cleaned him. You know what happened."

The sheriff nodded.

"I reckon I do," he said. "Federal offense to hit a captain on the water, ain't it?"

"It sure is. I lost my job and my license—the whole works. I didn't see that I was cut to stand the line of talk he handed out and I told 'em so. So me and them parted company. I made a face at the Gulf of Mexico and hopped the first rattler west-bound. I always wanted to shoot a few Injuns, and see red shirts wore in their lair. A regular bo showed me how to hang the rods and then I made the gondola. I was doin' fine 'til that shack booted me into your city of golden opportunity."

The sheriff leaned over.

"How much money yuh got?"

Pokerchip eyed him steadily.

"I ain't buyin' my way out of anything," he said succinctly. "If you want what I got on me, come and get it."

He hurled his cigarette away and pushed back his hair. Again, something flickered back in the sheriff's eyes.

"Yuh don't get my meanin'," he said slowly. "Are yuh broke?"

For a long time Pokerchip regarded him carefully. Then he nodded briefly.

"Barrin' a ten spot—yes."

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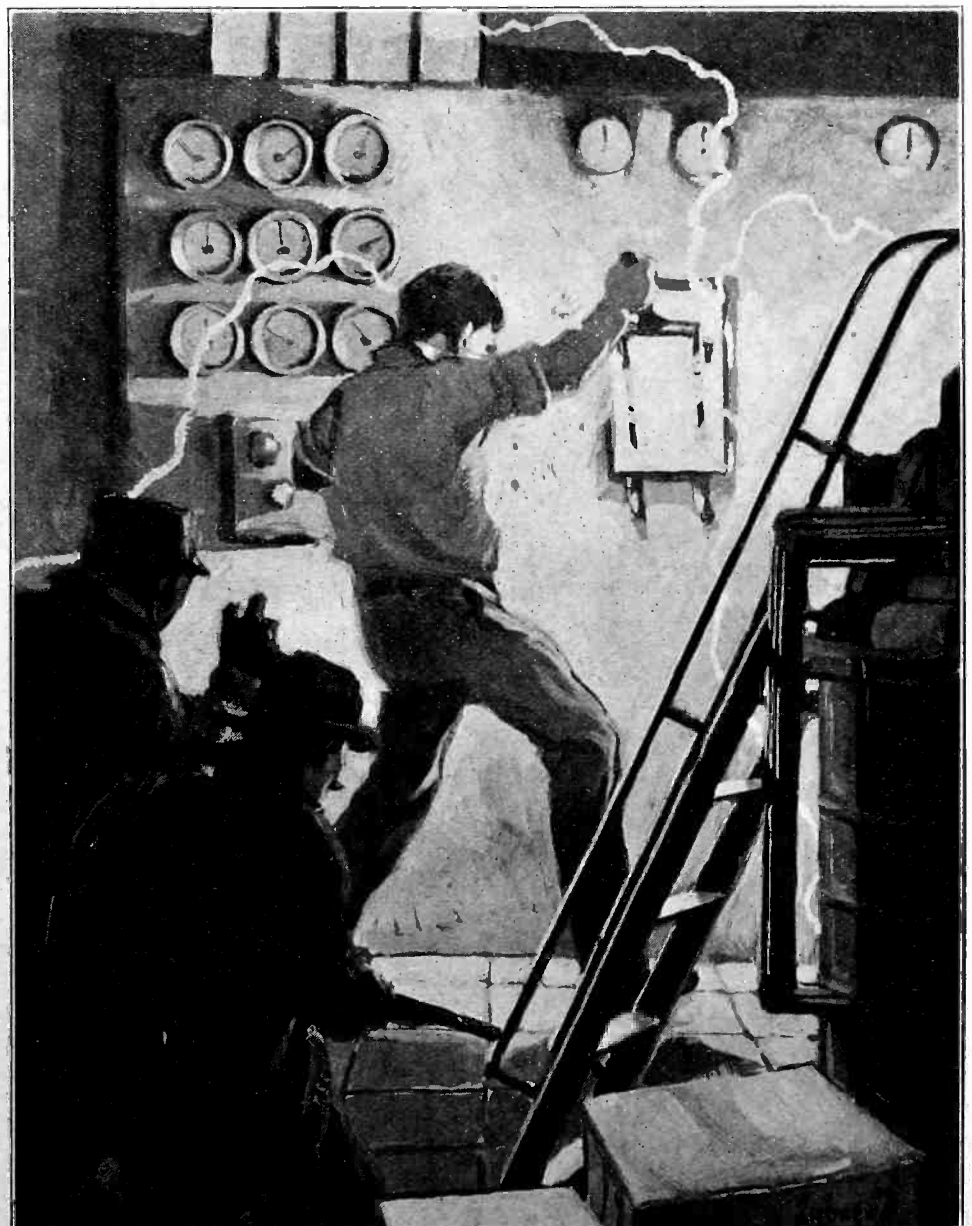


"Watts began to jerk the giant switch in and out."

Short Wave Antennas

Reasons for Designing an Antenna so as to Work Close to its Fundamental Frequency, with Practical Application to 80 Meters

By Gaston B. Ashe

THE three most important factors in antenna construction are location, effective height and resistance. The best location is on flat land, clear of absorbing structures, and having ground water close to the surface. The effective height should be as great as possible and the resistance as low as possible. As few of us can pick our location this discussion is confined to the two latter factors.

Experiments tend to prove that energy is transferred from a transmitting to a receiving antenna both by ground induction and by space radiation. The energy conducted by the ground includes not only that flowing directly from the aerial to the ground or counterpoise but also some of the energy radiated from the electric field of the antenna and entering the ground at considerable distance therefrom. In this conception of ground conduction the antenna system is considered as an air condenser, one of whose plates is the aerial wire and the other the ground or counterpoise.

The antenna system may also be considered as a means for producing local changes in the earth's electrostatic field. This field exists between the two plates of a gigantic condenser, the lower plate being the ground and the upper plate the vacuum existing above the earths atmosphere, the 20 to 100 miles of intervening air constituting the dielectric. The rapid alternation of change on an aerial in this field may cause changes in its intensity, these changes being transferred as energy to the receiving aerial. In this case the antenna height and voltage should be at a maximum to produce the greatest changes in the earth's electric field. Furthermore a one-wire aerial, either receiving or transmitting, should be as effective as ten wires.

Another explanation of energy transmission is by inductance such as occurs in an air-core transformer. The transmitting aerial may be considered as the primary whose electro-magnetic field cuts the wire of a receiving aerial, the secondary, thereby causing an electric current to flow therein. As this theory does not seem as plausible to the author as the condenser theory, the latter is adopted in the explanation of antenna phenomena.

In order to build up to the high voltage desirable the antenna should be as long or longer than the fundamental frequency to be transmitted, as its resistance rises very rapidly below the fundamental. If an antenna is exactly tuned to the transmitting set the feeble oscillations of a 5-watter will build up an enormous voltage in the antenna, possibly as high as 100,000 volts with only 1,000 volts on the plate. This is similar to the action of a correctly timed push causing a swing to make greater and greater sweeps.

Likewise if the swing were made of wooden arms suspended from bearings the friction would retard the swing's motion, just as resistance permits a high voltage from building up in the antenna.

Measurement of antenna resistance shows that it is a minimum at about 30 per cent above its fundamental frequency, increasing gradually above this frequency and becoming very high at more than 20 per cent below its fundamental. This is graphically shown in Fig. 1.

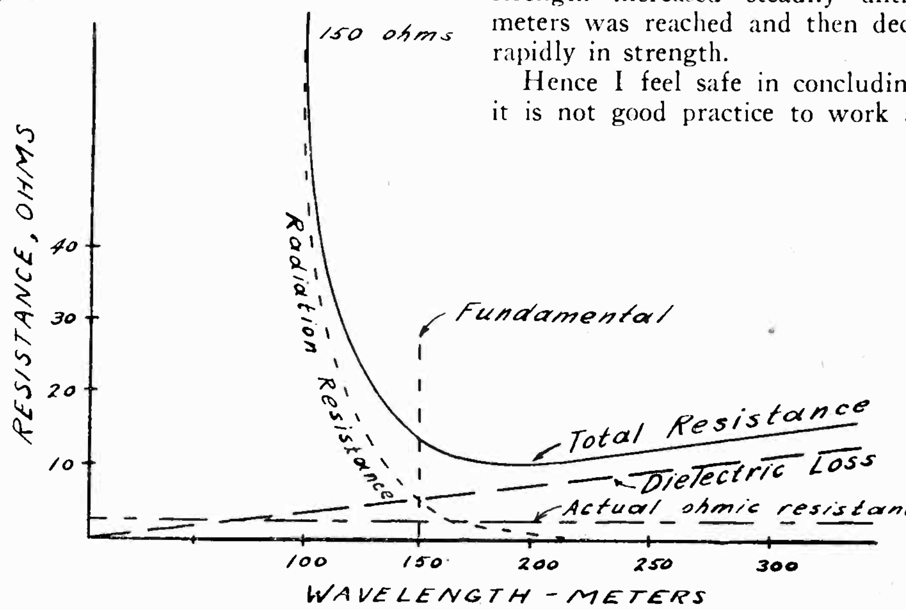


Fig. 1. Characteristic Resistance Curve of An Amateur Antenna.

The total resistance is made up of (1) the ohmic resistance (practically constant for all frequencies), (2) the dielectric loss (increasing with the wavelength), and (3) the radiation resistance. The first two cause direct loss of energy. The third is effective in transmitting energy. We may think of it as changing the potential of the earth's electric field just as an electric heater changes the temperature of a room.

As the radiation resistance is relatively greater in the neighborhood of the fundamental this is considered the best working wave. While the total resistance is generally much lower about 25 per cent above the fundamental, and hence the antenna current is greater, often as high as 50 per cent of the energy input is lost. Near the fundamental, while the antenna current is less, nevertheless, as much greater proportion of the input goes into useful work and hence the actual watt output is greater. For watt output equals the square of the antenna current times radiation resistance.

There has been some talk about working below the fundamental. In doing this the dielectric losses are certainly at a minimum but the radiation resistance is so great that the high voltage desired at the free end will not build up.

To check this theory several tests were run using a system with a natural period of 150 meters in which transmission was started at 220 meters and the wave length was decreased in ten meter steps down to 80 meters. The stations reporting these tests agreed that the signal strength increased steadily until 125 meters was reached and then decreased rapidly in strength.

Hence I feel safe in concluding that it is not good practice to work an antenna more than 25 per cent below the fundamental. This point is also borne out by the fact that the navy and the short wave experimental station KDKA are using antennas with the fundamentals near the working wave.

The problem then resolves itself into the design of an antenna system having the greatest possible effective height and the lowest possible ohmic resistance and having a natural period near the working wave. The resistance due to dielectric losses is automatically reduced by working near the fundamental. It is true, however, that could we reduce the dielectric losses it might be more desirable to work an antenna further above the fundamental because of the decrease in radiation resistance, and hence higher voltages to be obtained. However, to work above the fundamental for a given wavelength we would have to sacrifice antenna length and hence effective height in short wave work.

For 80 meter transmission we are limited to a total antenna length of from 50 to 75 ft. if the fundamental is to be kept down and in order to obtain any effective height it is necessary to extend the greatest part of this wire straight up. Also if a large flat top is used the capacity of the system is increased and hence the fundamental. Therefore, a vertical aerial would seem to be the best for short wave work.

In fact this applies to antennas for any wave. The construction of a flat top, other than that necessary to keep the center of capacity up, should be resorted to only when the total height is limited, that is when it is impracticable to provide support for the vertical type. In other words we should go as high as possible with the so-called lead-in and then add just enough flat top to bring the fundamental to the approximate value of the working wave. But for 80 meter work supports not more than 50 ft. high are necessary and hence a vertical antenna is undoubtedly the best.

Now in regards to whether this should be a cage, ribbon or a single wire. Mr. Reinartz in some recent tests found that the difference between the resistance of a No. 14 copper wire and a 2 in. cage was very small and that no advantage was gained by using a cage over 2 in. in diameter. However, a big disadvantage would occur in using a larger cage for in this case the capacity of the lead-in would be increased and hence the effective height would be lowered unless a large flat top was used.

A word of explanation in regard to effective height and center of capacity is in order at this time. An antenna has been considered as one plate of a condenser and every foot of wire has a certain value of capacity to ground or counterpoise as shown in Fig. 2A. We can for convenience lump all these small capacities into one capacity as shown in

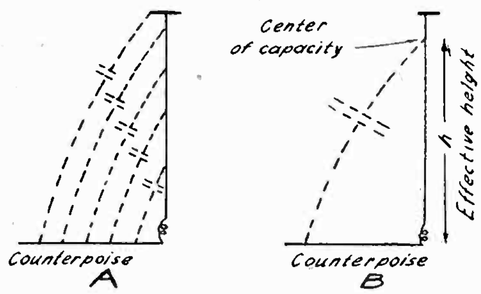


Fig. 2. Capacity Effect of Antenna

Fig. 2B. This one capacity would have a value equal to the total of all smaller capacities and the point on the antenna where it would be necessary to place this capacity would be the center of capacity. The effective height is the distance from this point *A* to the ground It can be seen that if the capacity of the lead-in or vertical part of the antenna were large compared to the capacity of the upper end, the center of capacity or effective height would be low. The effect of the capacity of the lead-in is minimized by placing some sort of a lumped capacity at the top of the antenna, such as a hoop or ball. Also the vertical part of lead-in should be kept as small as possible without introducing too great an ohmic resistance.

An antenna of this type was built for 80 meter work and proved particularly successful. A vertical copper ribbon just 50 ft. long with a hoop on the upper end was suspended from a rope tied between the tops of the two masts. A 3-wire star was used for a counterpoise, each wire being 40 ft. long and the center of the star being near the antenna lead-in. The fundamental of this system was just 70 meters which with a three-turn antenna coupling coil brought the working wave to 77 meters. No series condensers were used. The radiation was over 3 amps. using 300 watts input and the results were very satisfactory.

A new antenna is now being constructed which combines additional advantages. A 50 ft. iron pipe mast is to be set on a well insulated platform on top of the house. A copper ball will be soldered on the top of this mast and the guys will be placed as far from the top as possible. The guys are to be clothes line ropes, boiled in paraffine and will be well broken up by good insulators. The counterpoise will be a five or six-wire star directly beneath the antenna. All old masts and guys will be removed. This arrangement will, due to its rigid construction, eliminate swinging.

The center of capacity will be high, no metal guys will be present to re-radiate, brush discharge will be at a minimum and the appearance of the thing will certainly be a big improvement over many present systems. If your set is in the basement a power transmission line can be used to couple it to the antenna.

As before stated the design of the counterposes is of as much importance as that of the antenna but because of the length of this discussion it will be necessary to treat this in a separate article to appear in next month's RADIO. In this continuation both the theoretical and construction features of the counterpoises will be discussed.

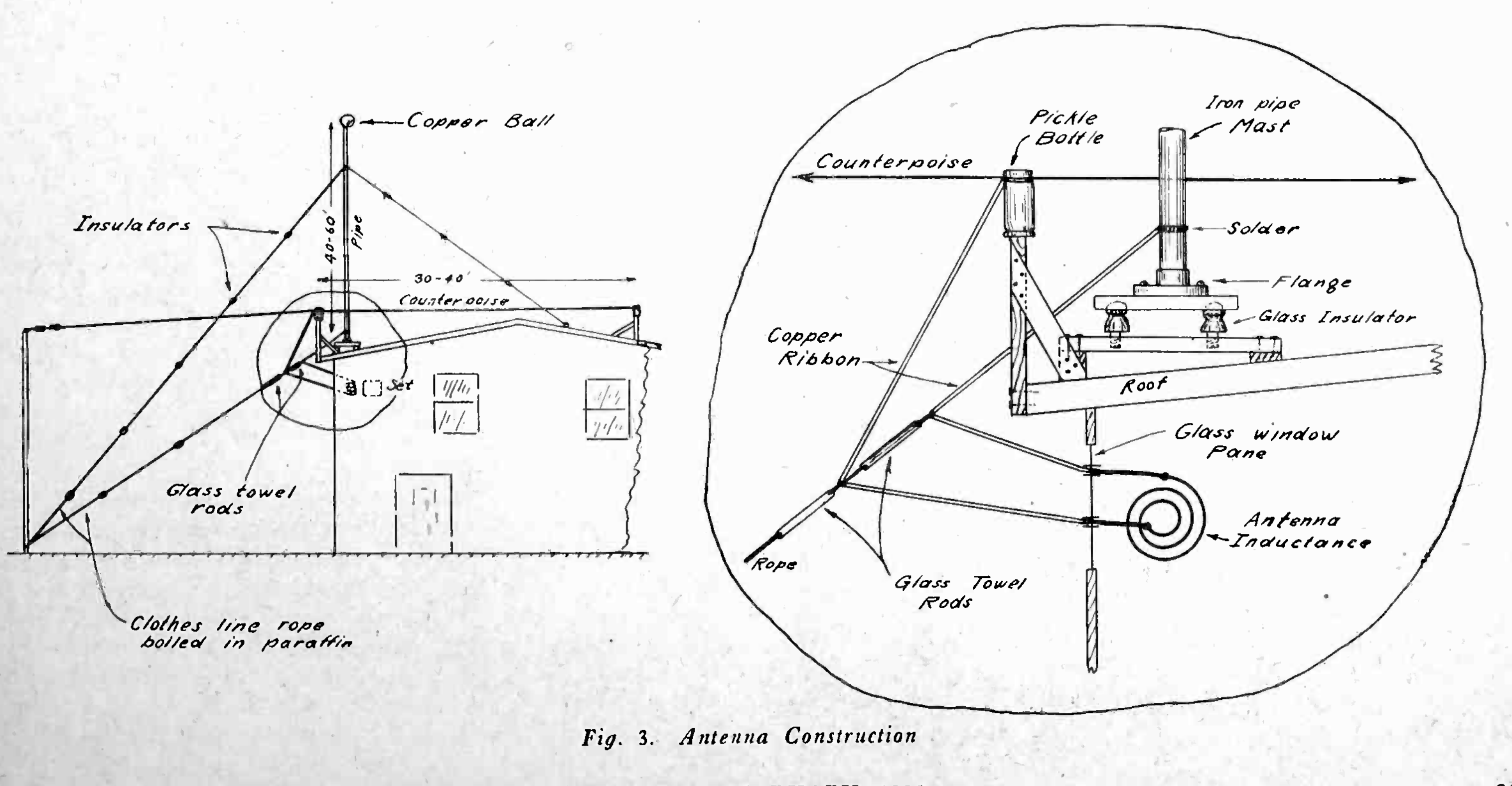


Fig. 3. Antenna Construction

A Constant Frequency Tube Transmitter

Practical Directions for the Application of Energy Coupling to a Hartley Circuit with Master Oscillator

By D. B. McGown

THE main cause of the widely prevalent irregularity of "notes" from amateur transmitters is the variation in the length of the emitted wave. This is usually due to the use of a "self-oscillator," when the grid is fed by a small amount of current from the plate circuit, and can generally be cured by the use of a "master-oscillator," when the grid is fed from another vacuum tube.

The basic circuit of the self oscillator is shown in Fig. 1 the grid of the oscilla-

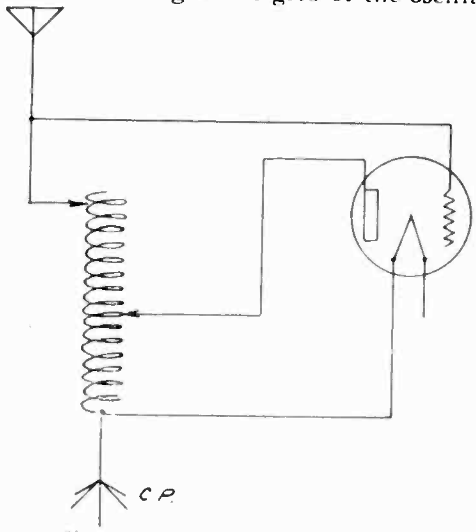


Fig. 1. Self-Oscillator Circuit

tor tube being connected to the antenna circuit by either inductive or capacative coupling or by both. This circuit contains several variables which cannot always be kept constant.

The basic principle of the master-oscillator is shown in Fig. 2 where the

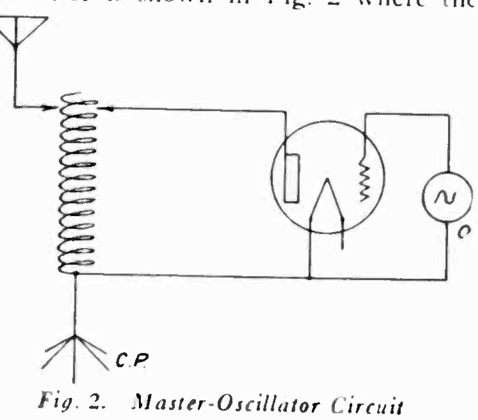


Fig. 2. Master-Oscillator Circuit

oscillator O actuates the grid and controls the entire oscillation of the circuit. In order that energy be radiated O must be tuned to the same wavelength as is the antenna. As the frequency of O can be kept constant, the output frequency likewise can be kept steady despite any changes in the constants of the antenna circuit due to swinging, proximity of moving objects, etc.

As the effect of frequency variation becomes more marked as the frequency increases constancy becomes of prime importance in short wave work. The receiving operator can then concentrate on copying and not have his attention diverted to instrument adjustments.

The wavelength constancy of a master oscillator system therefore more than compensates for the disadvantage of an extra tube and its filament current drain. Although two self oscillating tubes give a greater radiation, the signal improvement by using them in a master-oscillator circuit gives the system its superiority as a result-getter.

It may be most simply applied to the Hartley circuit, as shown in Fig. 3,

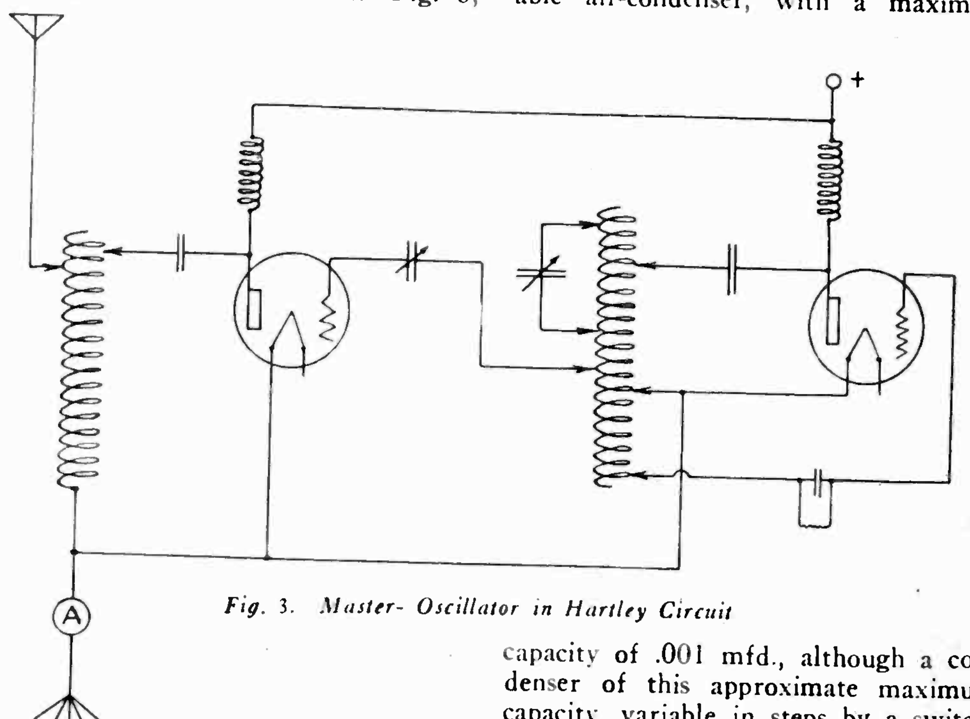


Fig. 3. Master- Oscillator in Hartley Circuit

where quick adjustment to any wavelength can be made by shunting a portion of the inductance with a variable condenser and adjusting to resonance. The grid of the amplifier tube is capacitively coupled to the master-oscillator.

As the direct antenna coupling, shown in Fig. 3 will probably be forbidden for amateur operation, the author advocates the use of energy coupling as described in January RADIO. The practical circuit is shown in Fig. 4 except that only one filament battery is necessary instead of the two indicated.

In the author's set one 50 watt tube is used as the master-oscillator and three 50 watt tubes in parallel as the amplifiers. More or less could be used without material change in the circuit. L_1 is composed of 20 turns of 1/16 by 1/4 in. copper edgewise wound strip, of 7 in. diameter; and is identical with L_4. L_2 is composed of two turns of No. 10 flexible rubber-covered battery wire, wound between the turns of L_1 and is connected to L_3 which is composed of two similar turns wound around L_4. L_5, which is the inductor in the master-oscillator circuit, is composed of 18 turns of similar edgewise wound strip, wound on a 4 in. diameter form.

C_1 is of .002 mfd. capacity, and is the usual bridging condenser, which is capable of standing several amperes radio frequency, at several thousand volts; this is identical with C_5, which serves a similar purpose. C_2 is a variable air-condenser, with a maximum capacity of .001 mfd., although a condenser of this approximate maximum capacity, variable in steps by a switch, would serve as well. C_3 is a by-pass condenser, of approximately 0.01 mfd., and serves to insulate the air-condenser, and to change the polarity, which may be necessary at times. C_4 is a variable air-condenser, which should be widely spaced, as quite high potentials are sometimes set up across it. C_6 is a common .002 grid condenser, as used in transmitting apparatus, and is shunted by the usual grid leak.

The radio frequency chokes, *RFC*, are all shown in their respective positions, and their use is absolutely essential in the places shown. They are composed of about 200 turns of No. 24 wire wound on wooden cylinders about 3 in. in diameter. The exact sizes of these chokes are not critical, as long as they are large enough to prevent the radio frequency from flowing through them. Honeycomb coils will not work here.

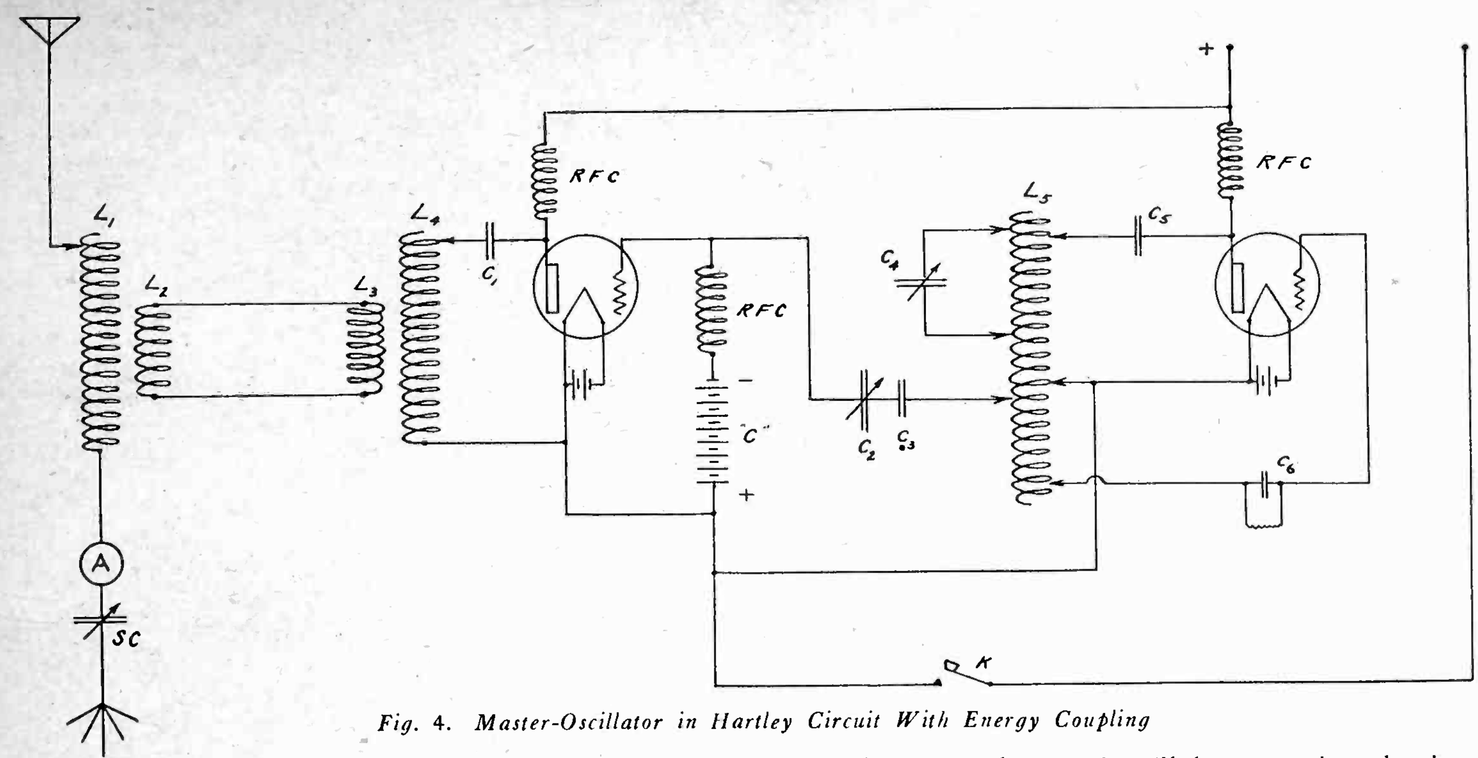


Fig. 4. Master-Oscillator in Hartley Circuit With Energy Coupling

The remainder of the circuit is as usual, the antenna ammeter being included in the ground lead, and the other meters, such as the filament and plate meters, being left out so as not to confuse the diagram.

The *C* battery in the grid lead, separated from the filament by the grid choke is of such large value that when the amplifier tube is not functioning the plate current drops to practically zero. This works the tube on a very peculiar point of its characteristic, but under the circumstances, this scheme is necessary, as when the plate current is applied to the system, and the grid of the amplifier is not excited at resonance, there will be no control over the plate current, as no oscillations are taking place, and the plate current will run up to enormous values, and the amplifier tube will be damaged. This could be obviated by tuning at very low power, or else putting a limiting resistance in the plate supply, which would not permit more than a certain current to flow, or by putting a fuse or circuit-breaker in the plate circuit, but such methods are not as satisfactory for obvious reasons.

In the writer's set, with a normal d.c. plate potential of 1,000 volts from a motor-generator, a 90-volt bias battery was used, which reduced the plate current to about 75 milli-amperes with three tubes in parallel, when the master-oscillator was detuned. The bias potential decreases as the plate potential is decreased, and vice versa. It is better to use too high a grid potential at first, and then gradually decrease it, as the higher potential will lower the plate current to below the danger limit, which is desirable to prevent "blowing" the tubes while adjusting the set.

For smaller tubes, such as 5 watters, the bias potential will not go much over 45 to 50 volts, while on 250 watt tubes, this potential will run up to as high as 200 or even 250 volts, with the usual 2,000 volts plate potential. Lower plate potentials could be used advantageously, while tuning, as the damage done by the failure of the larger tubes usually is quite serious.

To adjust the complete transmitter, as shown in Fig. 4, first turn on the filament of the master-oscillator tube and bring it up to normal. Reduce the plate potential to about 400 volts, or even lower, so as to obtain rough readings, and turn on the power. Tune with C_4 until the wave desired is resonated with on the wavemeter. Then adjust the grid and plate coils in the master oscillator until the lowest plate current is obtained. The lowest grid current, through the grid leak, should also be adjusted if a low reading (0 to 25 MA) ammeter is available, as the grid current seriously affects the life of the tube.

These adjustments are made preferably with the lead to the grid of the amplifier disconnected. With approximate resonance thus located in the master-oscillator circuit, the amplifier tubes can now be turned on and adjusted to proper filament potential. Still using the reduced plate voltage, turn the plate current on to the amplifier tubes as well as the master, which was just adjusted. Now vary condenser C_4, without paying much attention to its previous setting, until the antenna ammeter, *AM*, is deflected to a maximum, which indicates that the set is now approximately resonated. If the emitted wave is too long, reduce the inductance, or insert a condenser, while the reverse is to be done if the wave is too short, and retune with condenser C_4.

When the set is adjusted to the desired wavelength, adjust the variable clip on inductance L_4, so the plate current of the oscillators is at a minimum, which will be approximately the point of maximum radiation. Now re-adjust the amplifier grid clip, which goes to condensers C_2 and C_3 on inductance L_5. The adjustment of this clip is quite critical, and "fussy," as a turn one way or another will make a good deal of difference in the radiation; and also the amplifier plate current. Some slight re-adjustment may now be necessary in the plate circuit of the master-oscillator, whereby the latter is functioning with the plate current at a minimum.

The set is now tuned and for reasonable variations in wavelength, say 50 to 100 meters, the only changes necessary are to increase or decrease the period of the antenna circuit, and retune by re-adjusting the condenser C_4 until maximum radiation is obtained. No other leads need touching.

There is but one more point to be watched, in this connection. When using a series condenser to reduce the natural period of the antenna, a maximum of inductance in L_1 and a minimum capacitance in *SC* should be used. This seems to increase the potential on the antenna, and to increase the antenna input.

One method of keying is to couple a single turn loop of wire rather loosely to L_5 and short and open the circuit, giving so-called "coupled compensation," which works out very effectively. This system is satisfactory as far as the transmitting station goes, except that it keeps the tubes operating continuously, but it radiates on two frequencies, and hence uses up an additional frequency channel which might better be utilized for some other station's operation.

A variation of this system with high negative potential on the amplifier tubes, is to shunt C_4 with a small fixed condenser, say of about .00025 mfd. and insert a relay key, with the contacts working "backwards," so the condenser will be shunted across C_4 when the hand key is released and which will be disconnected when the latter key is depressed. This system detunes the master-oscillator so far that the amplifier will not radiate, and, as the grid is biased so strongly negatively, the plate current will drop, just as it would when the set was being tuned. This system appears to reduce the "key thumps."

The simplest method of keying is to break the negative plate lead, commonly referred to as breaking the "center tap." This is shown in Fig. 4, and is quite satisfactory, although when used on high power in congested districts there is sometimes some interference caused by key thumps.

The substitution of a grid leak for the *C* battery in the amplifier system, and the insertion of a key in that lead is seldom satisfactory. The usual tendency of the tubes is to continue to oscillate, when the key is opened, which is undesirable, and in some cases even, will not set up a sufficient change in the emitted frequency to give proper signalling at the receiving end.

No attempt should be made to break the radio frequency circuits for keying, unless small power is used. If this is the case, almost any of the radio frequency circuits may be broken with a simple key. Even though this can be done, however, this system should be avoided, as the sudden breaking of the circuit often sets up surges, which give a waver or variation to the emitted frequency, which leads to unreliable signals and which defeats the entire purpose of the master-oscillator power amplifier system.

The constants of the antenna for use with this type of transmitter need not differ from those of any transmitter used under the same conditions. For 150 to 200 meters, the usual amateur antenna is satisfactory, and for the lower waves, a smaller one naturally is more desirable. For work in the 75 to 80 meter band, a vertical antenna 30 to 50 ft. high—or even smaller, with a small counterpoise should be good.

Larger or smaller tubes should give as good results as the 50-watters used by the author. With one C-301A as a master-oscillator from one to three similar tubes or one 5-watt tube may be used as amplifiers. One 5-watt tube will drive from one to three 5-watters or one 50-watter. One 50 watt master-oscillator will drive from one to four 50-watt amplifiers or one 250 watter.

As a variation, a variometer covered with heavy wire and having a small inductance range could be used in series with C_1 and L_4 to tune this closed circuit. A variometer can also be used in the Colpitts circuit with master-oscillator to take the place of C_4, although this circuit does not seem to oscillate well on the lower wavelengths. A heavy contact key can be inserted in the coupling circuit between L_2 and L_3.

LETTERS OF A DEEP SEA OP.

In which he discusses a novel method of long wave reception with the Navy type receivers.

S. S. Jest Wester.

Dear Jack:—

While copying press on the trip home it struck me that there was an awful amount of labor involved in shifting the SE-1220 receiver from the short to the long waves. The taps on the loading coils in the primary, secondary and tickler circuits all have to be set, the coupling and condenser settings adjusted and sometimes the primary condenser has to be paralleled. Incidentally, the settings of the three circuits have to be remembered or logged. All of this comes under the head of work and if there is anyone hates work worse than I do, I want to meet him.

Did a lot of heavy thinking on the subject; in fact, you could hear the brains grinding all over the boat deck, and finally turned out the arrangement shown in the diagram.

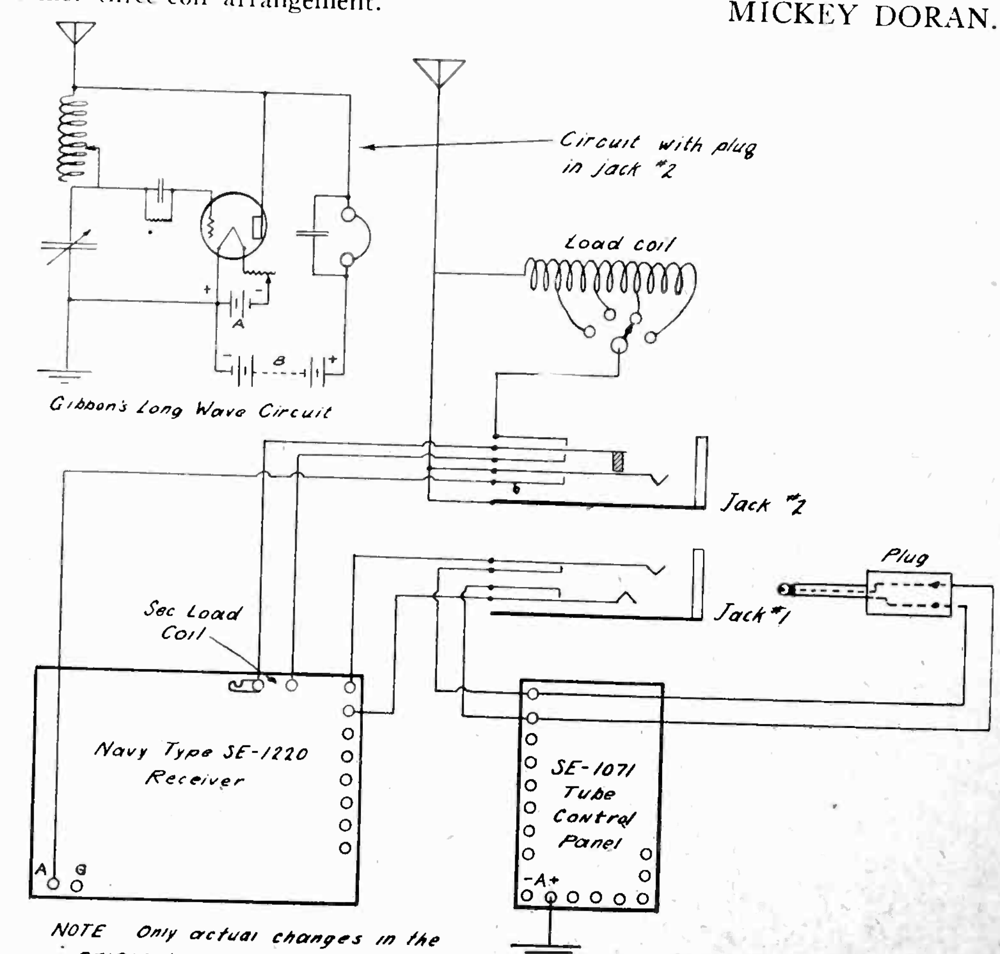
As you know, some of these SE-1220 receivers need a reversed tickler connection for regeneration on 600 meters. I was already using a jack and telephone plug to accomplish said reversal and it only took the addition of the other jack to give me the long wave circuit. The filament lighting jack which does the trick was out of a defunct broadcast receiver. Lucky thing I had it or the idea would still be unborn. The loading coil is one of the 1,200-turn honeycombs with four taps which was used in the former three-coil arrangement.

Sticking the plug in Jack No. 1 gives the reversed tickler connection for 600-meter work on the SE-1220. Pulling the plug out gives the straight tickler connections for the higher waves within the range of the receiver. For the long waves above that, just stick the plug in Jack No. 2. This wipes out all of the SE-1200 except the secondary variable condenser and rearranges the whole circuit with a simple twist of the wrist into the circuit shown on the diagram. The variable condenser and the taps on the loading coil are the only tuning controls and she covers a 4,000 to 20,000 meter range. NPG on 4,650 meters is louder on the single circuit rig than he is on the straight SE-1200 hookup. Varying the grid and bridging condenser settings on the SE-1071 will aid the selectivity and volume. The shift from 600 meters to the long waves can be made in about two seconds Mex and tuning the long wave circuit is simplicity itself. Very few changes are required in the original wiring and the load coil with two jacks and a plug are all the additional apparatus necessary.

This stunt is so simple and such a big improvement over the three-coil arrangement that it's funny no one thought of it years ago. It sure is a lucky thing that I had that six spring jack. Keep this in mind and when you get tired of that shore job and head back for the briny deep you'll be all set for heavy biz on the press waves.

Many seventy-threez,

MICKEY DORAN.



Simple Method of Shifting Control

Amateur Transmitting Antennas

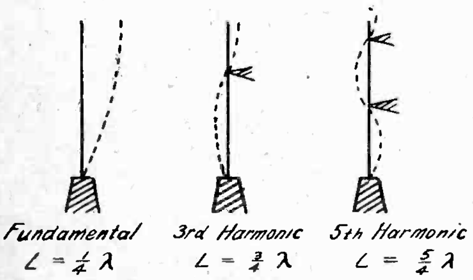
Some Simple Theory With Practical Applications

By G. F. Lampkin, 8ALK

THE ultimate object of a ham in building his station is to make his sigs get out. The easiest way to do this is to have a young central station and shove kilowatts of power into the air—a couple of 10 water-cooled tubes, for instance. But the government regulations and the ham pocketbook put a decided check in this method. And the easiest way is not always the best; there's a lot more joy in making a five-watter step out intelligently than in crossing the continent with a 500 watt ether buster.

The average ham can easily put together a circuit that will oscillate steadily and efficiently. The problem is to just as efficiently put this oscillating energy into the air; and this problem brings up the least known subject in ham radio—the transmitting antenna.

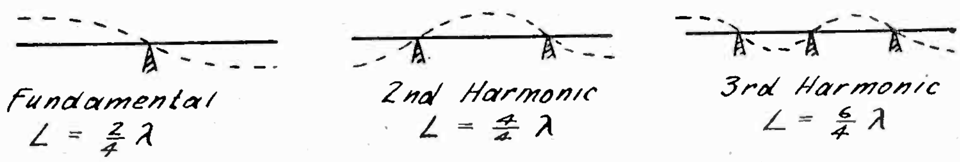
The easiest way to look at the subject is to compare the antenna, which is an electrically vibrating system, to a mechanically vibrating system. Take a spring steel rod and clamp it at the base. The rod, if given an initial dis-



One End Free, Grounded Antenna.

placement and released, will continue to vibrate at a definite frequency. The oscillation along the rod corresponds to ¼ wavelength. Therefore the fundamental wave is four times the length of the rod. The fundamental frequency of the rod can be changed by loading it with weights; similarly, the fundamental frequency of the antenna can be changed by loading it with inductance. If the rod, still clamped at the base, be held rigidly at a point 2/3 up its length, it will oscillate, with a distribution corresponding to ¾ of a wavelength. This can be easily verified by counting the loops along the rod. The frequency is three times the fundamental frequency, and this mode of oscillation is known as the third harmonic. By holding the rod at suitable points, and giving the free end a displacement, the fifth, seventh, ninth, etc., harmonics can be obtained. The harmonic frequencies of a grounded antenna are thus always odd multiples of the fundamental frequency.

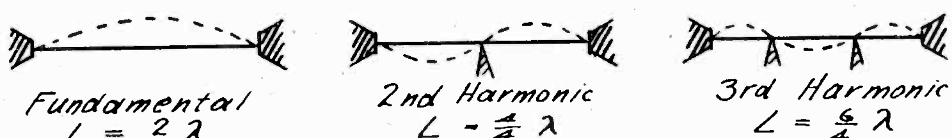
Another method of causing the rod to oscillate is to hold it at the middle, and allow the free ends to vibrate. Counting the loops, the wavelength is seen to be twice the length of the rod. The rod can be held at points ¼ of the length from the ends, and be made to vibrate in



Both Ends Free. Antenna and Counterpoise

the second harmonic. The third, fourth, fifth, and so on, harmonics can be obtained. This condition corresponds to an antenna and counterpoise. Both ends of each system are free, the antenna being merely bent back over the counterpoise to give greater capacity. The old Hertzian oscillator is of this form. The newer version is the vertical tube antenna used by Westinghouse.

The one remaining condition is that in which both ends of the rod are clamped; corresponding to a loop. As shown

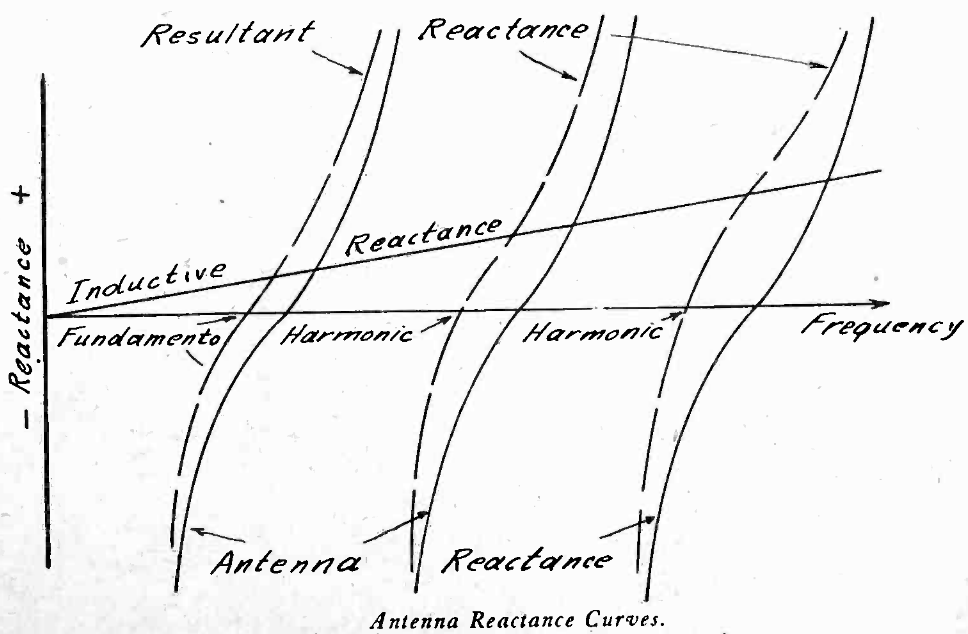


Both Ends Rigid—Loop.

in the diagrams, the harmonic frequencies are all integral multiples of the fundamental frequency—the same as above when both ends of the rod are free.

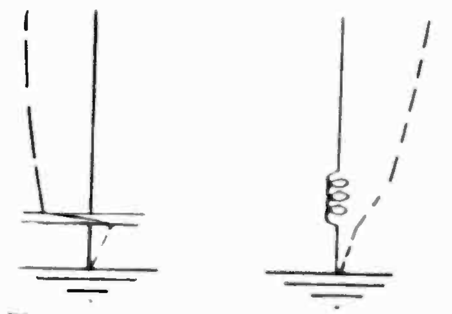
However, when any of these forms of antennas are loaded with either capacity or inductance, the harmonics are no longer integral multiples, but are only approximately so. This is most easily shown by referring to Bustan Circular 74. The curves for antenna reactance are shown to be a cotangent function. Where the curve crosses the axis, the reactance is zero, and there is a fundamental or harmonic oscillation. The addition of an inductance gives the straight line, positive, reactance curve shown. This, added to the natural reactance of the antenna, causes the resultant curves to cross the axis at points removed from the originals. These new points of zero reactance do not fall at integral multiples of the fundamental frequency. The addition of capacity reactance gives the inverse curve, a negative reactance, and throws the harmonics off for the same reason as above. Both capacity and inductance can of course be added, with essentially the same results as before.

The addition of capacity or inductance changes things in another way. It throws the voltage and current distribution curves awry. In the original dia-



Antenna Reactance Curves.

grams, the loops and nodes of the rod vibrations correspond to voltage loops and nodes in the transmitting antenna. Just as the rod could be held at a node without affecting the vibration, so an antenna can be grounded at a node without any effect on the oscillations. The currents lag or lead the voltages by 90 degrees, according as the antenna is worked below or above the fundamental wavelength. Some approximate distribution curves are shown; the addition



Voltage Distributions

of a condenser causes a reversal of voltage in the antenna; the addition of an inductance causes a comparatively high voltage drop across it. If some experimenter can determine accurately the distribution curves for various antennas, and the corresponding radiated signal, he can give us some real dope.

Now that the possible modes of oscillation are known, the proposition is to pick the one best suited to an individual case. The determining factors are the antenna ohmic resistance and dielectric losses. If a low resistance ground is available, located some distance from trees, buildings, and such, the grounded antenna will work well. But this is an ideal condition, so far as most hams are concerned; and it is safer to stick to the antenna and counterpoise.

The best place to work the antenna is below the fundamental. The total resistance curve of an antenna is shown. The value of the ohmic resistance is found by continuing the straight line portion of the total resistance curve back to the resistance axis. The resistance at the intercept is the ohmic resistance; its value is very nearly constant with wavelength, dropping slightly due to lessened skin effect. It is shown as a nearly-horizontal, straight line. The dielectric resistance is also a straight line function with wave, beginning zero at zero wave, and continuing parallel to the straight line portion of the total-resistance curve. The total resistance, minus these two components, gives the radiation resistance. A study of the three components shows that below the fundamenal wave, the radiation resistance represents the larger percentage of the total resistance; and therefore the larger percentage of the power put into the antenna will be actually radiated.

How far below the fundamental the antenna should be worked depends in a measure on what wave is used. At 200 meters, the ohmic, and especially the dielectric losses, are comparatively large; due to the size of antenna required. Here it is best to work as far below as poss-ble, which is usually around 3/5 of the fundamental. On the short waves, from 80 down, the conditions are different. It is possible to build a small, compact, antenna, set out in the clear, that will have negligible ohmic and dielectric losses; and it is not necessary to go so far below the fundamental to make the radiation resistance the dominant factor.

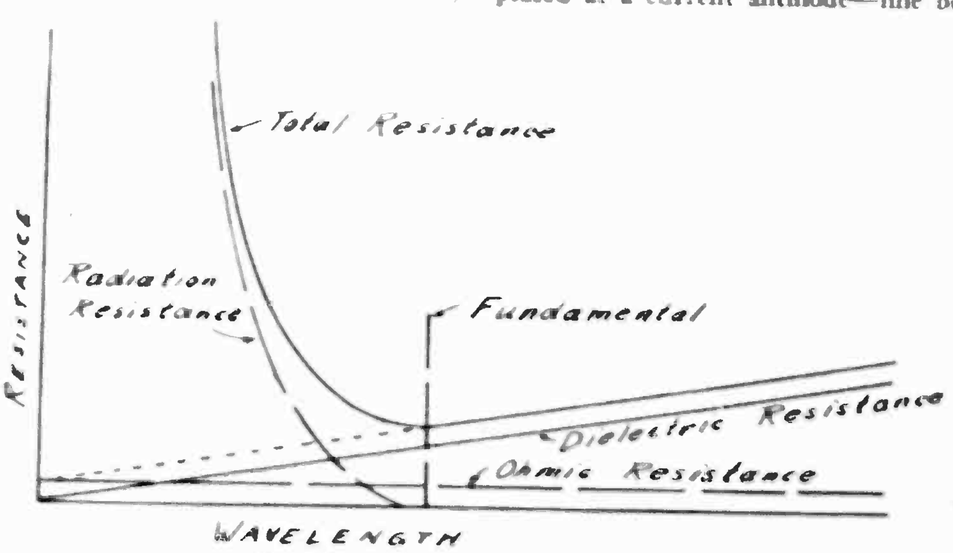
Working below the fundamental is advantageous in another way, in that it actually decreases the ohmic losses. The antenna always has a high resistance at this condition and the antenna currents will be small. Therefore the I^2R losses will become practically nil.

Speaking of small currents brings up the question of radiation. The radiation read on a meter, placed, as is usual, at the most convenient point in the antenna circuit, does not mean anything. Its only useful function is to show the resonance point. The currents when working below the fundamental are necessarily small. Add to this the change in current distribution caused by the addition of capacity and inductance, and the radiation meter becomes an awful liar. Of course, if the meter can be placed at a current antinode—fine business. Otherwise use a flashlight bulb to indicate resonance, and put the price of a radiation meter into another tube.

Two means of exciting the antenna are well known—the direct-coupled, or outlawed key-clicker method, and the inductively coupled method. Capacity coupling is not so well known, but is really the most convenient of all. Install the antenna and counterpoise in the best location, and do the same for the primary oscillator. Then join the two by a wire run through a very small coupling condenser, on the order of 5 or 10 micromikes. With the antenna system and the oscillator in tune, the radiation will be as great as with any other method of coupling. The insulation of the coupling wire does not have to be at all elaborate; and the usual antenna and counterpoise lead-in losses are eliminated.

The actual constructional details of the antenna have been gone over often. Use skinny glass or porcelain insulation, and keep the whole system out in the clear. This is easy to do with the short wave antenna—put the whole thing on top of the house. When working with small currents, a single enamelled wire layout will do very nicely.

About using the third mode of oscillation of oscillation above, corresponding to the loop, there has not been anything said. For the simple reason that there is not much known to be said. According to formula, the radiation resistance of a loop varies inversely with the fourth power of the wave. In other words, halve the wave and get 16 times the radiation; cut it in third and get 81 times the radiation. So get down on the short waves with a transmitting loop, and let's have some new and interesting information.



Total Resistance Curves of Antenna.

Don't try to use old batteries in the plate circuits of your set, unless you want plenty of unaccountable noises. *B* batteries that are more than about 15 per cent lower in voltage than normal should be replaced, as they have served their useful life.

Dead dry cells, or cells that are low, may be revived sufficiently to work for a reasonable time by removing from their cardboard cases, puncturing the zinc with a nail, to a depth of about an eighth of an inch, and soaking each cell for a short time in a saturated solution of salt and water, drying the cells, and replacing in their cases. Another and possibly simpler method is to crack the sealing wax out of the battery top, and pour in a couple of tablespoons of salt water.

Don't forget that it is better to put up a reasonably short antenna than a long one. Also if the leadin is very long, it will often serve as a very good antenna, without any flat-top portion.

Selectivity and How to Get It

An Elementary Discussion of Various Methods Employed, Including The Theory of the Super-Heterodyne

By Maurice Buchbinder

SELECTIVITY ranks in importance with quality of tone for a good radio set. Especially in congested sections is it a paramount requirement to be able to pick out the desired wave and cut out interfering ones. In the heart of New York City it is possible to draw a circle a little over two miles in diameter within the bounds of which no less than half dozen powerful transmitting stations exist, throwing their tremendous disturbances into the ether. Were it not for the great selecting power of a radio receiver it is easy to see that most wierd composite programs would result. Yet in the main it is a very simple matter with a good receiving equipment to choose one wavelength and close out all the others.

There are but two important methods for obtaining selectivity. The first is the most common—by tuning to wavelengths, embracing as it does most of the variations upon the single circuit tuners, such as tuned radio frequency amplifiers, regeneration, the superheterodyne and so on. The second is selectivity by direction thru the use of a loop.

To understand those factors which modify selectivity it is necessary to begin with very elementary considerations of a very elementary circuit—namely, the single circuit non-regenerative receiver, consisting of antenna, variable condenser, inductance, and conventional vacuum tube detector (Fig. 1). We should also

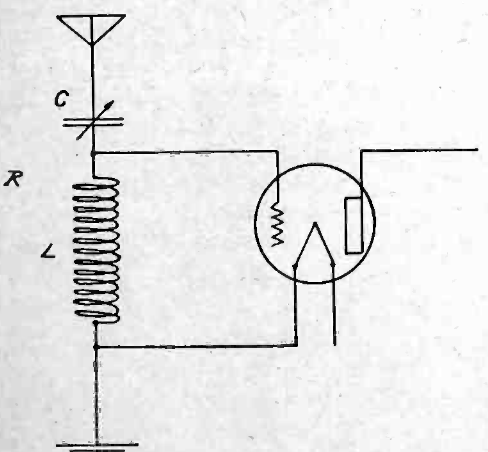


Fig. 1. Single Circuit Non-regenerative Receiver

independent continuous wavelengths dif-simplify our transmitting set into a transmitter sending a continuous pure musical note of 1000 cycles.

If we consider the origin of the familiar "squealing" due to a neighboring oscillating receiver we come to the conclusion that any transmitter of a 1000 cycle tone is in reality sending out *two* fering in frequency by 100 cycles. In other words just as two continuous waves heterodyning with one another bring about the "squeal," so working backwards a pure tone can be analyzed into its two constituent continuous radio-frequency currents. Thus we continue to the broader conclusion that any broadcast transmitter, whether in sending speech or music, is in reality emitting a series of *continuous wavelengths*, confined within a narrow band of wavelengths (a range of about 5,000 cycles difference, namely, the range of audible frequencies) and it is the "beating" or heterodyning of one with the other that makes the tone in the receiving set. It follows that for purposes of discussion then, we can concentrate the effect of but a single one of the radio frequencies and our conclusions will apply in general.

We now return to the receiving circuit, which contains the elements of capacity, inductance and resistance. The resistance is present in several forms—in the condenser as leakage, dielectric losses; in the core as copper, dielectric and leakage losses; in the antenna as copper, dielectric and ground losses. The total adds up to a value of R. The capacity is that of the antenna in series with the variable condenser. The inductance lies chiefly in the coil but partly in the antenna. Now a certain frequency or wavelength is being impressed upon the circuit. The loudness of response roughly follows the amount of induced current. The current I in turn follows the voltage E (strength of incoming wave and uninfluenced by receiver), and a quantity Z called impedance. Thus $I=E/Z$.

The impedance of any alternating current circuit, whether a hundred or a million cycles in frequency, is the sum of the resistance plus a quantity called reactance; not the algebraic sum but what mathematicians call the vector sum. It is not necessary to understand this but it is necessary to know the equation.

$$Z=\sqrt{R^2+\left(\omega L-\frac{1}{\omega C}\right)^2}$$

Should the current be tuned exactly to the given wavelength then ωL is made equal to $1/\omega C$ (by adjusting the condenser usually). In that case the reactance becomes zero and Z is merely R. What we are interested in primarly is this: Suppose the transmitter be not exactly in tune, how will it affect the receiver? A transmitter not in tune can then be likened to an interfering station. Evidently if the receiver is such that the slightest change in the transmitter wavelength will reduce the receiver current greatly, then the receiver will be a selective one, otherwise it will be a broad or non-selective one. This is the same as saying that if the value Z will change very quickly as we change the frequency or ω, then the circuit must be a selective one because any change in Z means a corresponding change in I and in the telephone response.

A mere common sense perusal of equation (1) without regard to mathematics will give us much information on this score. If R is very large compared with the reactance, then no matter how we change ω Z will remain substantially constant, namely equal to R roughly. Hence if R is large the circuit will tune broadly and the greater the R the broader the tuning. We have already analyzed the elements of R and these lead us to the following practical conclusions:

(a) To increase selectivity, reduce resistance throughout, in the antenna by keeping clear from trees and buildings, by a good ground, by good connections throughout and by heavy enough wires.

(b) To increase selectivity reduce receiver resistance by the use of *low loss* condensers and *low loss* coils.

We still wish to know how L and C should be with respect to one another. Is a large C or a large L conducive to good tuning? The answer to this question would come if we knew just how the reactance changes when ω changes a little. By assuming arbitrary values for W, L and C and substituting them into this expression one can readily be convinced that the smaller C is and the greater L is the more sharply the reactance changes as ω is varied. This again leads us to a practical conclusion.

(c) To increase selectivity, reduce the capacity and increase inductance. This means an antenna length as low as compatible with adequate volume. For local stations the antenna may be made surprisingly small and still bring in good signals. A short antenna is very much more selective and just as satisfactory in other ways.

So far we have arrived at conclusions as to selectivity in a single circuit non-regenerative receiver. Unfortunately, if we were to reduce the antenna length to an amount sufficiently low to give good selectivity we would ordinarily have only very poor volume. The addition of a loosely coupled circuit will solve this problem, permitting the use of a long antenna while preserving selectivity. When two circuits are loosely coupled together as in Fig. 2, they are inde-

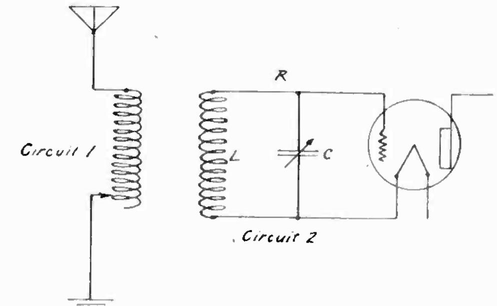


Fig. 2. Loosely Coupled Double Circuit

pendently tuned to the incoming wave, having little influence upon one another so far as wavelength is concerned. Circuit 1 contains the antenna with its large unavoidable resistance and capacity, and for both of these reasons will tune broadly. Circuit 2, however, can be made as loss free as we please and its C/L rates as low as practical consequently the secondary circuit will apply selectivity to the incoming wave after its transfer by loose coupling from the antenna or primary circuit. If the coupling is too tight the circuits mutually interact—increasing each other's resistance and changing the other constants.

Regeneration greatly increases the selectivity of a single-circuit receiver as well as its volume. There are two ways of regarding the increased selectivity. It is usual to say that the process of regeneration adds a negative resistance to the circuit—in other words reduces this resistance. As we have just seen, a reduction in resistance must bring about increased selectivity. Still another way to regard the matter is this: Regeneration is, in effect, a radio frequency amplification where the detector tube also does the amplifying. All wavelengths are not equally amplified, but only those at or near that to which the circuit is adjusted. Thus it is a common experience to notice that while the regenerative receiver is nicely tuned and amplifying a certain station it will not in the least regenerate an interfering station at another wavelength until the whole circuit is readjusted to that wavelength.

The single-circuit regenerative receiver is not, however, the ultimate in selectivity any more than it is the "golden rule" receiver. In order to get really good selectivity one must resort to repeated applications of the principles just stated.

The outstanding example of this type of selectivity is the tuned r. f. receiver such as the neutrodyne. The neutrodyne consists of two stages of radio frequency before the detector. The selectivity of the first circuit depends upon the antenna constants as well as the losses within the coil and condenser (neutroformer). To increase neutrodyne selectivity reduce the antenna length exactly as with any other type of receiver. After passage through the first neutroformer and tube the received current is impressed upon the second neutroformer circuit and tube.

This current will consist of a certain amount of the desired radio energy at the wavelength to which the circuits are adjusted plus a certain amount of energy at interfering wavelengths. Just as before, the constants of the second neutroformer circuit, namely R, L and C, will determine just how much current at each wavelength will be produced. If the circuit is a selective low loss one, very little interfering current can pass through onto the next tube. Finally the slight amount of interfering current which does pass through will be impressed upon the third tube and neutroformer and once more a big fraction of it is lopped off due to the selective action of the third neutroformer.

We may express the action of two stages of tuned radio frequency amplification as follows: Suppose that an amount of interfering current I passes through the first tuned circuit despite its selectivity. Then due to the selectivity of the second tuned circuit only a fraction, let us say $1/10$ of I, can be passed on to the third tuned circuit. But here again only a fraction $(1/10)$ of the new reduced amount can be further passed on to be detected. Thus there is a residual amount of only $1/10 \times 1/10$ of I or $1/100$ of I. In the same way an additional stage would reduce this to $1/1000$ of I. It is evident that interference can be reduced to virtually nothing by adding tuned radio frequency stages.

Nearly every type of radio receiver made and sold depends for its selectivity upon the two principles outlined above, namely, first, low internal losses plus a low C/L ratio, and second, repeated applications of the first principle by tuned r. f. amplification of some type.

There is one receiver, however, which departs radically from these principles, resulting in super-selectivity—the well known superheterodyne receiver. This receiving set incorporates the first two methods for selectivity, but introduces a third one which we shall next discuss. Beginning with a consideration of the transmitter, it has already been demonstrated that this may be taken, for practical purposes, to be a continuous wave transmitter.

As this assumption greatly simplifies the subsequent explanations we shall make it. It is assumed also that the transmitter sends out a pure wave of 300 meters or 1,000,000 cycles. When the wave reaches our superheterodyne receiver it is heterodyned, or "beat" with, by the oscillator in the receiver until a "beat" note of say 45,000 cycles results. If the oscillator were set to 1,045,000 cycles it would necessarily do this. Now the 45,000-cycle current is detected and then amplified by successive stages of intermediate frequency tubes and transformers, finally being brought into the audio circuit. The tremendous selectivity of the superheterodyne may be illustrated by assuming an interfering wavelength differing by only 1%, from the 300 meter wavelength, namely, 297 meters or 990,000 cycles. The oscillator having been set to cause a "beat" note of 45,000 cycles with the desired 300 meter wave, it will make a 55,000-cycle beat note with the interfering 297 meter wave, namely 1,045,000 minus 990,000. If the intermediate frequency transformers are sharply adjusted to 45,000 cycles it is easy to see that a 55,000-cycle wave would experience great difficulty in passing through several stages. In effect an original difference of only 1 per cent in wavelength (namely 300 meters from 297 meters) has been converted into a difference of 45,000 to 55,000 cycles, or over 20 per cent. This is what the superheterodyne principle contributes. It greatly magnifies the percentage difference in frequency of the desired from the interfering wave.

The three principles we have described constitute the chief present-day methods of tuning for selectivity. There are additional aids which come under the heading of filters or frequency traps. They do not so much pick out what we desire as exclude what we do not. The simplest of these and the one we shall discuss as a type consists merely of a coil and condenser connected together in series with the receiver. It can readily be shown by mathematics that any wavelength of the same frequency as that of coil L and condenser C (Fig. 3) (con-

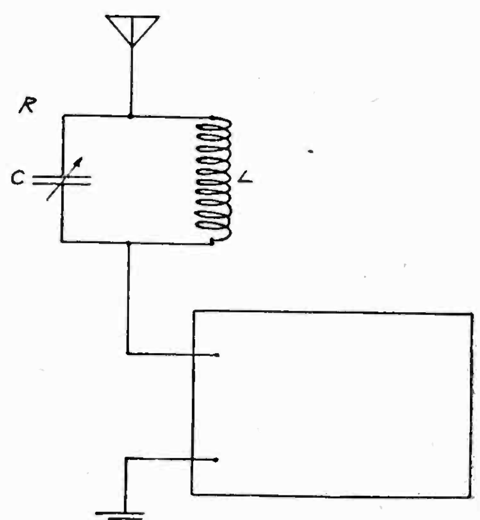


Fig. 3. Wave Trap

sidered as an independent circuit) will experience great difficulty in passing from the antenna to the receiver. In other words coil L and condenser C act like a very high resistance at that particular frequency. Strangely enough, the *lower* the actual resistance of C and L

Continued on page 78

A Five Meter Receiver

Constructional and Experimental Information on Short Wave Reception and Transmission

By C. William Rados, IBFA

THE band between 4 and 5 meters is from 75,000 to 60,000 kilocycles, a range of 15,000 k. c. This is more than ten times greater than the 1,475 k. c. frequency band between 200 and 20,000 meters.

We do not use one coil and condenser to tune from 200 to 20,000 meters, nor should we expect one coil and condenser to tune from 60,000 to 75,000. However, much of this range can be covered by a properly designed set. Reception of these high frequencies can be obtained by the ordinary tickler coil circuit.

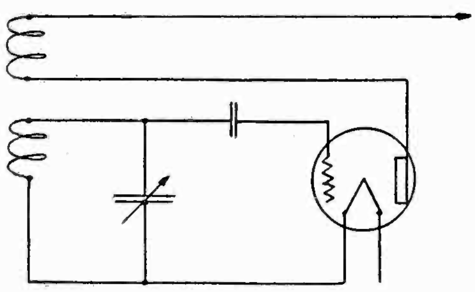


Fig. 1. Circuit Elements

Using the circuit of Fig. 1 with a .0005 Acme condenser across a 1-turn grid coil on a 3 in. tube and a 3-turn tickler about ½ in. away it oscillates over the entire condenser range using fixed tickler coupling with a C 301-A, and 45 volts *B* battery. Using an old Audiotron almost no tickler was necessary with 22 volts, tube noises being nil and reception better. A UV 200 ranked next. This type of receiver must be constructed very carefully in order to really be able to receive 60,000 k.c.

Tube capacity is bothersome if we use the ordinary one tube, tickler arrangement. In this type of receiver we have a variable tuning condenser across the grid coil. Across that is also the capacity of the grid tube filament in the tube

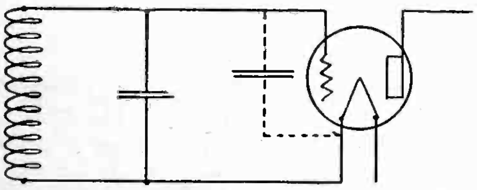


Fig. 2. Effect of Tube Capacity

(Fig. 2). This reduces the upper limit of frequency to which the set will respond. If we cut down the intra-tube capacity we can arrange a circuit to successfully receive the band between 60,000 and 75,000.

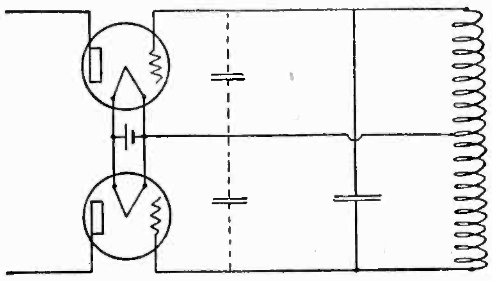


Fig. 3. Method of Reducing Tube Capacity

Fig. 3 shows how two tubes can be used across a coil with the grid to filament capacities in series. This cuts down the extra capacity so much that the tubes may be used in their sockets. The apparatus to be assembled on a 10 by 10 in. board consists of 1-Acme .0005 condenser, 2 General Radio sockets, 2 terminal strips, 2 coils, 1 Bradleystat, 1 Frost jack, 1 .0005 mica condenser. Care was used to pick two UV 201A tubes nearly identical in characteristics. As a concession to cutting down the losses the shells may be removed from the sockets. The two terminals on the side away from the pin are the filament prongs. No grid condensers or leaks were used. The grid coil was a 1-turn loop of bus bar with the ends attached directly to the grid terminals of the sockets. (Fig 4). The plate coil was the same as the grid coil and attached to the plate terminals of the two sockets. The sockets were about 8 in apart with the grid and plate coils between them as close to one another as possible, as in Fig. 5. The diameter of

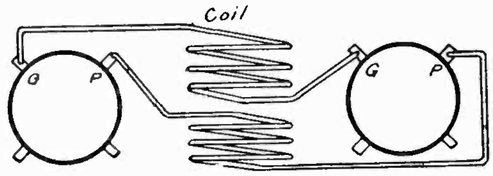
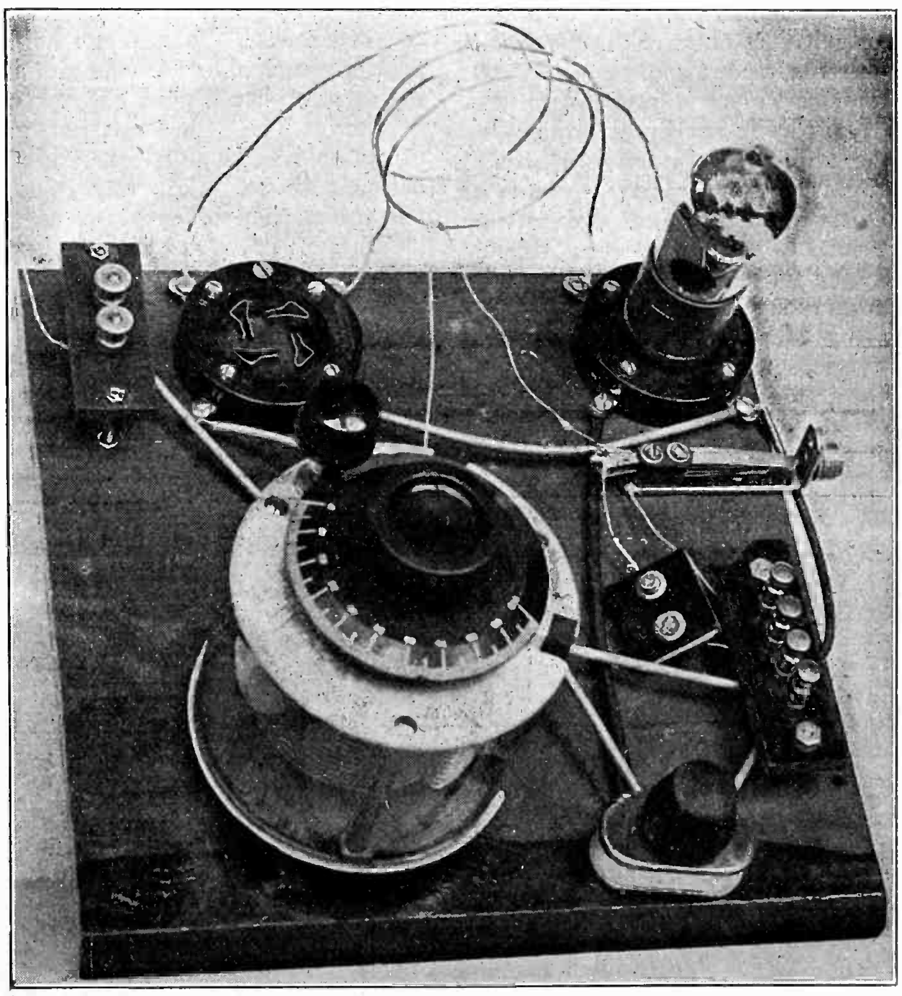


Fig. 5. Coil Placement

the coils in about 5 in. for 60,000 k.c. work.

The circuit is given in Fig. 6. The taps from the grid and plate coils must be from the center of the coils and the rotary plates are connected to a point midway between the filaments as shown



Assembled Equipment

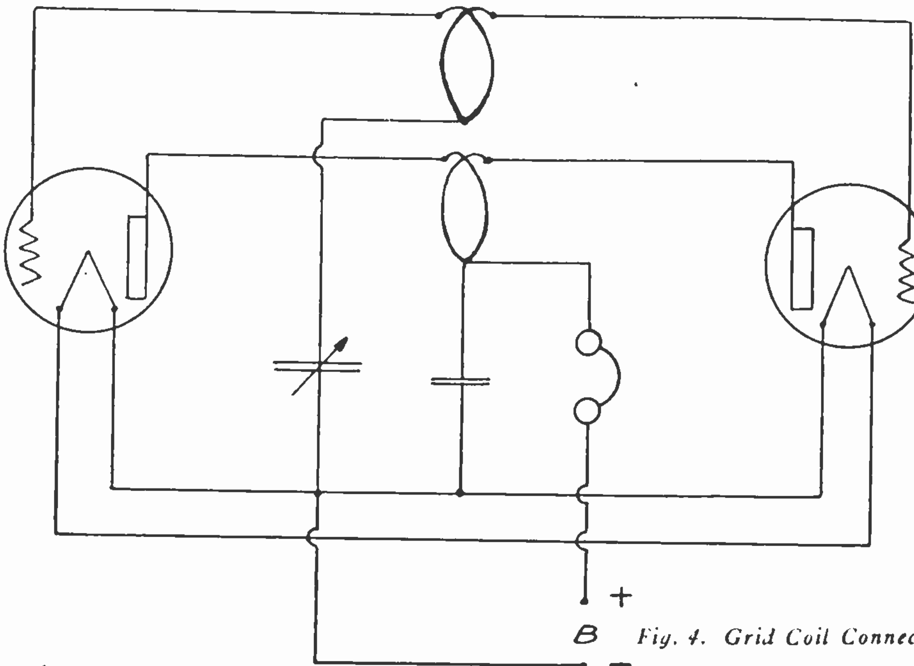


Fig. 4. Grid Coil Connections

These locations need not be exact but the experimenter may feel better if they are at least mechanically centered. One rheostat is better than two, as filament temperatures should be the same for best results.

The set in the picture was a rush job and thrown together in less than an hour. This is strictly in line with amateur traditions but more time may be advantageously spent in assembly.

However, the fun begins when we try to make the circuit oscillate. After about a half hour the set will begin to work and inside of an hour it should be completely settled down. A grid leak may be tried across the tuning condenser if the circuit does not work immediately. (hi). If the reader can get a 0-3 milliammeter and place it in the plate lead, oscilliation can be readily determined by it. The addition of an aerial or ground will stop oscillation at certain points of the condenser scale so a coupled antenna circuit should be used. A wire 5 meters long is used for aerial and a similar wire for counterpoise with one turn in the center for coupling. Coupling is best when as loose as possible as there are many harmonics on 60,000 k.c. Once the set is working, there will be no period of day or night in which it will not pick up the spark, cw, arc, and phone harmonics.

The advantages of this receiver are, (1), tuning is not difficult, (2), no special precautions need be taken with the tubes or wiring, and (3), the fundamental idea and circuit is sound.

This circuit looks somewhat like a push-pull circuit but the idea is different. An oscillograph in the plate will give an understanding of what is going on. At first glance, the plate arrangement might lead the reader to believe that we were neutralizing one half of the turn against the other half. The phase angles are probably such that the currents are aiding one another instead of opposing one another. The grid does not gain by using condensers and leaks and will do better without. Grid bias is used and the tubes are real detectors as well as oscillators.

The same circuit is used for transmitting. Two 50 or two 5 watters are used. The only radio frequency is in the plate and grid coils so no r.f. chokes are necessary. The antenna scheme is the same as for receiving; a 10 meter wire with the ammeter in the middle. As the frequency is so high, 2 ft., couplings give about the same results as 2 in.

As this is a new field it will take a lot of work by many stations before we get to a point where we can say that we have mastered it. Co-operation is necessary; and it is in this connection that the author wishes to thank Mr. Gisbourne and Mr. Kelley (of ICPI) of Acme Apparatus Company for their assistance.

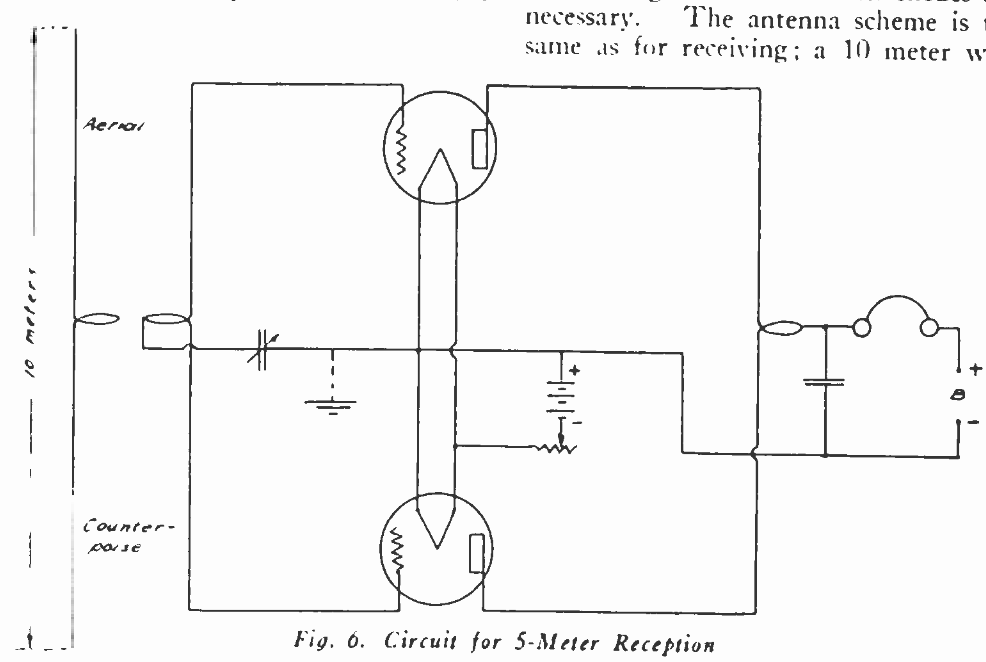
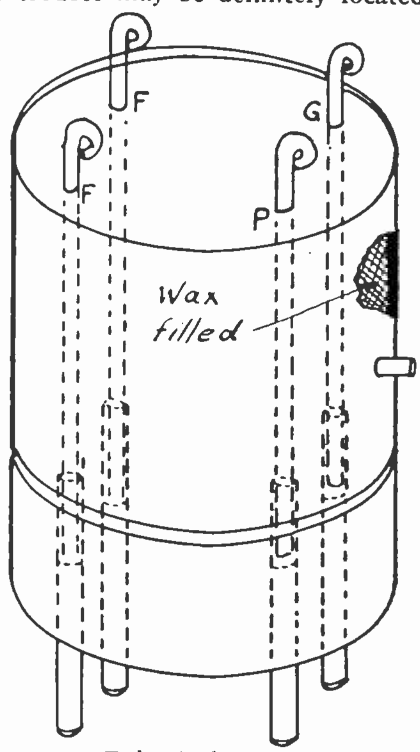


Fig. 6. Circuit for 5-Meter Reception

A TUBE SOCKET TESTER

By F. S. Root

It is often rather difficult to tell whether a bulb is defective or burnt out, or whether the socket clips are not in good contact with the bulb prongs. The accompanying sketch shows a device to help you in testing out sockets so that the trouble may be definitely located.



Tube Socket Tester

Remove the glass, cement, etc., from an old tube. Solder four short pieces of No. 14 bare copper wire to the four prongs, cutting the ends off about an inch beyond the top of the base. Knock off some of the sealing wax from the top of some dry cells, melt it, and fill the tube base around the four wires, nearly to the top. From an old white linen collar, cut a disc that will just fit inside the shell and press down on the wax while it is still sticky. Mark the four terminals with letters to designate filaments, plus and minus, and plate and grid. Double ends of the four wires into close loops and put a drop of solder on each one.

By slipping this testing plug into the lamp socket, it can be conveniently tested out for poor contact of socket clips with lamp prongs, as the four projecting pieces of No. 14 wire are very accessible, and the prongs of the plug are engaged with the socket clips just as the bulb prongs would be.

A Wavemeter for Short Waves

Suggestions as to Selection and Construction of Parts, Assembly and Operation

By L. J. N. du Treil

IN December, 1924 RADIO, I described a method of generating short waves on parallel wires and the accurate measurement of such waves. It is the purpose of this article to describe a wavemeter, having a range from 18 to 350 meters, which may be calibrated by the method described in that article.

Since the short wave bands have been opened to amateur use the wavemeter can no longer be considered a luxury but is a real necessity in every station. The cost of construction is such that no one need do without a wavemeter from this standpoint.

The essential parts of a wavemeter are (1) a variable condenser, (2) a number of coils of different inductance values chosen so that one coil may overlap the other so as to give a continuous range of wavelengths over the entire range of the meter, and (3) an indicating device. When it is desired to measure the wavelength of a transmitter the coil of the wavemeter is placed in inductive relation to the coil of the transmitter and the condenser of the wavemeter is moved back and forth until maximum indication is obtained, at which adjustment the wavemeter circuit is in resonance with the transmitter.

The inductance coils should be tightly wound and fastened to the insulating form, because, if the winding is disturbed after the meter has been calibrated, such calibration will no longer be good.

In the meter illustrated in Fig 1 the coils are wound in the grooves of four wooden forms, which are easily turned in a lathe. The dimensions used by the writer are given in Fig. 2. Before winding, the wooden forms are boiled in hot paraffin to exclude moisture from the pores of the wood. Collodion should be used to fasten the winding to the form. Shellac is said to absorb moisture and should not be used. In using collodion proper care should be exercised in keeping it away from open flames, inasmuch as the solvent is ether which is highly inflammable.

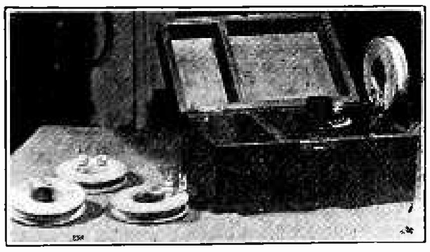


Fig. 1. Wavemeter and Coils

Fig. 2 shows the details of constructing the connectors for the coil. These connectors also serve as a support for the coil when in use on the wavemeter.

The following table gives the winding data, the inductance, and the wavelength and frequency range for each coil when used with a variable condenser of 0.00035 mfd. maximum capacity.

Coil No.	No. of turns	Inductance in Micro-henries	Wavelength range	Frequency Range in Kc.
1	4	1.85	18-47	16,660-6,379
2	8	8.0	45-100	6,663-2,998
3	15	33.0	95-200	3,156-1,499
4	30	130.0	195-350	1,538- 857

Double cotton covered wire (copper) of any size between No. 16 and No. 24 will be suitable. The writer used No. 16 on coils 1, 2, and 3, and No. 20 wire on coil 4. The turns on each form should be wound close together and the terminals clamped under and soldered to the screws shown in Fig. 2.

The condenser should preferably be of the low loss type with heavy metal plates supported on rods of ample size and separated by large washers and nuts which will assure rigid support. The movable plates should have ample large bearings, preferably of conical shape, securely mounted on the end plates. To reduce wear the bearings should be of dissimilar metals. There should be a short flexible connector (pig-tail) to the movable plates.

There should be eliminated from consideration variable condensers having any but air dielectric, condensers with thin

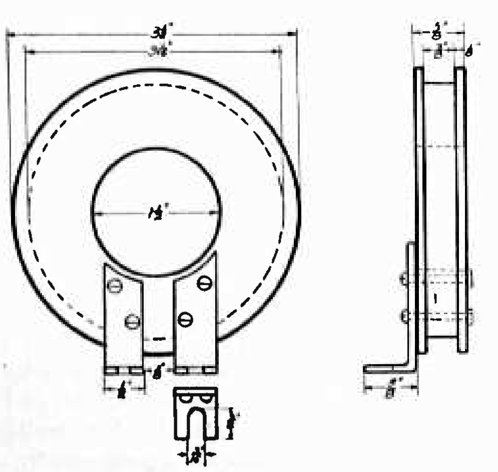


Fig. 2. Dimensions of Forms for Coils

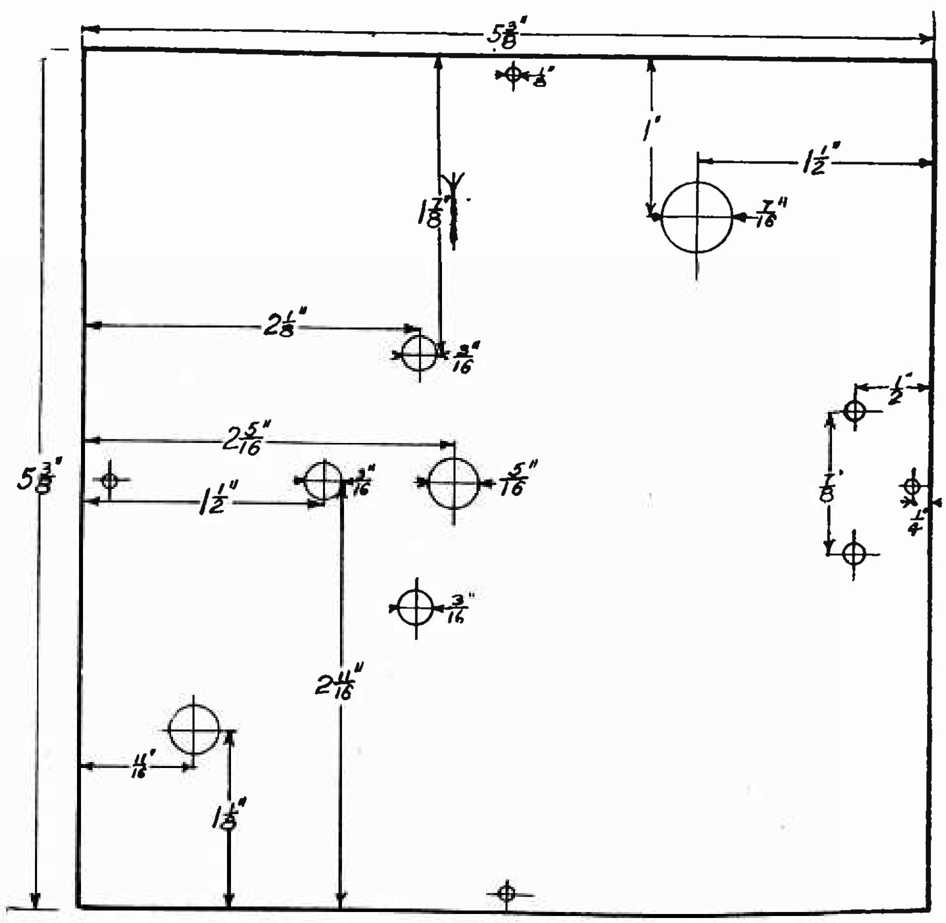


Fig. 3. Panel Layout.

or closely separated plates, and those in which the movable plates are supported on a spring or in bearings which permit of lateral motion. There should also be eliminated such condensers as depend upon the motion of a screw to vary the distance between the plates as they will not retain the same capacity for various settings upon various observations, and wavemeters using such condensers would be of little value from the standpoint of accuracy.

Condensers equipped with vernier attachment may be used to advantage, especially for short waves. However the experimenter may find it better to fasten a long rod to the dial of the condenser, this arrangement having the double advantage of keeping the hand away from the condenser and thus eliminating body capacity, and also giving the fine adjustment of a vernier.

Morecroft recommends the use of a condenser of 0.001 mfd. maximum capacity for each 1,000 meters to be covered, hence for the range desired here a condenser of 0.00035 mfd. maximum capacity was selected.

The high-frequency milli-ammeter rightly holds first place among indicating devices. There are two types available, the thermo-couple meter and the hot-wire meter. Either having a scale reading from 0 to 100 milli-amperes is suitable for a wavemeter. The cost of the milli-ammeter, however, is usually beyond the purse of the average experimenter.

The glow lamp, or flashlight lamp, is a very popular indicating device. Readings obtained with this indicator are not as precise as those obtained with a milliammeter, and the glow-lamp requires more energy to operate than does a milliammeter. These disadvantages are overbalanced by the low cost. Hence this device has been chosen for the wavemeter described herein.

The condenser and indicating device should be mounted on a panel and mounted in a box. Fig. 3 shows the panel layout of the wavemeter illustrated in Fig. 1 Fig. 4 is a diagram of connec-

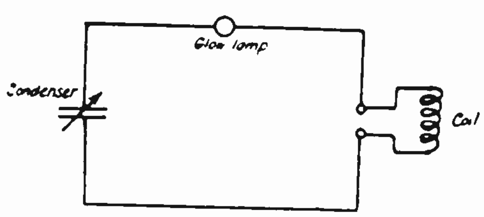


Fig. 4. Diagram of Connections

tions. The wiring should be done with heavy copper wire not smaller than No. 14 and should be hard-drawn.

The dial is placed on the shaft of the condenser and the position of the fastening screw noted. The dial is removed and a small depression drilled out of the shaft at the point of contact with the screw. The dial is then replaced and the screw tightly screwed into the depression. This precaution will prevent the dial from slipping.

The wavemeter may be calibrated by the method described in the former article. When a glow lamp is used as the indicator it may be necessary to increase the power of the short wave oscillator by the addition thereto of another power tube in parallel. It should be remembered, however, that the use of more than one tube increases the capacity of the oscillator circuit and may make it difficult to go down to the very short waves.

Another method of calibrating the wavemeter is to make use of the standard frequency signals transmitted from station WWV of the Bureau of Standards in Washington, and from station 6XBM of Stanford University at Palo Alto, Calif. The schedules are given in the current magazines and in the Radio Service Bulletin.

The Elements of Tuning

By Kennard McClees

The first type of tuning inductance was the tuning coil, which consists of a layer of insulated copper wire, wound on a tube of some insulating material. This insulation is removed in a straight line at one place so that a sliding contact can vary the number of turns brought into play. A more efficient form uses two sliders.

Inductance is the property which any electric circuit has of storing energy in the form of magnetism. Observation of the deflection of a compass needle when brought near any flowing electric current will show that a magnetic field is set up wherever this occurs. This property is many times increased when the wire is wound into the form of a coil; and a coil makes compactness. Since it is necessary that your aerial equal, electrically, the aerial from which you wish to receive, it is obvious that it is better to have this means wound on a coil and varied by means of a slider, than to have a great windlass on your roof to change your aerial length.

The other factor in tuning is termed capacity and has to do with a condenser's property of storing electrostatic energy. A cloud is one form of condenser, when taken with the earth as the opposite plate, and the air between as the dielectric. When a certain amount of static electricity has been stored in the cloud the insulating property of the air is overcome and a flash of lightning is seen. Likewise your aerial and ground system form a great condenser but the energy there stored up is led through the various instruments of the set and turned into audible signals.

The simplest illustration of a variable inductance is shown in Fig. 1. In this

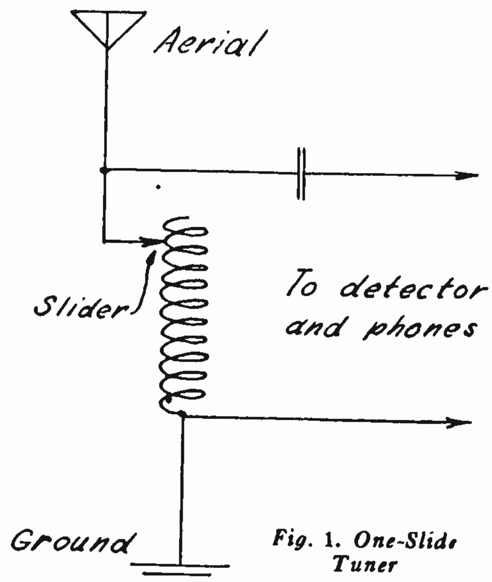


Fig. 1. One-Slide Tuner

case the capacity remains fixed and the inductance is changed as the slider moves along the coil.

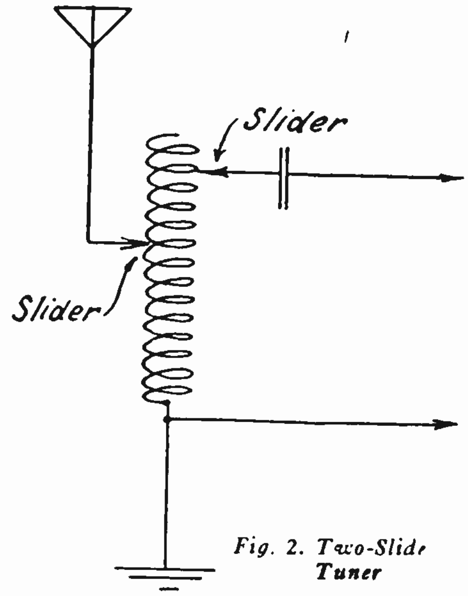


Fig. 2. Two-Slide Tuner

Fig. 2 shows a two-slide tuning coil, this gives better reception as the tuned detector circuit provides more energy for the detector.

In the circuit illustrating the loose coupler, Fig. 3, it will be seen that the

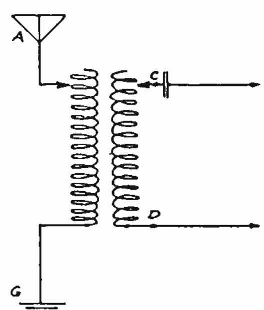


Fig. 3. Induction Coupling

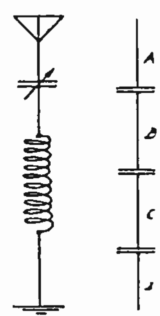


Fig. 4. Series Connection of Capacity

inductance is formed of two coils without mechanical connection. They are separated by air, and energy from the first, which is inserted in the aerial and ground circuit, reaches the second by virtue of the magnetic fields set up, when the latter is also in resonance.

(Continued on Page 94)

Sending and Receiving on One Tube

By Brainard Foote

THE experimenter dabbling in low power transmission and the radiocast listener whose interest in the amateur side of the radio game is just awakening often feel the need for some compact, light and portable arrangement whereby both transmitting and receiving may be carried on without unnecessary impedimenta in the way of heavy batteries. Some cheap and effective method whereby 200 or 300 volts for transmission may be generated is in widespread demand not alone for portable work but on the part of those in outlying districts where there is no city power supply available.

For low power transmitters using a tube rated at five watts or less, there is nothing quite so satisfactory and convenient as an ordinary automobile spark coil for the generation of the high plate voltage. Of course, in the customary service, such coils deliver several thousand volts at slight amperage, but to suit them to radio purposes, some means must be provided so that the voltage is cut down greatly and the current output increased. To accomplish this change, a simple fixed condenser shunted across the secondary of the spark coil draws sufficient power to "hold 'er down." If the condenser be too large, the load on the secondary will be too great and the voltage may be too low. With too small a condenser, on the other hand, the voltage will be so high as to cause spark-over in the tube, condensers or other apparatus in the circuit.

In order to still further increase the usefulness of a portable outfit, the same tube may be employed for both sending and receiving, a C-301A or UV-201A being a good amplifier, detector and oscillator. With proper plate voltage it will put .1 ampere into the average antenna. Of course, this is a relatively slight amount of radiation, yet fifteen or twenty miles may be covered during daylight and at night phenomenal distances are frequently reported with such insignificant power.

An ordinary Ford spark coil is ideal as the high voltage source, and may be operated from the battery used to light the tube filament. A common grid circuit can be used with a switch to transfer from one tuning condenser to another, so that the receiving and transmitting "sides" will be independent of each other as regards wavelength. In other words, we may send on one wavelength and receive on the same or any other.

To provide regeneration and oscillation for both transmitting and receiving there must be separate tickler coils.

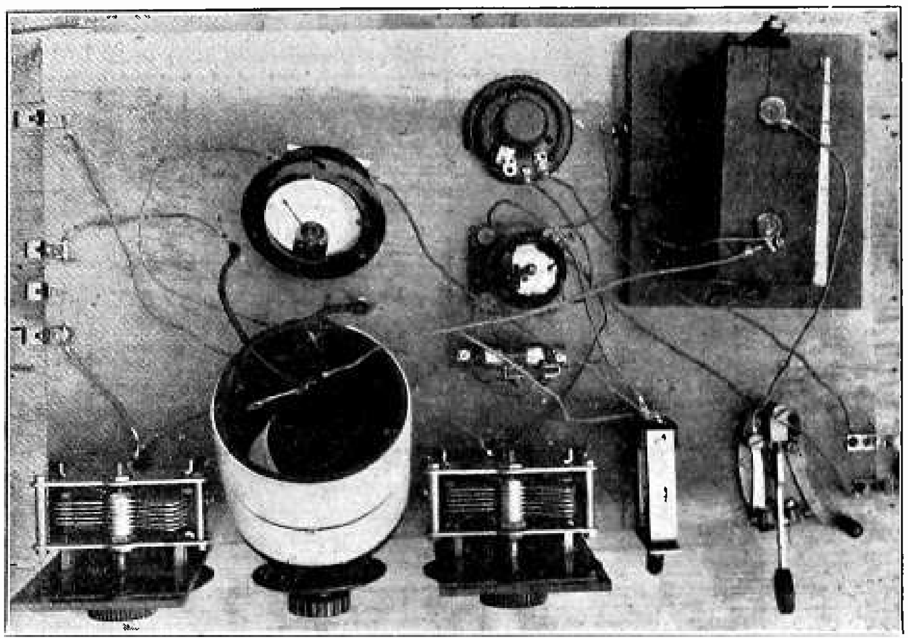


Fig. 1. The Send-Receive Equipment. The Controls Are, Left to Right, Transmitting Condenser, Receiving Tickler, Receiving Condenser, Anti-capacity Change-over Switch.

Since fixed tickler coupling is satisfactory for transmission, but not for reception, we may employ a regular rotor with a tickler winding and dial adjustment for the receiving side. For transmitting, we adopt a separate plate coupling or tickler inductance, which is in reality a mere extension of the grid inductance.

If, however, the sending tickler were a straight continuation of the grid inductance, as in customary transmitting circuits, we would run up against a snag in the supply of the plate potential. The Ford spark coil has but three terminals—two of them connected to the primary winding and the third being one end of the secondary. The other end of the secondary winding is connected to one of the primary terminals—it makes no difference which. We must therefore make this common point a connection to the battery.

In the circuit diagram of Fig. 3 *R. T.* is the receiving tickler; *L* the grid inductance or secondary winding, and *S. T.* the sending tickler or plate coupling coil. *R. T.* has 40 turns of No. 20 wire wound on an ordinary rotor such as is used in any vario-coupler. *L* and *S. T.* are wound upon the same form, preferably a piece of high grade insulating tubing 4 in. in diameter and at least 4 in. long. The entire coupler may be conveniently made with this piece of tubing and a "180 degree" type of rotor removed from another vario-coupler. *L.* and *S. T.* are of No. 16 double covered.

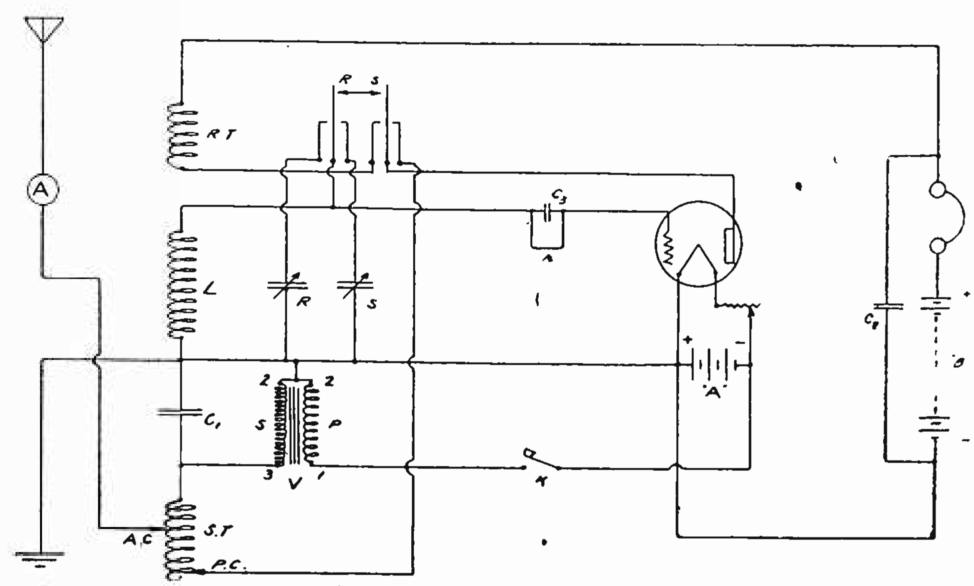


Fig. 3. Combination Transmitting and Receiving Circuit

wound in the same direction with one-quarter in. spacing between them. *L* is wound with 25 turns and *S. T.* with 30 with a tap taken out at every fifth turn. These may either be in the form of a twisted piece of wire or, to make a better looking job, a short length of brass strip soldered to a short scraped portion of the turn of wire.

The "load condenser" is connected between the two coils. Hence it acts as a by-pass condenser as well as a loading device to reduce the voltage delivered by the spark coil. It must be a condenser of approximately .002 mfd. and also be capable of withstanding about 1,000 volts. Condensers supplied for transmitting purposes may be had with a 1,000-volt breakdown specification. This is condenser C_1 in the figure.

Terminals *1* and *2* of the Ford spark coil in Fig. 2 are those of the primary

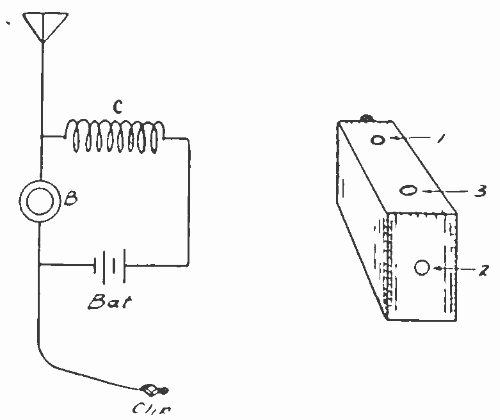


Fig. 2. Radiator Indicator and Spark Coil

winding. The free end of the secondary is *3*, the other end of the secondary being grounded to the primary winding. These markings correspond with those of the circuit, Fig. 3, where the spark coil is indicated by *V*. The primary and secondary are labelled *P* and *S*, respectively.

The "send-receive" switch is an ordinary anti-capacity or cam switch, double pole, double throw. Reception and sending are indicated by *R* and *S*, as are the tuning condensers for each purpose. These are of the .00025 mfd. size (about 13 plates). They should preferably be of the low-loss form, especially in the case of condenser *R*. C_3 is a .0005 grid condenser—a larger size than is usually chosen—to fit it for both functions. The grid leak is fairly low in resistance, preferably not over one-half megohm. A rheostat having about 15 ohms resistance is suitable. C_2 is a .002 by-pass condenser to facilitate oscillation and reduce body capacity through the phone cord.

A battery polarity is of great importance—the grid return going to the positive for best results. This increases the plate current and at the same time the radiation. Moreover, for best reception, the grid return goes to the plus side of the filament. The transmitting key *K* is located in the negative line to the spark coil.

In rigging up the circuit, it is best to get the receiving side going first. If possible, but little coupling should be used between antenna and secondary, and therefore the tuning should be first tested with the antenna clip, *A. C.*, on the lowest tap, so that only five turns of wire are included between it and the C_1 end of the *S. T.* coil. If regeneration is not obtained, the connections to the tickler coil should be reversed. The *B* battery for the receiver need not be larger than the 22½-volt size, providing it is up to full voltage.

It is important to determine the natural wavelength of the antenna circuit, and this may be done with some accuracy even without a wavemeter. By virtue of the antenna-ground capacity and the inductance included in coil *S. T.*, a certain wavelength is attained automatically. If this lie within the tuning range of coil *L* and condenser *R*, the antenna's "natural" can be found at once. A point is found on condenser *R* where regeneration cannot be obtained except by much increased coupling between coil *L* and the tickler *R. T.* And with the amount of tickler coupling needed to get oscillation at other points on the scale a double click will be heard as the condenser dial is moved past the point of the antenna's wavelength. This is caused by the stoppage and starting of oscillations as the absorption by the antenna starts and stops.

Where a wavemeter is at hand, it is a simple matter to bring its coil into relation with coil *L* while the tube is oscillating and to find by the absorption method just to what wavelength the receiving circuit is tuned. Without a wavemeter, it is possible to tell only by comparison with signals received. The natural period of the antenna and coupling inductance in use on *S. T.* should be less than 200 meters, to insure transmission on a wavelength legal for amateur stations. Where a number of amateur signals may be heard both above and below the absorption point at which the antenna stops the oscillations of the tube, one is safe in going ahead with the transmitting side.

First remove the headphones to guard against any possible spark-overs in the wiring and consequent shocks, and move the switch to the sending position. With the tube lighted normally, press the key. The tube will be dimmed slightly, due to the extra load on the storage battery. In case of sparks, move the connecting wires so that there are no small gaps across which they may jump.

In the absence of a radiation ammeter, 0 to 1 ampere scale, as in Fig. 1, a flashlight lamp *B* may be rigged as in Fig. 2 to aid in finding the point of resonance between the antenna and the oscillating grid circuit *L* and *S*. The coil *C* consists of 50 or 60 turns of small insulated wire on a small cardboard tubing. When the condenser *S* is so set that the secondary circuit *L* and *S* is in tune with the antenna circuit, the bulb should become visibly brighter. The point of resonance is very sharp and will usually also be shown by a slight lowering of the pitch of the vibrator, indicating additional load on the spark coil.

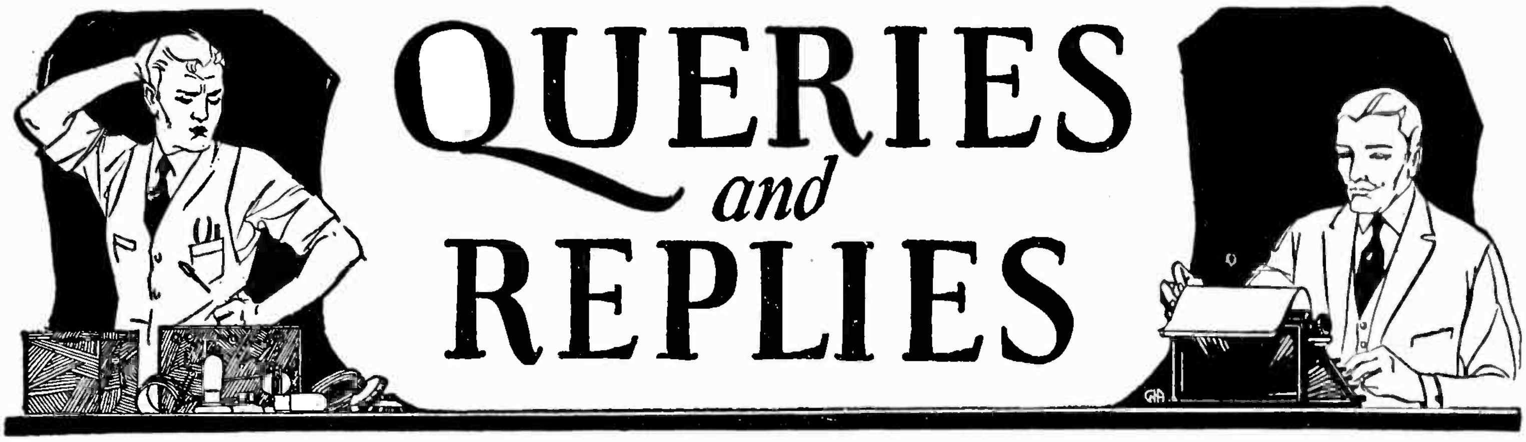
It is practically impossible to get the outfit properly in tune unless the natural wavelength of antenna and coupling coil is first found when the switch is thrown to the receiving position. The sending condenser will be placed in about the same position for proper tuning. In case the natural wavelength is too high, a variable condenser of about .001 capacity may be inserted in the antenna lead to lower it, or the antenna may be shortened. Where the "natural" is too low, it is best to lengthen the antenna or to move the antenna clip nearer the end of coil *S. T.* In most cases, the plate clip *P. C.* is attached to one of the last two or three taps of *S. T.*, depending somewhat upon the position of the antenna clip.

When transmitting the tube operates upon alternating plate current. Hence the radiated note will not have the whistling characteristic of a continuous wave transmitter, but will have an audible pitch corresponding to that of the vibrator. The higher its pitch the more easily may the code letters be copied and the more the radiation. It is difficult to maintain the vibrator for any considerable time on a smooth tone unless the spring is "doctored." A piece of stiff brass may be cut and fitted underneath the spring to shorten this vibratory portion. However, a fairly high tone may be secured by placing a padding of two or three strips of tape between the armature and the core of the spark coil.

In Fig. 1 is shown the apparatus mounted on a board for experiment. A plate milliameter is in view also, this being added in studying the effects of changes in tuning and in vibrator pitch upon the plate current. With the "A" tube, the plate current is about 7 milliamperes, varying from 5 mils up to 10 mils with very low and very high vibrator notes. Changes in the tone naturally change the voltage output, so that the increased radiation on higher notes is really due to higher voltages.

Spark coil C. W. is being widely used because of its great economy and continued good results. When combined with a send-receive circuit whereby one tube does for both, a very simple little portable outfit may be constructed which is just the thing for the automobilist, inasmuch as his storage battery may be used for radio purposes without removal from the car.

QUERIES *and* REPLIES



Questions submitted for answer in this department should be typewritten or in ink, written on one side of the paper. All answers of general interest will be published. Readers are invited to use this service without charge, except that 25c per question should be forwarded when personal answer by mail is wanted.

What is the simplest form of *B* battery eliminator, in reliable form. I do not care to use electrolytic rectifiers of any sort.

—J.B.E., Syracuse, N .Y.....

A simple one-tube rectifier is illustrated in Fig. 1. The use of a half wave rectifier, such as is shown is dependent upon the filter, which must be of high grade. A choke coil of 50 henrys or more should be obtained, and used in combination with 4 mfd. condenser capacity, and more if the cost is not prohibitive. Otherwise, 60 cycle noise will surely be present in the direct current output. The diagram shows a rectifier having 150 volts output. If lower voltages are desired, a Bradleyohm, or other variable high resistance, placed in series with the positive lead, will lower the voltage to the desired value.

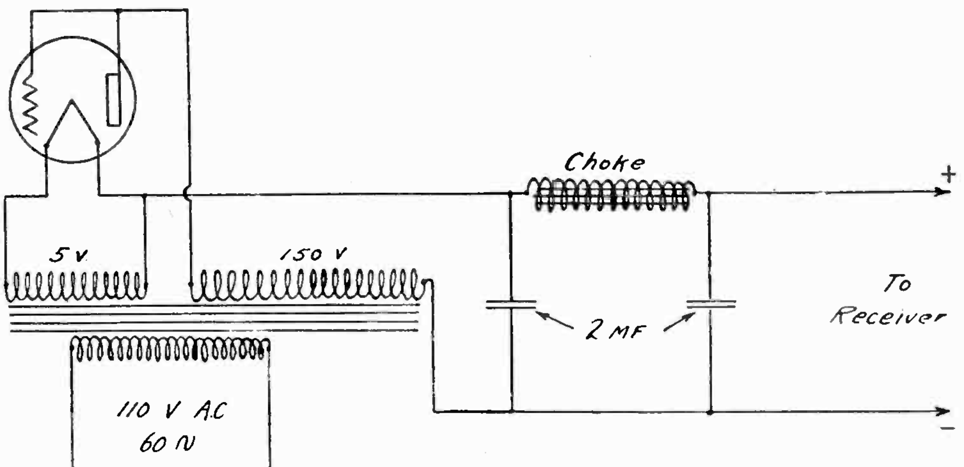


Fig. 1. Simple One Tube Rectifier

What will be the impedance ratio of a 3 to 1 audio frequency transformer when connected in a vacuum tube circuit.

—H.B.W., Wenatchee, Wash.

The impedance ratio will be 9 to 1, being the square of the turns ratio. If the transformer is connected to the output of a tube having an impedance of 20,000 ohms, then the secondary impedance will be approximately 180,000, provided that all conditions for the proper operation of the transformer are met.

Will the addition of a ground connection to a super-heterodyne receiver using a loop antenna, result in increased signal strength or distance?

—L.F.T., Los Angeles, Calif.

A ground lead of considerable length, where the set is some distance above the ground, will probably result in slightly increased signal strength, although it may not be of appreciable amount. The ground connection may be of benefit in cutting out noise due to induction from nearby lighting circuits, particularly those in the same room with the set.

I have a two tube Harkness Reflex which is satisfactory on distance, but the crystal continually gets out of adjustment. Is there some way of substituting another vacuum tube for the crystal without unduly complicating matters?

—E.S.M., Brooklyn, N. Y.

The circuit given in Fig. 2 shows the method of connecting the extra vacuum tube used as a detector. Using the tube will eliminate the instability caused by the crystal and will no doubt give greater signal strength.

Can a Hegehog audio frequency transformer be used with the C-299 tube? Please publish a three tube hookup using these transformers. Can a Sterling D. C. ammeter be used as a radio frequency ammeter?

—E.S.S., San Francisco, Cal.

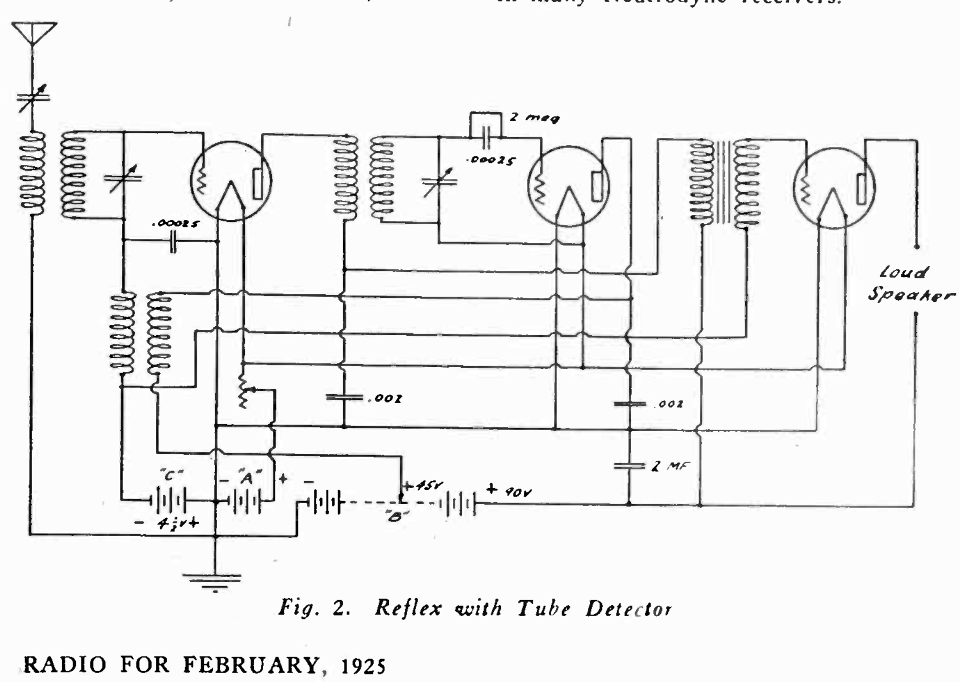


Fig. 2. Reflex with Tube Detector

The Hegehog transformer will work with a C-299 tube. Fig. 2 shows a good three tube radio receiver capable of receiving over a considerable distance. It is of the non-regenerative type. Your direct current ammeter will not work in a radio frequency circuit. A radio frequency ammeter operates with either a thermocouple, or is a hot wire device and meters used in ordinary direct current service will not respond to alternating current of any frequency above a few cycles.

Is the panel a very necessary adjunct to a radio set? Does it matter whether the phones are placed between the plate of the tube, and the *B* battery positive, or between the *B* battery negative and the filament of the tube?

—R.L., West Point, N. Y.

A radio set can be built entirely on a board, if the tuning controls and associated apparatus are mounted so that they can be accessible and easy to operate. The panel provides a convenient method for mounting most of the apparatus, and adds to the looks of the set. It is preferable to have the phones between the plate of the tube and the *B* battery, although absolutely no difference in results will be noted.

Can a crystal be used with much success in a super-heterodyne, in the second detector circuit? Can any of the tubes be reflexed in this circuit?

—H.S., jr, Red Bluff, Calif.

A crystal detector can be used in either the first or second detector circuits in a super-heterodyne receiver. It would be advisable to get the best crystal possible, particularly one which does not get out of adjustment easily. It would be possible to reflex one of the radio stages as an audio frequency stage, similar to the method used in many Neutrodyne receivers.

Please publish a circuit diagram for a 5 watt C. W. transmitter using Kenetron rectifier tubes for the plate supply.

—H. J. D., Sandusky, Ohio.

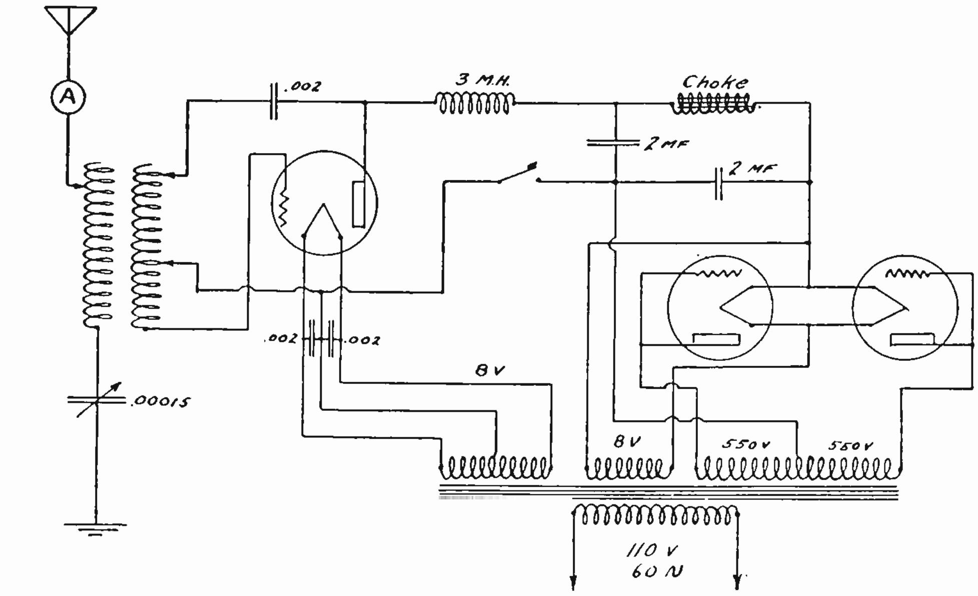


Fig. 3. Single Tube Transmitter with Kenetron Rectifier.

Fig. 3 shows the circuit of a single tube transmitter, with two Kenetron rectifiers for furnishing the plate voltage. It may be necessary to ground the filament of the transmitting tube at the center tap of the transformer secondary, if the set does not radiate properly.

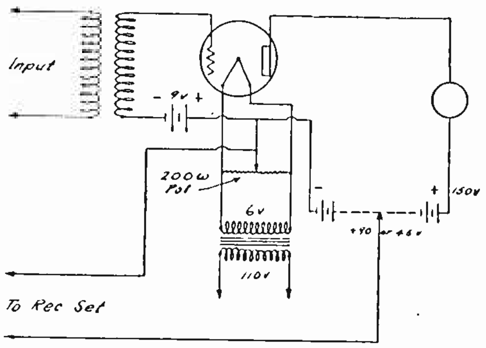


Fig. 5. Power Amplifier.

I wish to build a Neutrodyne receiver suitable to connect to my Western Electric loud speaker, which is of the 14-A type. Please publish a circuit diagram of such a receiver.

—P.F.N., Milwaukee, Wis.

The circuit for a four tube Neutrodyne receiver, having one stage of audio frequency amplification is shown in Fig. 4. The antenna circuit is tuned with an air condenser, but may be of the conventional untuned type if desired. Under ordinary conditions, the audio frequency stage will not be needed, but is shown in the diagram for convenience.

Kindly publish a circuit diagram for a power amplifier stage, suitable for connection to a two stage amplifier using UV-199 tubes.

—N.O. Name, No Address.....

A circuit for the power stage is shown in Fig. 5. As the tube should be of the storage battery type, it is shown connected to the lighting circuit through a bell ringing transformer having a secondary of six volts. A 200 ohm potentiometer will enable the finding of the proper point of balance between the grid and the filament circuit. The same *B* battery as is used in the receiver may be used with the tube, with the addition of enough voltage to provide a total of 130 volts or more.

BOOK REVIEWS

The "Burgess Index of Radio Broadcasting Stations, Record and Atlas," is a convenient pamphlet whose name indicates its scope. It is published at a price of 25 cents by the Burgess Battery Co., Harris Trust Bldg., Chicago, Ill. "Burgess Dry Cell Batteries with the MacMillan Expedition" is an interesting account of severe service conditions successfully met by Burgess batteries.

"Radio Facts" is a title of an interesting house organ from the Kellogg Switchboard and Supply Co. ,of Chicago. It gives the news of rew Kellogg products for radio use.

"Manual of Radio Telegraphy and Telephony" by Admiral S. S. Robinson, 895 pages, 7x10. Published by United States Naval Institute, Annapolis, Md.

This, the sixth edition of a text which is the standard for naval instruction about radio, has been brought up to date so as to cover the fundamental principles of all radio transmitting and receiving apparatus. While, by courtesy, it still bears the name of Admiral Robinson, the revision has been done by Commander S. C. Hooper and his staff of technicians. It is unusually clear in treatment and constitutes the best all-'round reference book on the subject yet published. The mathematics used does not extend beyond algebra and trigonometry. It covers both theory and practice and should be of special value to the amateur and commercial operator. Its explanation of vacuum tube and arc equipment is particularly lucid. Its explanation of loop phenomena is the most complete yet published. The arrangement is logical and well adapted to home study as many problems are worked out by example. The treatment is non-commercial and unbiased.

"Standard Electrical Dictionary," by Prof. T. O'Connor Sloane, 790 pp. 5x7, 497 illustrations. Published by The Norman W. Hanley Publishing Co., New York City. Price, $5.00.

This new edition of an old standard reference book also contains a dictionary of radio terms. It gives concise definition of about 6,000 words and terms employed in electrical application. The definitions are so clearly given as to be understandable to a layman. It is good not only for reference but also for consecutive reading so as to secure a general knowledge of electrical science.

Catalog 101 from the Radio Division of the Peerless Light Co., Chicago, Ill., is devoted to illustrations and descriptions of a wide variety of radio sets, kits, accessories and parts for which they are distributers.

Publication X-7 from the Cutler-Hammer Mfg. Co., of Milwaukee, Wisc., describes the entire line of C-H radio products including such items as the new low-loss sockets, the Radiolve and parts for receiving and transmitting equipment.

Bulletin No. 160-W from a Federal Telephone Mfg. Corp., of Buffalo, N. Y. illustrates and describes the complete Federal line of radio telegraph and telephone apparatus. New items described include the No. 94 tuner, large capacity condensers potentiometers and battery switch.

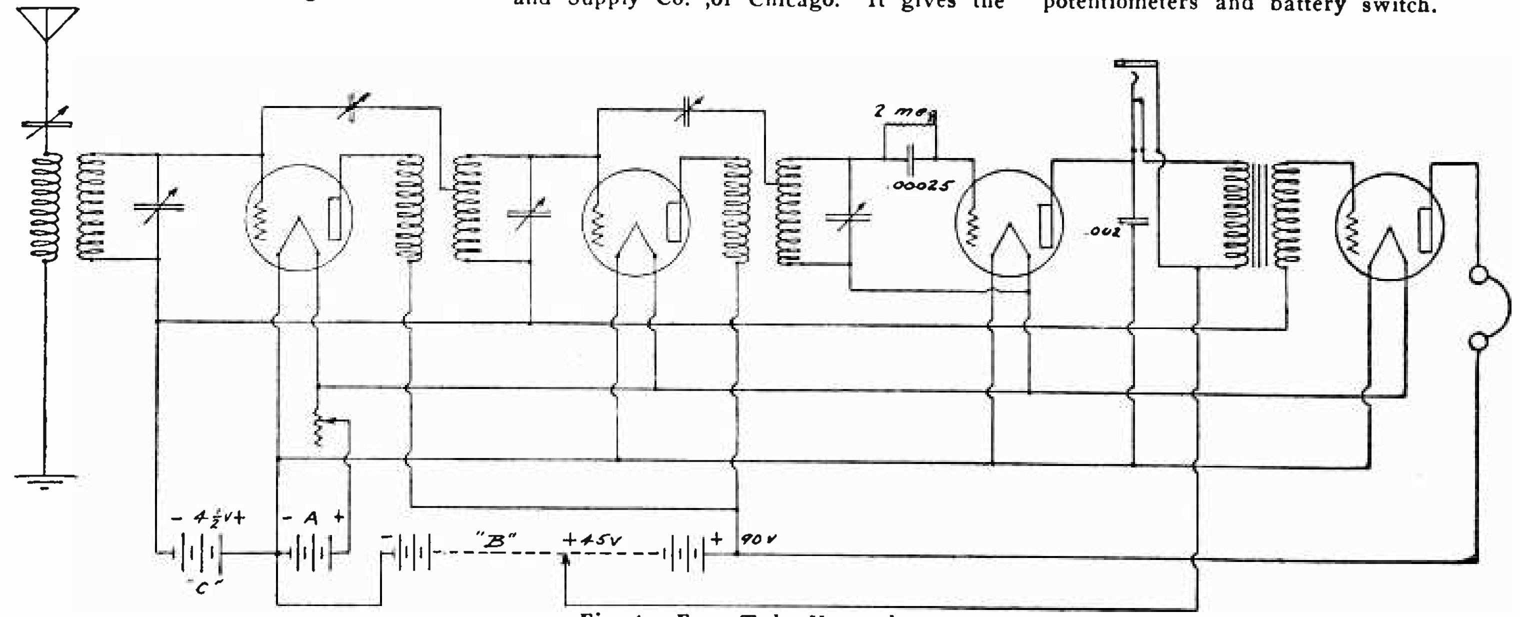


Fig. 4. Four Tube Neutrodyne

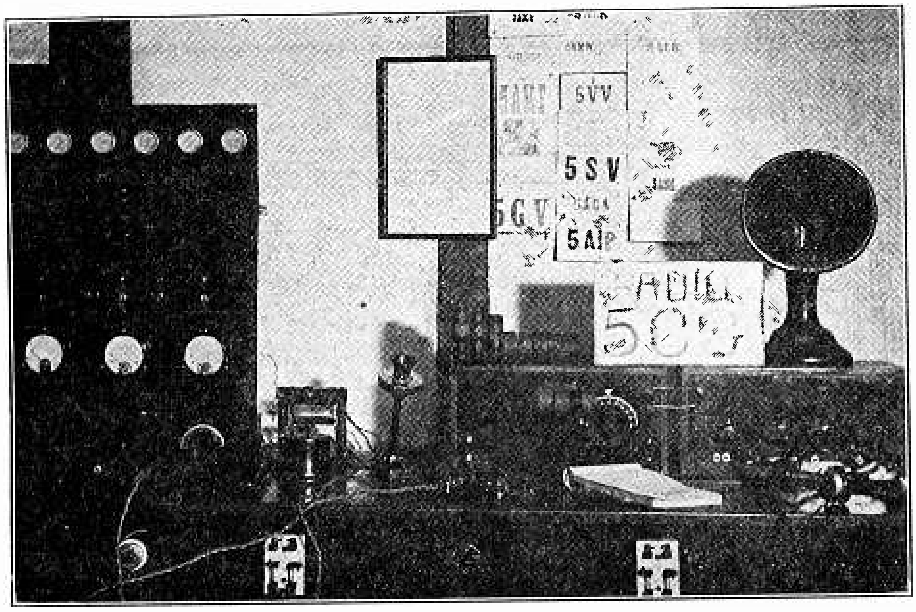
With the Amateur Operators

9CMK has been assigned to Bryce E. Warner, 841 E. Burnett Ave., Louisville, Ky., who is using 15 watts CW on 180 meters.

8PS, H. C. Heiss, 9506 Columbia Ave., Cleveland, Ohio, has been reported as heard by English 6ZX when using 10 watts. He will appreciate reports from the Pacific Coast.

4XE, Wm. J. Lee, Winter Park, Florida, is q r v for experimental work on 12 to 50 meters and for traffic on 80 meters. He has worked NZ2AC and NZ4AA after sunrise in Florida. A 150-watt master oscillator is used on 81 meters with 4.5 amp. antenna current. A 50-watt Hartley operates on 41.5 meters.

1AFJ has been assigned to LeRoy Johnson, 31 Perrine Ave., Pittsfield, Mass.



Radio Station 5CB

Call 5CG has been assigned to J. M. Patterson, 601 North F St., Hugo, Oklahoma. He is using the Hartley circuit in a 20-watt C. W. transmitter, with 550 volts and 200 millis. on the plate and an antenna current of 2.5 amps. For 'phone 15 watts are used as oscillator and 10 watts as modulator in Heising circuit. 5CG is q r v for traffic, and will promptly acknowledge report of signals.

Call 1AMU has been reassigned to Franklin Rowell, 106 Cedar St., Pawtucket, R. I., who is operating 5 watts on 40-43 and 75-80.6 meters.

1AHJ has been assigned to Pawtucket High School, Pawtucket, R. I., with J. B. Rowell as senior operator and J. Clarkin as junior; 5 watts, 75-80.6 and 150-200 meters.

8TZ has been assigned to Guy Smith, Sunburg, Pa.; 5 watts, c. w. and 'phone, all cards ASL'd.

5QD has been assigned to the Alpha Sigma Delta National Radio Fraternity, Stillwater, Okla. The Alpha Sigma Delta is a national college radio fraternity now having three active chapters, the Alpha Chapter being at the University of Oklahoma at Norman, Oklahoma, the Beta Chapter at the Agriculture and Mechanical College at Stillwater, Okla., and the Alpha Lamba Chapter at the Mass. Institute of Technology. Only college and universities are qualified to petition the Alpha Sigma Delta.

6ZD, Allen H. Babcock, Berkeley, Calif., attended the session of the American Section of the International Union of Scientific Radio Telegraphy at Washington, D. C., upon the invitation of the National Research Council.

WORK WITH AUSTRALASIA

By 6AWT,

653 Union St., San Francisco, Calif.

Date	Worked	Time
Nov. 13	Z-4AG	6:09 a.m.
Nov. 14	Z-2AC	12:04 "
Nov. 14	Z-4AA	2:04 "
Nov. 17	Z-4AK	1:42 "
Nov. 19	Z-4AA	1.34 "
Nov. 24	Z-2AP*	12:32 "
Nov. 24	A-2CM	2:00 "
Nov. 27	A-3BQ	4:11 "
Nov. 27	Z-2AC*	6:54 "
Nov. 28	Z-2AC	4:27 "
Nov. 28	Z-2AC	5:15 "
Dec. 4	Z-2AC	1:52 "
Dec. 5	Z-2AC	1.12 "
Dec. 6	Z-2AC	12:13 "
Dec. 8	Z-2AC	1:01 "
Dec. 13	Z-2AC	1:45 "
Dec. 15	Z-2AP	1:50 "
Dec. 15	A-2YG	3:00 "
Dec. 15	A-3BQ	4:10 "
Dec. 15	Z-4AK	4:58 "
Dec. 16	A-2DS*	3:00 "
Dec. 17	Z-4AA*	1.05 "
Dec. 17	Z-2AC	3:10 "
Dec. 19	Z-4AG	1:40 "
Dec. 24	Z-4AA	4:20 "
Dec. 25	Z-4AA	2:00 "
Dec. 25	Z-2AC	4:27 "
Dec. 25	A-2DS	5:15 "
Dec. 25	Z-4AG	7:45 "
Dec. 28	A-2BX	3-4:00 "
Dec. 28	A-3BD	5-5:50 "
Dec. 28	A-2YI	6-6:20 "
Dec. 28	Z-2AC	6:50 "

Remarks

Work done on one 250-watt tube putting 5 amperes into antenna at 80 meters.

*Means stations also worked on 6AWS. 1 amp. 150 watts input. On Dec. 13 at 1:45 a.m. connected Z2AC and M BX together. In all 25 messages were handled. On Dec. 25 worked Z2AC from 6:50 a.m. till 7:47 a.m. It was daylight at 7:00 and the sun rose at 7:45 a.m.!!!

By 6BLT-6BNH, Geo. H. Smith, Route A. Box 120, Ceres, Calif.

1axz, 2by, 4io, 4jr, 4my, 5aiy, 5ajh, 5ao, 5gu, 5kw, 5lh, 5ls, 5ms, 5oq, 5ql, 5qy, 5sb, 5se, 5vm, 6acl, 6bip, 6buh, 6bui, 6rv, 7ads, 7afo, 7afw, 7aip, 7ajv, 7aj, 7dd, 7di, 7fg, 7fr, 7gb, 7gj, 7ho, 7ii, 7io, 7iy, 7ku, 7lr, 7ma, 7mf, 7nd, 7ol, 7qd, 7sf, 7un, 7uv, 7ze, 7zq, 8bal, 8ak, 8cp, 9acp, 9aey, 9amx, 9awo, 9axx, 9bdf, 9bhv, 9bnk, 9bva, 9bzj, 9caa, 9cld, 9dev, 9dfg, 9dge, 9dkv, 9dqu, 9dxw, 9eam, 9efo, 9eht, 9ejh, 9fo, 9jh, 9nv, 9xi.

Canada: 5bf, ucc, 5bz, cr, 5go, nkf, nst, nsw, vnn, wgh, ksa.

By 7SY-7PD, 345 Mill St. Eugene, Oregon

1fd, 1gv, 1kc, 1my, 1pl, 1sf, 1apu, 1aww, 1bgq, 1bis, 1cmp, 1xam, 2ag, 2by, 2cg, 2kf, 2aay, (2anm), 2brb, 2cjj, 2czr, 3hh, 3ot, 3zw, 3adp, 3alx, 3bdo, 3bhv, 3bof, 3bov, (4ai), 4eh, 4eq, 4fz, 4io, 4mi, 4si, (4sb), 4tj, 5am, 5au, 5dm, 5dw, 5ek, 5ew, 5fc, 5fo, 5hl, (5in), 5jf, (5li), 5lu, 5mi, 5ph, 5oq, 5ot, (5ov), 5ql, 5qy, 5rh, 5sd, 5sf, 5uk, 5za, 5aaq, 5acm, 5aef, 5adh, 5afn, 5agj, 5aex, 5ahd, 5aiu, 5ajh, 5ajj, 5aju, 5alz, 5amw, 5amg, 5apg, 5zav, (6rv), (7oy), 8ah, 8fm, 8gz, 8nb, 8pl, 8rg, 8tr, 8zg, 8zz, 8ada, 8apn, 8ajn, (8bau), 8bbf, 8bhu, 8bos, 8bsv, 8buk, 8bxh, 8byn, 8cjd, 8cnw, (8cse), 8ctz, 8cyi, 8dgb, 8dhw, (8doo), 9em., 9es, 9hm, 9mf, 9mn, 9ny, 9qw, 9rd, 9vz, 9xi, (9yb), 9zd, 9zt, 9adc, 9aim, 9aau, 9abf, 9amx, 9aod, 9aoi, 9aws, 9bcd, 9bcj 9bdq, 9bhd, 9bht, 9bhx, 9bje, 9bkr, 9bmu, 9bmv, 9bmx, 9bnf, 9bnk, 9bof, (9bvz), 9bye, 9cbf, 9cej, 9cfi, 9cfy, 9cii, (9cip), 9cir, 9cjc, 9cjs, 9cju, 9cjy, 9cld, 9cmk, (9cov), 9cpm, 9epv, (9ctr), 9cvo, 9cvs, (9cxx), 9dct, 9ded, (9dfh), 9dfq, 9dhl, 9dix, 9dlw, 9dms, 9dng, 9dnv, 9dqu, 9dun, 9dvg, 9dvp, 9dxw, 9eae, 9eak, 9efh, 9efy, 9efz, 9egu, 9ehs, 9eld, 9xbg, 9bm, nerk, nfv, wgh.

Canadian: 2be, 2bg, 2cg, 4aj, (4ax), 4cb, 4dq, 4fv, 4gh, 5af, (5an), (5bf), (5cn), (5ds), (5hg).

Reports on my sigs appreciated. All cards ansd.

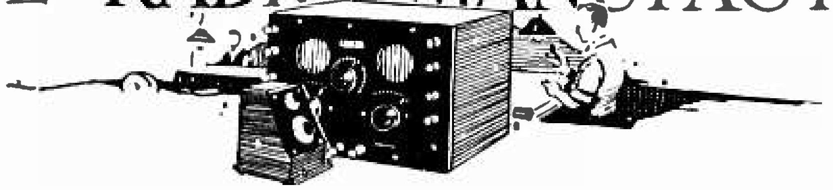
By Vernon Holmes, 2114 Grandview Blvd., Sioux City, Iowa

1aac, 1aal, 1 abf, 1abl, 1aea, 1afn, 1agg, 1aid, 1ana, 1ar, 1asi, 1atj, 1awe, 1bcu, 1bdn, 1bep, 1bgq, 1bip, 1bjp, 1bkq, 1blx, 1bvl, 1bvs, 1cak, 1ckp, 1cln, 1cme, 1cmx, 1cpn, 1er, 1fd, 1ga, 1gu, 1if, 1ii, 1iv, 1kc, 1ml, 1my, 1ow, 1py, 1sf, 1sz, 1te, 1xw, 1xz, 2aan, 2aay, 2acf, 2adj, 2ahw, 2anm, 2axf, 2axq, 2bco, 2beo, 2bgg, 2bof, 2bqb, 2bqw, 2brb, 2cdp, 2cil, 2cqz, 2dn, 2ef, 2kd, 2kf, 2ku, 2ld, 2mc, 2mu, 2pd, 2tp, 2wc, 2xq, 3acc, 3adb, 3aec, 3alx, 3aus, 3auv, 3avk, 3bdo, 3bhv, 3bmn, 3bof, 3cav, 3cbl, 3cdg, 3chg, 3ckj, 3eh, 3hs, 3js, 3kq, 3lr, 3ly, 3og, 3oq, 3rl, 3sl, 3wn, 3xi, 4ai, 4cl, 4cr, 4du, 4he, 4eq, 4fs, 4io, 4ke, 4nc, 4nr, 4pi, 4qf, 4rr, 4rs, 4sa, 4sx, 4sz, 4tj, 4uk, 4ux, 4vn, 4vl, 4xe, 4xx, 4zd, 5aaq, 5abn, 5ac, 5add, 5adh, 5adi, 5ads, 5agq, 5ags, 5aib, 5aij, 5ajh, 5ame, 5anl, 5ano, 5api, 5aqc, 5arn, 5be, 5bj, 5ek, 5ew, 5gw, 5iy, 5iz, 5jh, 5ju, 5kq, 5li, 5lu, 5mi, 5ml, 5oq, 5ot, 5ov, 5ph, 5ru, 5uk, 5vv, 6aao, 6alv, 6apw, 6arb, 6bft, 6bgc, 6bjj, 6bka, 6bqr, 6bur, 6cgw, 6cig, 6cmu, 6fy, 6ne, 6rm, 6vf, 6vw, 6xbn, 7ahs, 7gk, 7gr, 8acm, 8add, 8ahl, 8aju 8alf, 8alw, 8amr, 8aol, 8ase, 8atp, 8ayk, 8bbi, 8boy, 8bp, 8bqr, 8bvu, 8byn, 8caz, 8cbx, 8ccq, 8cdt, 8cjd, 8cyi, 8dal, 8dfn, 8dhw, 8dmt, 8dnv, 8dpn, 8ef, 8fd, 8gz, 8hj, 8hn, 8kc, 8pl, 8px, 8rg, 8rv, 8tr, 8up, 8xs, 8zd, 8ze, 8zg, 8zz, 9aad, 9aav 9abf, 9ado, 9aho, 9ahq, 9aod, 9axt, 9axx, 9ays, 9azd, 9bga, 9bhx, 9bje, 9bji, 9bjl, 9bkr, 9bkx, 9bmj, 9bmu, 9bmx, 9bnu, 9brx, 9bso, 9buk, 9bva, 9bvn, 9bvz, 9bxg, 9cap, 9cbf, 9cbk, 9ccm, 9cdv, 9cfi, 9cfy, 9cga, 9cii, 9cju, 9clj, 9cpq, 9cyk, 9dac, 9dfh, 9dia, 9dqu, 9dsa, 9dtx, 9dwk, 9dxn, 9dvy, 9eas, 9efy, 9egg, 9egu, 9ehy, 9eih, 9ek, 9eky, 9elv, 9elx, 9es, 9fe, 9fk, 9hn, 9ih, 9mn, 9ny, 9pj, 9qu, 9rd, 9vz, 3xi, 9xw, 9zd.

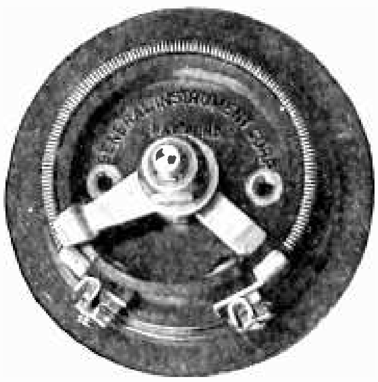
Cards sent to all who QSL.

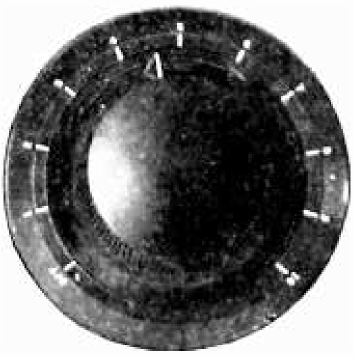
Continued on Page 44

FROM THE RADIO MANUFACTURERS



The General Instrument Rheostat is provided with a fixed bakelite panel dial (held in position by the screws that hold the rheostat proper) so that the operator may know the relative position of his contact arm. The contact arm, with its auxiliary spring, bears down firmly upon the resistance winding so that there is no tendency of the contact arm to dig into the wire and cause a non-microphonic contact. The rheostat comes in three parts; the knob, the dial and the base proper. The shaft of the knob ends in a small chucklike device on the back of the instrument and the mere tightening





of a nut with the fingers is sufficient to hold this member in place. Brass inserts threaded to receive 6 32 machine screws are imbedded in the bakelite base. The instrument (of bakelite throughout) is made to accommodate any panel up to a thickness of 3 8 inch, and no tool save a screw driver is needed to attach it. A high heat, non-rusting resistance wire is used and winding of 6, 20 and 30 ohms may be had. Potentiometers of 200 and 400 ohms resistance are also available in the same style.

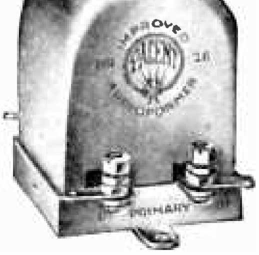
The Flewelling Uniformer is an audio frequency transformer with terminals placed

so that a Flewelling socket may be mounted directly on two transformers. This permits the construction of a 6 or 8 tube set with but three bus wires, two for the *A* and one for the *B* battery. This not only gives a compact neat assembly but also increases the sharpness of tuning, prevents feed-back and removes loss-producing elements.

The Type 285 General Radio Transformer has been designed to give maximum amplification at extreme high and low audio frequencies with an improved quality of tone throughout the entire range. This has been accomplished by using more turns in a larger core made of high grade steel.

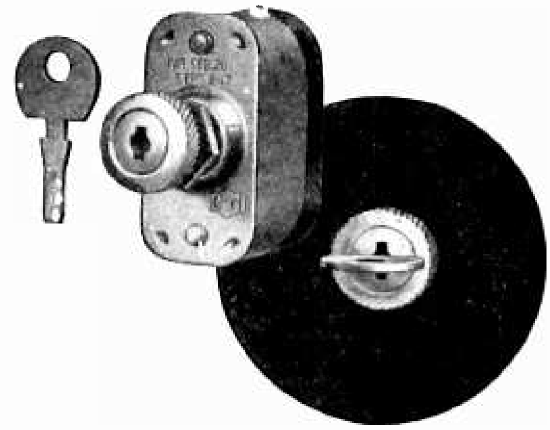
Its efficiency is so great that it is claimed to give more volume than two stages of the ordinary transformer. Its impedance has been designed to match that of the associated tube.

The Pacent Improved Audioformer is a 3½ to 1 ratio audio frequency transformer designed to give an exceptionally high degree of amplification over the entire band of sound frequencies. It is handsomely mounted in a nickeled brass case grounded to the base so as to shield the windings. Perfect connections are obtained by first soldering the coil ends to the soldering tabs and carrying this thru bakelite strips that run through the case to the binding posts.



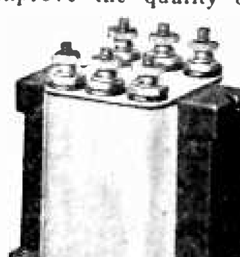
They are conveniently located at the bottom to keep the wiring close to the base below the level of the sockets.

The Cutler-Hammer "Radioloc" is an *A* battery switch with a key which locks it. This protects the batteries from being run down or the tubes burning when the set is not in use and provides a convenient means of interrupting reception without loss of station. The set is "on" when the key is in the slot and "off" when the key is removed. It is easily installed, requiring but one hole in the panel. The switch mechanism is direct and firm, insuring quiet operation.



Broad contact surface assure high efficiency and freedom from noise.

The Thordarson Interstage Power Amplifying Transformer has been designed for use between a pair of standard input and output power amplifying transformers so as to inprove the quality of reception.

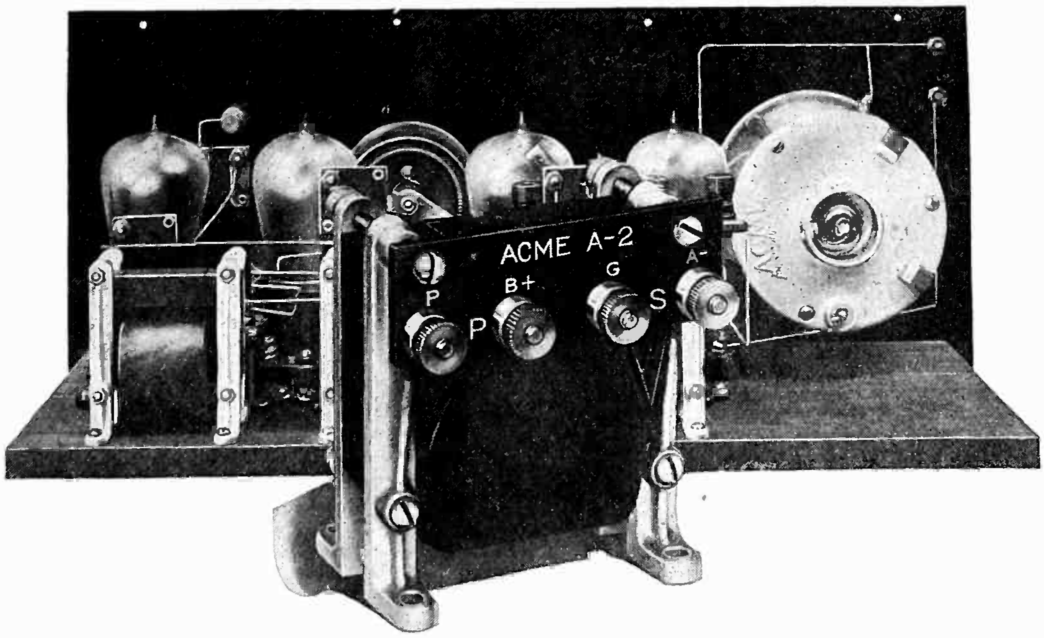


Two stages of this power amplification requires the use of four tubes. Wiring diagrams and directions are supplied by the manufacturer with each transformer.

The 3X-P Grimes Inverse Duplex is a three-tube set giving two stages of radio and three stages of audio frequency amplification with a fixed crystal detector. It has three tuning controls. It is simple and economical in operation, sensitive and selec-

tive, and has fine tone quality. It is designed for operation with an aerial and ground.

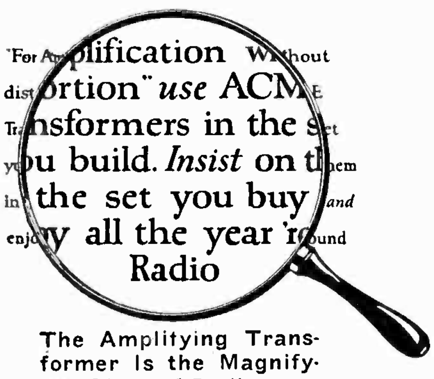
You can give your set this big advantage—



Amplification without Distortion

How to make sure of getting everything loud and clear

YOU can make your set so that it will reproduce clearly and distinctly without distortion. The real pleasure in radio comes when you can understand and enjoy what you hear—voices that are natural—music that is clear in tone. In order to hear clearly and distinctly you want to be sure that you are using amplifying transformers that amplify the sound without distorting it.



The Amplifying Transformer Is the Magnifying Glass of Radio.

Give your set this big advantage—Amplification without Distortion. Whether you have a neutrodyne, super-heterodyne, regenerative or reflex the addition of the Acme A-2 Audio Amplifying Transformer will make it better.

The Acme A-2 has become famous among radio owners for increasing the volume of sound without distorting. It has improved thousands of radio sets. If you are bothered by distortion, try an Acme A-2 and note the difference.

Each transformer is tested and carries a guarantee tag. If you want Amplification without Distortion use Acme Transformers in the set you build and insist on them in the set you buy. (That's one of the big reasons why the Acmeflex Kit-set gives such good results—it uses Acme Transformers). Send for our 40-page booklet which explains how to get the best results by proper amplification and also contains a number of valuable wiring diagrams. It will help you build a set. Mail the coupon with 10 cents.

ACME APPARATUS COMPANY
Tranformer and Radio Engineers and Manufacturers
Dept. 86, Cambridge, Mass.

Have the fun of making your own Radio Set

ACME
~ for amplification

ACME APPARATUS COMPANY,
Dept. 86, Cambridge, Massachusetts
Gentlemen:
I am enclosing 10 cents (U. S. stamps or coin) for a copy of your book "Amplification Without Distortion."

Name ....
Street ....
City .... State ....

Continued from Page 41

By 6CLP, Box 64, Empire, Calif.

1aac 1ajp, 1ap, 1bcc, 1bgc, 1bgq, 1bkq, 1bvl, 1cmf, 1er, 1fd, 1gv, 1kc, 1my, 1ow, 1py, 1qp, (1sf), 1te, 1xav, 1xm, 1xw, 2aay, 2ana, (2brb), 2cdg, 2cjj, 2cvu, 2cxl, (2czr), 2dn, 2gk, 2kj, 2mu, 2pd, 3alx, 3bab, (3bdo), 3bhv, 3bsv 3bta, 3bwj, (3ab), 3hh, 3nf, 4cr, 4du, 4eh, 4fg, (4fs), (4io), 4ka, 4ku, 4oa, 4pi, 4qf, 4rr, 4sa, 4tj, (4xe), 5aai, 5abe, 5acl, (5aex), (5afn), 5agl, 5agq, (5aij), (5ajh), (5ajj), (5ame), (5amo), 5apg, 5aph, 5as, (5dw), 5ka, 5kq, (5mi), (5mz), (5nw), 5oq, (5ot), (5ov), (5ox), 5ph, 5ru, (5uk), 5wy, 5za, 8add, (8aly), 8apw, 8atp, (8bau), 8bjv, (8bpa), 8bxh, 8caz, 8cei, 8cyi, 8dhw, 8doo, 8ah, 8ef, 8fm, 8gz, 8ld, 8pl, (8tr), 8wo, 8xb, 9agl, (9aju), (9azr), (9bcd), (9bcj), 9bfg, (9bjl), 9bjy, 9bkx, (9bmx), (9bnf), 9bpy, 9bvz, 9cap, 9cbk, (9ccm), 9ccx, (9cdo), (9cfi,), 9cfy, (9cjc), 9cju, 9cld, (9clq), 9cqq, (9ctr), (9cxx), 9dct, 9ddp, (9ded), 9dfh, 9dfq, 9dfz, 9dmj, (9dng), 9dnv, (9dyt), (9dxn), 9efy, 9ekl, 9eld, 9eli, 9bm, (9em), 9es, (9vz), 9yb.

Canada.—1ar, (2ax), 2cg, 4cr, (5an).

New Zealand.—2ac, 2ap, 4aa, 4ag, 4ak.

Australian—3bq.

Mexico.—bx, 1b.

U. S. Government.—NFV, NKX.

All cards answered. Please QSL my 5 Watts.

By H. C. C. McCabe, 71 Holloway Road, Wellington, N. Z.

U.S.—1cmp, 1sf, 1pl, 1mv, 1ow, 2cz, 5hl 5dw, 5ox, 5za, 5mi, 5uk, 5go, 5amf, 6ac, 6bra, 6buo, 6vw, 6bcr, 6cgo, 6arb, 6age 6bqr, 6aem, 6css, 6ase, 6cej, 6vo, 6of, 6apw 6cto, 6vc, 6bcp, 6bca, 6bwl, 6cmu, 6cdn, 6bdt, 6ct, 6gt, 6bt, 6agk, 6cgw, 7ij, 9bjl, 9bm, 9xi, 9dma, 9cjc, 9eky.

Naval.—NKF heard about 100 meters calling Z4AA at 7:10 p. m., N. Z. time, on October 25th.

Special.—WGH. (Don't know who this chap is).

English.—2od, 5nn.

French.—8ab, 8sm.

By 6BDH, Box 494, Blythe, Calif.

1aac, 1aay, 1aja, 1ajo, 1axz, 1cmp, 1fd, 1fv, 1gv, 1kc, 1lw, 1ow, 1py, 1wl, 1xam, 1yb, 2aan, 2ag, 2agk, 2ana, 2anm, 2brb 2bsc, 2cee, 2cei, 2cgb, 2cty, 2cvu, 2czr, 2eg, 2kf, 2ku, 2kx, 2rk, 2xq, 3adb, 3ade, 3adf, 3ajd, 3auv, 3bco, 3bjp, 3bmn, 3bof, 3bwj, 3bz, 3cdg, 3chc, 3chg, 3cjn, 3ckp, 3hg, 3mf 3ot, 4eq, (4fz), 4jr, 4ka, 4kt, 4ku, 4oa, 4si, 4tj, 4uk, 4xe, 5aaq, 5ac, 5acl, 5adh, 5aeq, 5aex, 5afu, 5ahd, 5ahj, (5aiu), 5aiy, (5ajb), 5ak, 5akh, 5akl, 5akx, 5alr, 5ame, 5api, 5apm, 5aqm, (5aqw), 5bj, 5ca, 5ce, 5dm, 5dw, 5ek, 5ew, 5ik, 5in, 5jf, 5ln, 5lu, 5mz, 5nw, 5oa, (5oq), 5ov, 5ox, 5ph, 5qj, 5qy, 5sd, (5se), 5uj, 5uk, 5ux, 5xa, 5xau, 5za, 5zav, 7abb, (7adm), (7afo), 7agn, 7ahs, 7ajt, 7akh 7di, 7fd, 7fm, 7fr, 7ge, 7ho, 7ij, 7jq, 7ku, (7lq), 7lu, (7ly), 7mf, 7mp, 7no, 7nt, (7ot), 7oy, (7qd), (7sp), 7sy, 7qz, 8acy, 8ah, 8alf, 8aro, 8ayu, 8bau, 8bf, 8bxh, 8cav, 8cea, 8ced, 8cp, 8cq, 8cxi, 8cy, 8cyi, 8dal, 8dgp, 8dnv, 8gq, 8gz, 8ih, 8lr, 8oe, 8pl, 8rg, 8tr, 8uf, 8up, 8yt, 8xk, 8aze, 8zt, 9aad, 9abf, 9aby, 9ado, 9afz, 9aim, 9aj, 9aju, 9anj, 9arr, 9asq, 9avj, 9avv, 9axs, 9axt, 9axx, 9bcj, (9bdf), 9bdu, 9beg, 9biq, (9bht), 9bje, (9bm), 9bmu, 9bma, 9bnf, 9bnk, 9boa, 9bvz, 9bwb, 9caa, 9cap, 9ccm, 9ccs, 9cdv, 9cfr, 9cfy, (9cip), 9cju, 9cjy, 9ckj, 9ckv, 9cp, 9cpm, 9csg, 9ctg, 9cvf, 9cvn, 9cvo, 9cxx, 9dap, 9db, 9dbj, 9dee, 9deu, 9dev, 9dfv, 9dge, 9dkr, 9dkv, 9dlo, 9dms, 9dpu, 9dun, 9dwx, 9eak, 9efh, 9eky, 9ely, 9ep, 9ev, 9hn, 9lb, 9nv, 9vd, 9zd, 9zt, NKF.

Canadian.—2be, 3bp, 3oo, 3zt, 4cr, 4io, 5an, 5bz, 5go.

New Zealand.—2ac.

Mexican.—1k, 1b.

Argentine.—CB8, LPX.

By 6CIX, Robert Amsbury, 317 N. Friends Avenue, Whittier, Calif.

(1are), 1awe, 1bvl, 1cme, 1er, 1fd, (1ga), 1my, 1ow, 1qp, 1sw, 1vj, 2aqs, 2brb, (2cqz), 2cvk, 2cvs, 2cvu, 2kf, 2mu, (3ade), 3adp, 3adq, 3aih, 3avv, (3bhv), 3bue, 3chg, 3ckl, 3hh, (3jo), (3oq), 3sf, 4eh, 4fz, 4io, 4iz, 4mi, 4oa, (4si), 4tj, 4uk, (5aaz), 5acl, 5aef, 5aex, 5afu, 5ahd, 5ail, 5aiu, 5asz, 5zav, 5be, 5cm, 5ew, 5hd, 5in, 5ka, 5lu, (5ox), 5ph, 5qy, 5rg, 5sd, 5se, 5to, 5uk, 5ul, 5vv, (6cek), (6clz), 7afn, 7afo, 7agi, 7ajy, 7bj, 7fq, 7fr, 7gb, 7gq, 7gr, 7gu, (7ho), 7ij, 7ku, 7lq, 7ly 7ls, (7mf), 7nx, 7oy, 7pm, 7qd, 7zq, 7zz, 8ala, 8aro, 8atp, 8ayu, 8bau, (8bnh), 8cse, (8cyi), 8cci, 8dal, 8fm, 8ge, 8gz, 8jq, 8kc, 8lr, 8pl, 8sn, 8vq, 8yv, (8ze), 9aau, 9abq, 9aey, 9aim, 9bcj, 9bdu, (9bht), 9bji, 9bhx, 9bgh, 9bkr, 9bmf, 9bmh, 9bnu, 9ccm, 9cdv, 9cee, 9cer, 9cfy, (9cip), 9cju, 9cpm, 9ctg, 9ctr, 9cvo, 9cvs, 9cyk, 9cwx, 9ckl, 9daw, 9ded, 9dix, 9dms, 9dng, 9dqh, 9dqu, 9dxm, (9dyt), 9egh, 9ehs, 9eky, 9bm, 9ek, 9ei, 9es, 9hk, 9hn, 9mm, 9mn, 9nq, 9ny, 9qw, 9wx, 9xi, 9zt, kdka, nkf.

Mexican.—bx, 1b.

Canada.—3ly, 4bp, 4io, 5an, 5gf, 5go, 5mn, 5al.

New Zealand.—2ac, 4aa.

Continued on page 46

Continued from page 44

By 6CLZ-6COW, 1045 Peralta Ave., Berkeley, California

1aac, 1abf, 1abs, 1ana, 1aie, 1ary, 1atj, 1aww, 1bhm, 1bie, 1bip, 1bkq, 1bsd, 1bvl, 1cak, 1cbr, 1ckp, 1cme, 1cmp, 1bv, 1er, 1gs, 1ld, 1kc, 1my, 1ow, 1pl, 1sf, 1wf, 1xae, 1xam, 1xz, 2afp, 2ana, 2anm, 2bgi, 2bgo, 2bqc, 2bqu, 2brb, 2bsc, 2cee, 2cgi, 2chk, 2cjj, 2cpa, 2cpk, 2cvj, 2czr, 2ag, 2br, 2by, 2dn, 2kr, 2ku, 2mu, 2pd, 2rk, 2xi, 2xq, 3adq, 3aih, 3ajd, 3bhv, 3ccx, 3chg, 3chk, 3cjn, 3ab, 3hg, 3hh, 3ll, 3sf, 3wb, 3wu, 3yo, 4bq, 4gw, 4io, 4jr, 4kl, 4ku, 4oa, 4tj, 4xe, 5aaq, 5acx, 5aex, 5afu, 5ahd, 5aij, 5ail, 5aiu, 5ajh, 5akn, 5ame, 5amw, 5aoj, 5aqw, 5asi, 5ap, 5ca, 5cn, 5cv, 5dm, 5dw, 5ek, 5ld, 5in, 5ka, 5lh, 5li, 5lu, 5mi, 5nw, 5oq, 5ox, 5ph, 5qy, 5sd, 5se, 5uk, 5xau, 5za, 5zal, 5zav (too mani 6's es 7's), 8ada, 8adg, 8adk, 8ads, 8afn, 8agm, 8ago, 8ame, 8amr, 8aro, 8atp, 8ayu, 8bau, 8bbf, 8bdk, 8bjv, 8bqr, 8btf, 8buk, 8cbp, 8ced, 8cko, 8cyi, 8dae, 8dal, 8dgp, 8dnw, 8dme, 8dnf, 8doo, 8dse, 8ah, 8bo, 8cp, 8gz, 8hn, 8jq, 8kc, 8pd, 8pl, 8rj, 8rv, 8ry, 8tr, 8up, 8vq, 8xav, 8yv, 8ze, 8zk, 9abf, 9aby, 9adq, 9aen, 9alm, 9alo, 9amb, 9amx, 9asw, 9auy, 9awe, 9axs, 9axx, 9bag, 9bcj, 9bdf, 9bdw, 9bfg, 9bgh, 9bht, 9bhx, 9bkb, 9bmu, 9bmx, 9bnk, 9bof, 9bpy, 9brx, 9bso, 9bye, 9caa, 9caj, 9cbz, 9ccs, 9cdv, 9cea, 9cee, 9cfi, 9cgd, 9cgx, 9cli, 9cip, 9cju, 9cjy, 9ckb, 9cpm, 9ctr, 9cvo, 9cvs, 9cyx, 9dac, 9ddp, 9ddv, 9ded, 9dev, 9dfh, 9dge, 9dvg, 9dit, 9dmj, 9dng, 9dqu, 9dtk, 9dyn, 9eak, 9eam, 9eas, 9eth, 9efy, 9efz, 9egh, 9eky, 9elb, 9ei, 9em, 9ep, 9es, 9hn, 9mc, 9mm, 9ny, 9sx, 9xbg, 9xl, 9yb, 9zb, 9zd, 9zt, nfv, nkf, wgh.

Canadian—3ad, 4cl, 4cr, 4io, 5ac, 5an, 5ba, 5bz, 5ef, 5gf, 5go.

Mexican—1b, bx. N. Z.—2ac, 4ak.

All cards gladly answered. pse QSL.

By 1AGS, L. Leslie Memaster, 36 Yale Avenue, Wakefield, Mass.

4du, 4eg, 4ig, 4io, 4is, 4jr, 4ko, 4ku, 4ly, 4mi, 4my, 4oa, 4pb, 4qy, 4sb, 4si, 4tj, 4un, 4uo, (4ux), 5acb, 5ags, 5ado, 5aec, 5aek, 5ajb, 5amu, 5am, 5apc, 5aex, 5aqy, 5bj, 5cn, 5ic, 5ln, 5jf, 5ls, 5lu, 5nn, 5mz, 5nw, 5ql, 5se, 5si, 5uj, 5uk, 5yd, 6ao, 6bm, 6fy, 6ol, 6rn, 6rv, 6abp, 6ahz, 6aib, 6alv, 6alu, 6arb, 6aws, 6awt, 6bbv, 6bny, 6cal, 6cch, 6cel, 6cgo, 6gw, 6chl, 6cix, 6clp, 6cmu, 6crs, 6cex, 6xad, 6zp, 7abp, 7afn, 7bd, 7dd, 7fq, 7gb, 7gm, 7go, 7gr, 7jq, 7ku, 7ig, 7ly, 7mp, 7pm, 7zz, 8aam, 8acm, 8ade, 8adm, 8afq, 8aig, 8ajf, 8ajq, 8apr, 8apu, (8arg), 8aub, 8awt, (8axd), 8axn, (8azw), 8bcu, 8bcw, 8bdk, 8bdw, (8ben), 8bfn, 8bgn, (8bhj), (8boa), (8boe), 8boq, 8boy, 8brl, 8bsm, 8bsu, 8bsw, (8bvr), 8bwk, 8bxp, 8byv, 8bzf, 8bzb, 8bxp, 8bzd, 8bzk, 8cbp, (8cbm), 8cci, 8cct, (8ced), 8cjp, 8cko, 8cse, 8cud, 8cuk, 8cyo, 8czy, 8daa, (8dal), 8dah, (8dae), (8dbm), (8dw), 8dcv, 8dfo, 8dfk, (8dhw), 8dgl, 8dgp, 8dgo, (8dgt), 8dhd, 8dhs, 8div, (8dki), 8dlm, (8dmr), 8dmz, 8dmk, (8dof), 8dog, 8doo, 8dph, 8dpk, 8dqv, 8dqp, 8drc, 8dsb, 8xbc, 8xbn, 8bn, 8bo, 8bv, (8dy), 8fu, 8jz, 8mt, (8or), 8tj, 8uf, 8vo, (8vg), 8wz, 8xe, (9ado), (9adq), 9aef, 9aen, 9agy, 9aio, 9aju, 9anf, 9aoe, 9aor, 9avp, 9axs, 9azw, 9bbr, 9bcj, 9bcm, 9beg, 9bhi, 9bhx, 9bmx, 9bnk, 9bpm, 9bpv, 9bid, 9bie, 9bw, 9bwb, 9bwx, 9bxi, 9caj, 9cax, 9cbz, (9ccj), 9cel, 9cfs, 9cgs, 9cht, 9cjc, 9cjy, 9ckl, 9cku, 9clg, (9clx), 9cpm, 9csg, 9cur, 9cvr, 9cwn, 9cxg, 9cxw 9cxx, (9dbj), 9dct, 9del, 9dev, 9dfv, 9dhi, 9dln, 9dlw, 9dmx, 9dmy, 9dng, 9doz, 9dq, (9dtt), 9duc, 9duj, (9dxl), 9dxr, 9dxy, 9dyt, 9eas, 9edh, 9eel, 9efj, 9efh, 9efz, 9egg, (9egh), 9eht, 9ej, (9eji), (9ejy), 9ekq, 9eky, 9elv, 9ep, 9es, 9ev, 9he, (9ib), 9lx, 9mc, 9mm, 9nv, 9ny, 9oa, 9qi, 9vz, 9ws, (9za).

Foreign calls: Canadian—2ax, (2fo), (3mp), 3wv, 3aec, 5go, 5bz. Cuban—dz. Mexican—bx. Argentine—cb8. English—2sz, 2kt, 2nm, 5sz. French—8bf, 8go. Hawaii—6bdt. New Zealand—4aa, 4ag, 4ak, 2ac. Australian—2ds. Dutch—pcii. Italian—ido. German—poz.

6AMO, Al Taggart, 4257 Telegraph Ave., Oakland, Calif.

1abf, (1ajp), 1are, (1awe), 1aww, (1axz), 1bd, 1bdx, 1bej, 1bky, (1cl), (1cmp), (1er), 1gv, (1lw), (1on), (1ow), 1yb, 1zt, (2atf), 2aqh, 2bm, (2brb), 2by, (2cee), 2cej, (2cpa), (2cvu), 2cws, 2cyq, 2kx, 2me, (2rk), 2wr, 3ab, 3adb, (3bg), 3bh, 3bhv, 3bj, 3bta, 3bva, 3bwj, (3cnc), (3chg), 3cjn, (3hh), (3jo), 3lg, 3mf, (3qt), 3sf, 3wb, 3yo, 4bq, 4fz, 4gw, (4io), 4kl, (4my), 4tj, 4ua, (4xe), 5aaq, (5acl), 5af, (5afu), (5ahd), (5alc), 5ail, 5aiy, 5ajb, 5ak, 5akn, 5ame, 5atx, 5cu, 5ef, (5jz), (5lh), (5ls), (5nw), (5ph), 5qy, (5sd), (5se), 5uo, 5uk, 5wa, 5wy, 5zal, 5zav, 6's es 7's, 8aa, 8as, (8abs), 8ada, 8aly, (8anb), 8bau, (8bbi), (8bnh), (8bpa), 8byd, (8byn), 8bva, (8cp), 8cy, 8cyl, (8dae), (8dal), 8dgf, (8dgp), 8doo, 8kc, (8pl), 8nb, 8rb, (8rv), (8ry), 9aai, 9abf, (9aby), 9acq, (9and), 9apa, (9axs), 9bav, 9bdf, (9bdw), 9bej, 9bfl, 9bhs, 9bht, 9bhx, 9bix, 9bkw, 9blk, 9bmk, 9bmv, 9bpy, 9bwy, 9caa, (9ccs), (9cds), (9cdv), 9ced, 9cfl, (9clp), 9cjc, (9cjy), (9ckb), 9clq, (9cpm), (9csg), 9cuc, 9cvs, (9cxx), (9cyx), 9dac, (9dan), 9ded, 9dev, 9dge, (9dlt), (9dmj), 9dnk,

Continued on page 48

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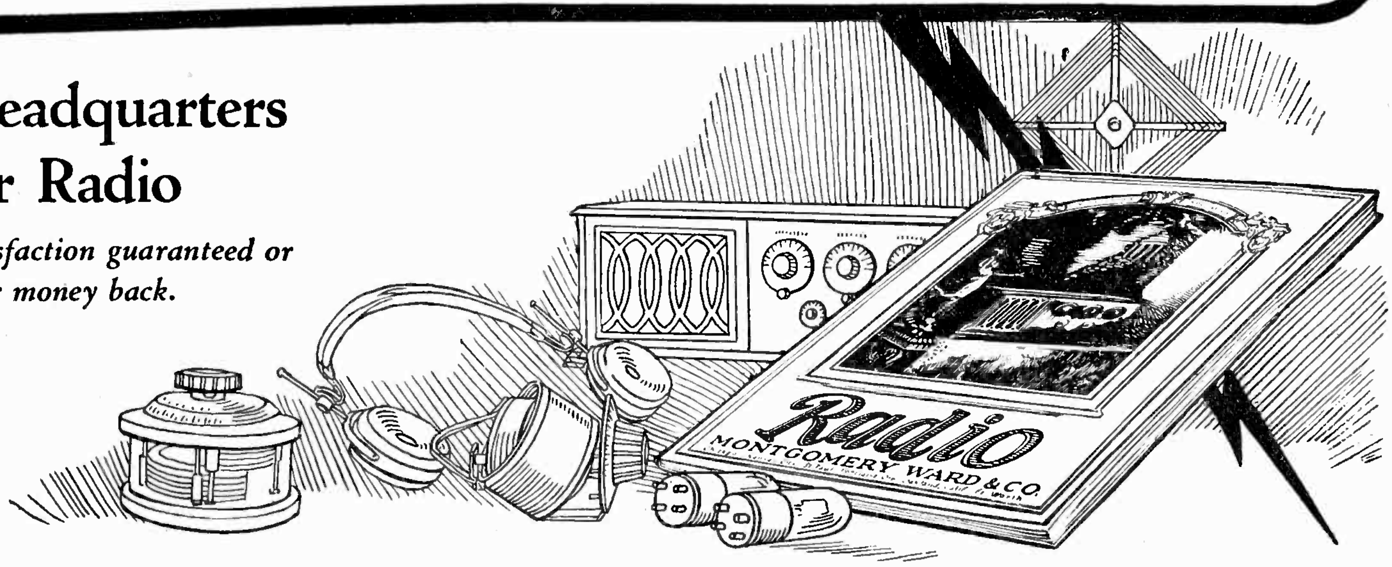

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Continued from page 46

9dpd, 9dpx, 9dqu, (9duo), 9dwx, 9eam, 9efh, 9eht, 9eky, 9bm, 9dm, 9ex, 9ny, 9wa, (9xl), 9zb, 9zp, 9zy, (9zt). Canadian—1br, (2be), (4cr), (4fv), (4gt), 4io, 4nf, 5af, (5an), 5ba, 5bz, 5ef, 5go. Mexican—1b, bx. New Zealand—4aa, (4ag). French—3ag. Please QSL as I answer all cards. QRK GANO?

At 9DMA, Caledonia, Minnesota

1aae, 1aac, 1aar, 1aau, 1aal, 1abf, 1abt, 1aid 1aii, 1aiv, 1ajg, 1ajo, 1ajw, 1akz, 1ana, 1aox, 1aqm, 1are, 1arc, 1ark, 1ary, 1atj, 1aww, 1ayt, 1bcu, 1bdw, 1bgq, 1bhm, 1bhn, 1bip, 1biq, 1bkq, 1bsd, (1bub), 1bvl, 1bzp, 1cab, 1cak, 1cbg, 1ccx, 1cg, 1cit, 1cln, 1cme, 1cmp, 1cmx, 1cqm, 1da, 1ef, 1ga, 1gv, 1hn, 1jg, 1kc, 1kr, 1ml, 1my, 1oi, 1ow, 1pl, 1py, 1sf, 1uw, 1vc, 1rd, 1xav, 1xm, 1xt, 1xz, 2aan, 2abj, 2aco, 2acs, 2adu, 2afo, 2afp, 2ag, 2agq, 2agw, 2ale, 2alg, 2amn, 2amo, 2av, 2axf, 2axq, 2ayp, 2bbr, 2bbn, 2bbx, 2bgg, 8bir, 2bl, 2bm, 2bmg, 2bo, 2bqb, 2bqo, 2bqu, 2bqw, 2br, 2brb, 2brc, 2bsc, 2bv, 2by, 2ca, 2cbg, 2cdf, 2cdv, 2cee, 2cg, 2cgl, 2cgj, 2chh, 2chk, 2cje, 2cjj, 2cjr, 2cpd, 2csl, 2cty, 2cva, 2cvu, 2cwa, 2cwj, 2cyw, 2czq, 2czr, 2dd, 2dn, 2fk, 2fl, 2gl, 2ha, 2ku, 2kx, 2mo, 2me, 2mu, 2qh, 2qs, 2rk, 2rr, 2ud, 2wc, 2wr, 2wz, 2zb, 3aaw, 3ach, 3ade, 3adp, 3adq, 3adv, 3aeq, 3ais, 3ajd, 3alm, 3auv, 3bel, 3bg, 3bhv, 3bjp, 3blb, 3bmn, 3bmt, 3bng, 3bob, 3bof, 3bpm, 3bpp, 3br, 3bss, 3bta, 3btu, 3bva, 3cb, 3ccu, 3ccx, 3cdq, 3cf, 3cgc, 3chc, 3chg, 3chk, 3cjn, 3ckj, 3csk, 3cr, 3gc, 3gy, 3hs, 3kd, 3kl, 3ll, 3mf, 3oq, 3pp 3qc, 3qv, 3qt, 3sf, 3tp, 3wb, 3xx, 3zo, 3zs, 4ai, 4cl, 4cr, 4do, 4eb, 4eh, 4eq, 4fg, 4ft, 4fz, 4io, 4js, 4ke, 4ku, 4ll 4oa, 4pd, 4qf, 4qy, 4rm, 4rr, 4si, 4tj, 4tw, 4uk, 4xe, 5aaj 5aaq, 5aaz, 5abn, 5ac, 5adh, 5aef, 5aeh, 5aek, 5aex, 5agh, 5agj, 5agl, 5agq, 5ahd, 5aib, 5ail, 5aio, 5aiy, 5ajj, 5ajn, 5ajt, 5akh, 5akn, 5alz, 5am, 5ame, 5amf, 5aom, 5apq 5api, 5asd, 5ash, 5atz, 5bb, 5ca, 5cm, 5cn, 5dw, 5ed, 5ek, 5ew, 5fc, 5fs, 5fv, 5gj, 5gk, 5hi, 5hl, 5hp, 5hu, 5hy, 5ii, 5in, 5jf, 5ju, 5ka, 5kn, 5kr, 5lh, 5lu, 5mi, 5ml, 5mo, 5oe, 5ov, 5ph, 5pi, 5qh, 5ql, 5qs, 5rh, 5ru, 5se, 5sd, 5uk, 5vv, 5wk, 5wt, 5yd, 5xau, 5za, 5zav, 5zai, 6ab, 6abc, 6ac, 6ach, 6afg, 6age, 6ahp, 6ajh, 6aji, 6alo, 6alv, 6ame, 6amm, 6apw, 6aqd, 6arb, 6ase, 6avb, 6awt, 6bas, 6bba, 6bbh, 6bcr, 6bdi, 6bfi, 6bgv, 6bip, 6bjj 6bjv, 6bka, 6bku, 6bnt, 6bph, 6bqr, 6bqu, 6buf, 6bvm, 6bwl, 6cct, 6cdc, 6cdg, 6cgo, 6chi, 6chl, 6cia, 6cje, 6ckj, 5cmi, 6cmu, 6cnl, 6com, 6cqe, 6cto, 6ew, 6gt, 6hk, 6ih, 6im, 6ji, 6jz, 6nx, 6of, 6qi, 6rn, 6ur, 6vc, 6vr, 6wi, 7abb, 7acf, 7adf, 7adl, 7agn, 7aha, 7ajt, 7ajy, 7ald, 7alk, 7ar, 7dd, 7gb, 7gs, 7ij, 7is, 7iu, 7jq, 7jr, 7ku, 7kz, 7mp, 7no, 7ot, 7ok, 7qc, 7qf, 7sl, 7uh, 7zq, 8ah, 8ak, 8ap, 8aeb, 8aee, 8aey, 8ago, 8agw, 8ahi, 8ahk, 8ahm, 8ajf, 8alg, 8alx, 8aly, 8amd, 8ans, 8aow, 8aro, 8arw, 8ase, 8asq, 8ava, 8axt, 8ayp, 8ayw, 8bau, 8bbf, 8bdk, 8bdw, 8bfe, 8bgo, 8bhp, 8bjz, 8bnm, 8bqa, 8bqn, 8bqr, 8btv, 8buy, 8bvr, 8bvu, 8bxs, 8bxt, 8bzf, 8cad, 8cae, 8caz, 8cbp, 8cci, 8ccn, 8ccr, 8ccx, 8cei, 8cej, 8cfm, 8cjp, 8cke, 8ckl, 8ckp, 8clc, 8cnz, 8coi, 8coj, 8cpf, 8cpp, 8cre, 8cse, 8ctz, 8cuk, 8czy, 8daa, 8dae, 8dac, 8dal, 8dcg, 8ddc, 8ddt, 8ddw, 8ded, 8dfb, 8dgm, 8dgv, 8dhw, 8dil, 8dme, 8dmf, 8dmr, 8dnf, 8doo, 8dou, 8dp, 8dpe, 8dpn, 8dnf, 8drs, 8dsn, 8fd, 8gh, 8gz, 8ii, 8jq, 8jz, 8ir, 8mm, 8nb, 8pl, 8rv, 8sp, 8up, 8vt, 8wo, 8xbc, 8xe, 8xw, 8zae, 8zg, 8zor.

Canadians—1ar, 1bq, 1dd, 1dq, 2be, 2bn, 2cg, 3aa, 3aec, 3ck, 3co, 3fc, 3fu, 3hg, 3ka, 3ly, 3sp, 3tf, 3ws, 3wx, 3zb, 3zl, 3zt, 4ae, 4cr, 4dq, 5ah, 5ak, 5bz, 5go, 9ad, 9bj. Comm.—Ncg, nfv, nkk, wgh, wwv, 6xl. English—Ger, 2ku, 2nm, 2yt. French—8ab, 8sm. Mexican—1b. Fones—3bhy, 5acu, 5ahw, 5ars, 5lj, 5ls, 5lw, 5qd, 7ahc, 8ayl, 8ayw, 8bca, 8bqn, 8brc, 8dat, 8dcf, 8lo, 9abx, 9aj, 9ajw, 9avt, 9ayq, 9bc, 9bdq, 9bft, 9bjj, 9bmk, 9bq, 9bwl, 9byc, 9byy, 9bzy, 9caa, 9cbr, 9clb, 9cop, 9cuh, 9dfc, 9dhl, 9dhy, 9dig, 9dlr, 9dmc, 9dpc, 9dpf, 9ebq, 9hx, 9my, 9pf, 9pq, 9tf, 9tz, 9uayl, 9wy, 9yau. Part of above heard on portable at St. Paul. Please QRK me Dec. 17 to Jan. 5. Will QSL all cards.

At 6BKU, 810 E St., Oxnard, Calif.

1ajx, 1are, 1avp, 1cmp, 1sp, 2ana, 2bum, 2brb, 2cpx, 3cde, 3cex, 3bel, 3sp, 3auw, 4fa, 4ft, 4rh, 4tw, 5abc, 5abo, 5ado, (5ak), (5are), 5af, (5gu), 5ht, 5ou, 5pq, 5qh, 5qu, 5vu, (6ceu), (7abb), (7adf), (7adg), 7aha, 7ald, 7dx, (7hb), (7ho), 7jn, (7lw), (7ok), (7ol), 7pz, (7qf), (7sp), 7uh, (7uj), 8alx, 8ams, (8bcu), 8bjz, 8blb, 8boc, 8bqa, 8bql, (8cci), 8ccw, (8czy), 8dat, 8db, 8ded, 8doj, 8dqn, 8ed, 8eh, 8wy, 9agl, 9ami, (9amp), 9and, 9aop, 9avv, (9ayq), 9bay, 9bbj, (9bcc), 9bde, 9beh, 9bhb, (9bio), 9buv, (9bxc), (9cde), 9ce, 9cld, 9cvn, 9cyq, 9czl, 9dkc, 9dsl, (9eac), 9ecl, 9efe, 9egs, 9elq, 9hp, 9lz, 9pb, 9ud,
Canada.—(5ba), 5fl.

Porto Rco—4je.

6BKU has plenty of qsl crds and wl answer ani es all crds promptly. Tri it and see. Pse let me kno if u hr mis igs.—Anx.

Continued on Page 88

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The De Luxe Haynes Super-Heterodyne

A. J. Haynes, Associate Institute Radio Engineers, designer of the new De Luxe Super-Heterodyne.

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Since the first appearance of the Haynes Simplified Super-Heterodyne in January, 1924, Mr. Haynes has concentrated on the development of a De Luxe Super-Heterodyne, one that would represent the last word in super-heterodyne construction for the man who builds his own. And now Mr. Haynes gives for the first time a complete description of the De Luxe Super-Heterodyne embodying the utmost selectivity and sensitivity—and with distance range limited only by location and atmospheric conditions.

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3	Haynes-Griffin .0005 Geared Vernier Condensers....each	$8.00
1	Rathbun 3-Plate Condenser	1.00
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1	Haynes Griffin 20 Ohm Rheostat	.75
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5	Hoosick Falls Type 199 Sockets....each	.50
1	Haynes-Griffin Type 91 Audio Transformer	5.50
1	Resistor Coupler (Daven)	1.50
1	Special Oscillation Coupler	3.25
1	Special Radio Frequency Transformer	3.50
1	Set of 4 Matched Haynes-Griffin Intermediate Wave Transformers	20.00
1	Type H-G 2 Input Condenser	1.75
2	.00025 mfd. Dubilier Condensers, with leak mtg....each	.45
1	.006 mfd. Dubilier Condenser	$ .75
2	.5 mfd. Dubilier Condensers....each	.90
1	.002 mfd. Dubilier Condenser	.40
2	.1 meg. Daven Resistances....each	.50
1	.2 meg. Haynes-Griffin Resistance	.50
1	.1 meg. Haynes-Griffin Resistance	.50
3	Amperites with mountings....each	1.10
8	Eby Binding Posts....each	.20
1	0-10 Jewel Voltmeter	7.50
1	7 x 18 inch Bakelite Panel, drilled and engraved	5.25
1	Cutler-Hammer A Battery Switch	.60
1	Haynes-Griffin Double Circuit Jack	.60
1	Haynes-Griffin Single Circuit Jack	.50
1	Marco Single Pole Double Throw Switch	.70
1	Wood Baseboard, 17 x 9½ inches	.75

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CONSTRUCTING A QUALITY SUPER-HETERODYNE

(*Continued from Page* 13)

way of the point where the radio frequency amplifier goes into oscillation. The potentiometer may be set at this point, and very rarely need be changed.

Make a log record of both the tuning dial and the oscillator dial. This may assist you when locating stations near the same wavelength and also serve as a record, should you wish to hear the same station again.

If the set does not function as outlined, you should look for the following sources of trouble before blaming the receiver itself: *A* or *B* batteries discharged; loop, phones or loud speaker out of order; broken connections leading to the set; poor tubes.

If none of these are found to be the trouble, try a pair of phones across the primary of the input transformer, turning the oscillator dial slowly if whistles are heard it shows that the first detector tube and oscillator are working properly. This leaves the trouble to a large extent in the intermediate frequency amplifier which should be tested again very carefully.

If the potentiometer does not control the oscillation of the intermediate frequency amplifying tubes, their circuit should be looked over, as there is probably a broken connection in the wiring.

If body capacity is apparent in the tuning of the loop condenser, this would indicate that the first detector tube is in an unstable condition. To overcome this, reduce the amount of capacity in the Chelton condenser and cut down the filament current in the detector tube.

Many friends of the writer have constructed the set described herein without assistance from him and all these "supers" have proven satisfactory. I trust that those of my readers who build this set may have equally good results which I hope will come up to their expectations. The author is at all times desirous of receiving criticisms and suggestions regarding this set and the results obtained with it, as it is through this method that we all enrich our store of knowledge.

Don't throw away the No. 6 dry cells when they are too far run down for your set. Use them on the door bell, and they'll last nearly as long as new ones, in the latter service.

Sometimes, when using a Tungar or Rectigon bulb charger, you will find the filament sagging, which indicates an approach of the end of its life. If this is the case, you can quite often save the tube for many more hours, if you turn it upside down, and let the sag go the other way.

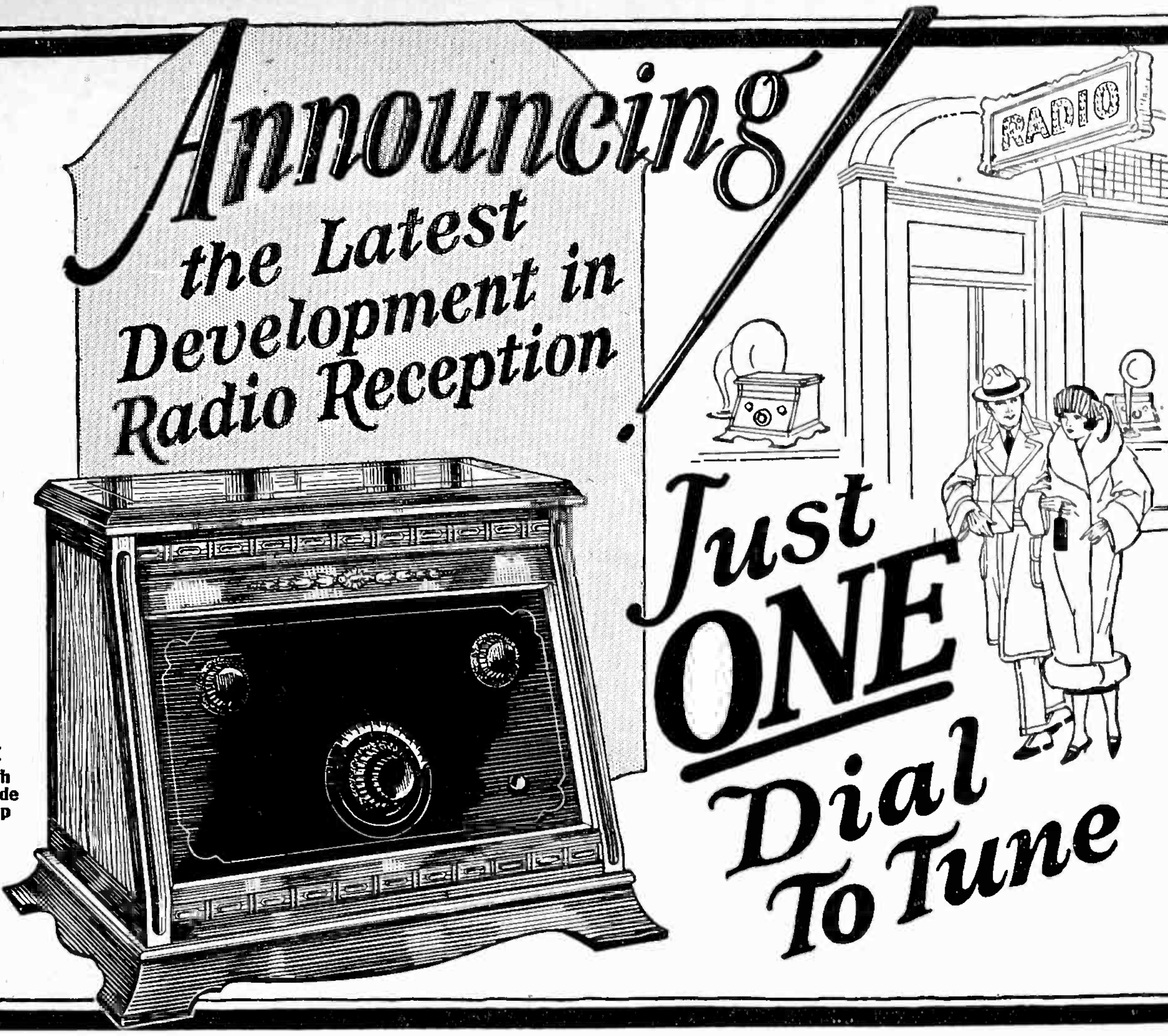


TABLE TYPE
16 Inches High
21½ Inches Wide
14 Inches Deep

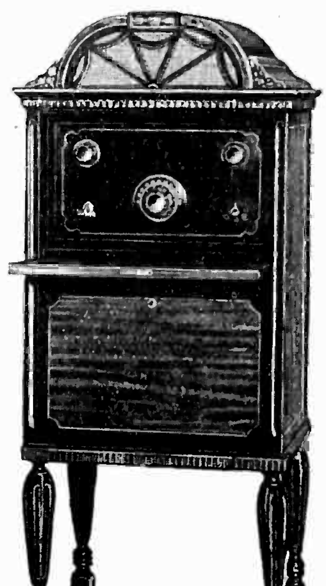
Just ONE Dial to Turn to Get Coast to Coast Range
Just ONE Dial to Adjust to Get Perfect Tone Reception
Just ONE Dial to Tune to Get the Utmost in Selectivity

Years ahead, the sensational simplified Mohawk 5-Tube Receiver now contributes the most drastic and far-reaching improvement for the universal enjoyment of radio. Never before has loud speaker reception been so simplified and dependable that head phones are not required, and tuning skill is no longer necessary.

The new Mohawk creates new conceptions of what loud speaker radio can do. No more difficult tuning on complex multiple controls. Handle all your control on just ONE dial. Reach out from coast to coast. Cut through local stations at will. Bring in distance loud and clear on the loud speaker. Repeat your tunings on identical dial settings as often as you like. Children can do it—elderly people—anybody among your family and friends.

Five tubes have long been recognized as the most efficient, practical coast to coast power—and with the new Mohawk everything heretofore possible on any other 5-tube set is now achieved so much faster, easier and better on just ONE Dial (and at no greater cost). The knife-like sharpness of tuning and the resulting greater beauty of tone and loud speaker volume exceeds anything you have ever heard.

Send for the new facts. Compare the Mohawk on the basis that on just ONE Dial it will surpass the performance of any other set. The new Mohawk stands alone — truly the last word in radio.



CONSOLE TYPE
51 Inches High
21 Inches Wide
16 Inches Deep

Mohawk sets are a quality product through and through. Built in THREE MODELS. Each encased in a distinctive type, hand-carved Adam-Brown walnut cabinet instantly appealing to the artistic taste of the most critical. Console models have LOUD SPEAKER and battery compartment built into the cabinet.

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2250 DIVERSEY BOULEVARD, CHICAGO, ILL.

DEALERS: Limited territory still available. Write or wire at once for Complete Information on attractive Mohawk Franchise.

The Mohawk
5 Tube Receiver

A DE LUXE SUPER

(*Continued from Page 17*)

If the wiring has been properly followed and the right apparatus used, the radio frequency tube can be easily neutralized with the small three-plate condenser. This point of neutralization is reached when the tube will not oscillate even though all three dials are brought into resonance. It will be found that a slight change in this adjustment will be necessary when going from very low to very high wavelengths. However, the adjustment is not bothersome and does not change over a comparatively large wavelength band. When the right point is found the neutralization is perfect and the first tube cannot be driven into oscillation even when the oscillator is brought directly into resonance with it.

This is where the average tuned radio frequency ahead of a super falls down. Even ordinary forms of neutralizing are not sufficiently effective to prevent the first tube from oscillating when the resonance point of the tuned r. f. circuit is crossed by the oscillator.

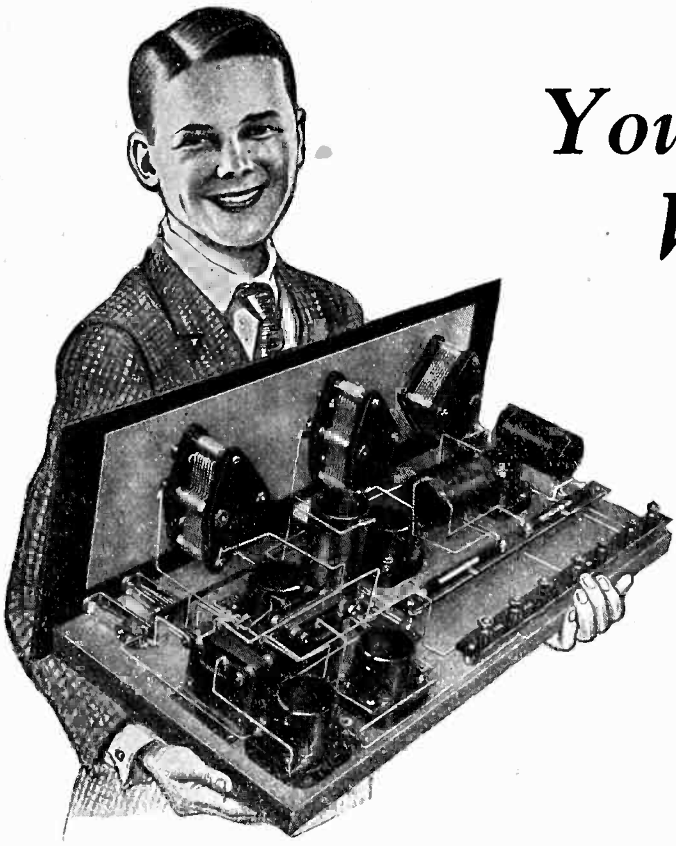
By slightly unbalancing the neutralizing condenser, not sufficiently however, to allow the tube to oscillate, and by using maximum regeneration in the intermediate amplifier, this set can be made to tune so sharply that it will actually distort by cutting side bands of the received signals. This means that the operator has absolute control over the set and can always tune up to the limit of possible sharpness.

What can actually be accomplished with any particular set under various conditions and in various locations is speculation and depends almost entirely upon the location conditions, amount of noise present, etc. This set, however, gave a very good account of itself during the recent trans-Atlantic tests, when it picked up several European stations in a thickly populated suburb of New York City. It is certainly more sensitive and capable of sharper tuning than the straight super-heterodyne. More than this it would be hard to say for any set.

Don't forget to check the polarity of your head-set when putting it on an amplifier. If you don't get the polarity right, the permanent magnets in the phones will be demagnetized, and will be rendered practically worthless.

When charging lead storage batteries, remember that a long slow charge is much better than a short one at a higher rate.

Keep a good watch on the diaphragms of the telephones. If they are bent, even if ever so slightly, it will practically ruin them for reception. Get a couple of new ones, anyway, and see how much better they work in the phones.



You Like it Better When You Build it Yourself

THE 5-TUBE THOMPSON NEUTRODYNE KNOCK-DOWN SET

LICENSED TYPE K-40

THE American boy is a natural-born builder. His imagination—his inherited constructive spirit—craves a worthy objective.

There is nothing that so satisfies the natural creative ability of American boys—young and old—as the building of a radio set; for when a radio is finished it brings to the boy the world's best entertainment and education from far and near.

Many of the achievements in modern radio reception have been made by young men who a few years ago built radio sets, listened to code messages, and were the first to listen in when speech and music were first broadcast.

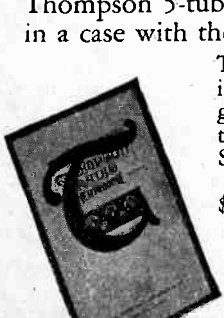
Building a radio receiver is a happy event in *any* boy's life.

The Thompson Knockdown Licensed Neutrodyne Set contains parts that have been developed by famous radio engineers of many years experience. The perfectly designed and perfectly matched Thompson parts are in no way similar to ordinary parts. Thompson neutroformers and audio transformers, that have made the Thompson quality of tone reproduction famous, cannot be bought separately.

The Neutrodyne circuit, which was designed since present-day broadcasting was perfected, plus Thompson experience of many years in radio, make the results from Thompson Knockdown Set superior to any Knockdown Set on the market. It is easy to assemble.

All Parts included in Case
No drilling necessary

All parts, (except batteries and tubes) needed to assemble the Thompson 5-tube Neutrodyne Knockdown Set are packed in a case with the Thompson 16 page instruction booklet.



This booklet contains easily understood building directions together with photographs, diagrams and actual size blueprints—everything to make building a Thompson Knockdown Set about the easiest thing you have ever tried.

The Thompson Knockdown Set is only $72 at good radio stores.

R. E. THOMPSON MANUFACTURING CO.

Maker of Thompson Neutrodyne Radio Receivers and the Thompson Speaker.

30 CHURCH ST., NEW YORK, N.Y.

Licensed by Independent Radio Manufacturers, Inc. NEUTRODYNE Reg. U.S. Pat. Off. Pat. March 27, 1923 and April 1, 1924 Hazeltine Pats. Nos. 1,450,080 and 1,489,228 Other Patents Pending

"Experience is the Vital Factor in Excellence"

300 TO 30,000 METER RECEIVER

(Continued from Page 22)

is used for the detector tube; two 45-volt batteries in series for the amplifier.

The entire radio-frequency section of the panel is shielded with a piece of grounded copper sheet. A copper sheet is also mounted in the oak cabinet, at right angles, to the panel. When the set is in place, this sheet goes in between the primary and secondary variocouplers and loading inductances. This limits coupling between the two circuits strictly to that obtained through the rotor winding in the primary variocoupler. Additional long-wave coupling may be had through the large honeycomb coils on the front of the panel. These are usually left loosely coupled, by setting them at right angles.

In mounting instruments on a shielded panel, care should be taken to cut holes in the copper around all screws and metal parts that are in electrical connection with any circuit. Panel and shielding should be completely laid out and drilled before permanently mounting any pieces of apparatus.

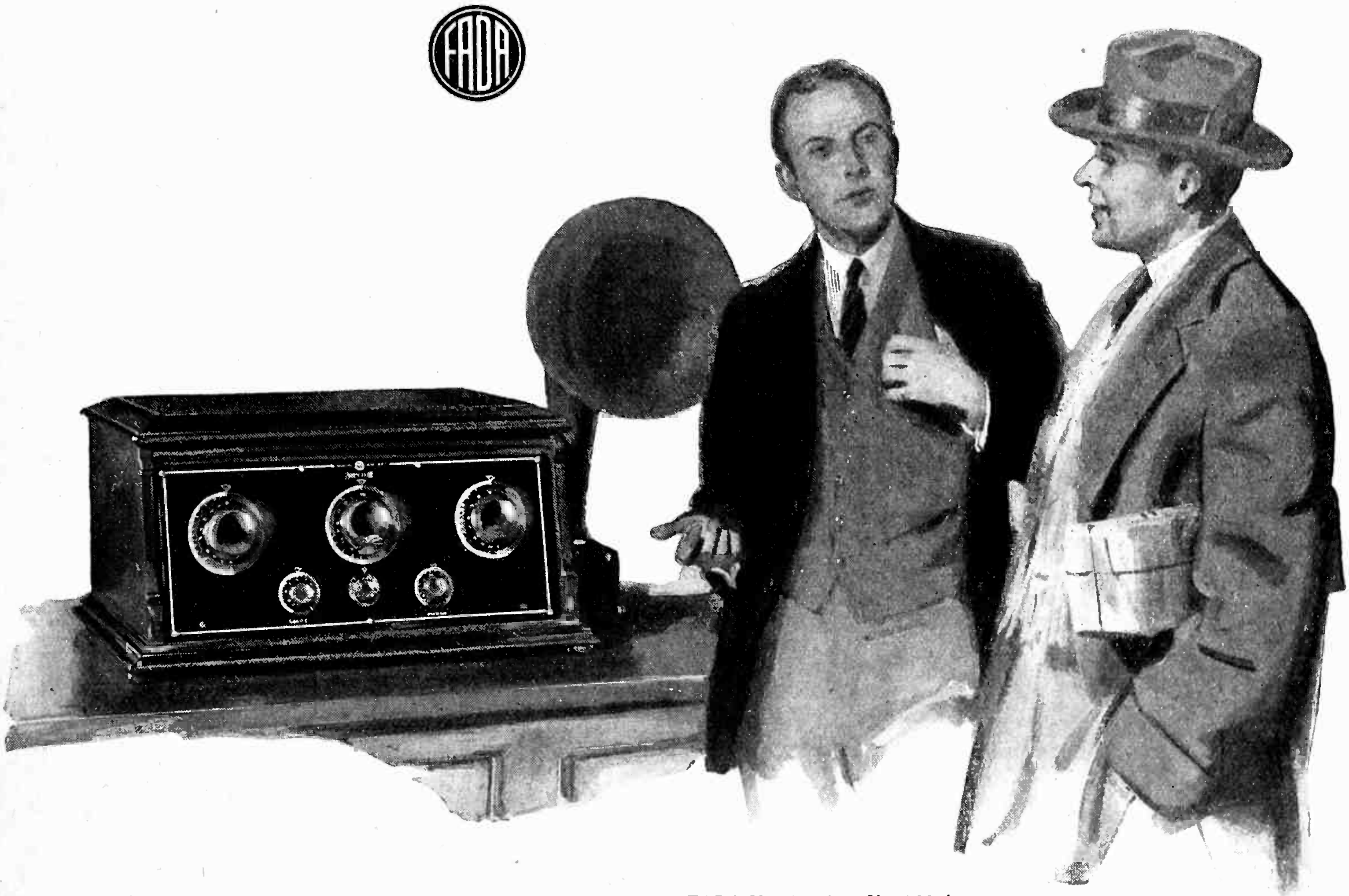
When assembling the receiver, it is not advisable to solder too many connections before the instrument has been tested and adjusted, as it may be found necessary to make some alterations before the best results are obtained. Soldering paste must be carefully cleaned off after soldering, using small pieces of clean rag well moistened with gasoline or alcohol. Insulation should be thoroughly cleaned between the contacts or taps of inductance switches.

The front mounting of the tubes on this set is a practice that does not seem to be often followed. It has several advantages. Tubes may be easily removed and replaced; comparative tests of various tubes may be most conveniently made; and finally, but not least in importance, the socket springs may be frequently cleaned without trouble. Faulty contact between socket springs and tube prongs is responsible for poor operation of radio receivers to a surprising extent—particularly in the case of contacts to type 200 and 300 detector tubes. It is sometimes necessary to clean the socket springs every two or three days, to keep them right.

This nuisance can be eliminated as follows: Take a silver dime, file it smooth on one side, and then cut it with a hacksaw into four equal quarters. Solder these, smooth side up, onto the top surfaces of the contact springs in the detector tube socket, taking care to get them as flat and neat as possible, and using no more solder than necessary. Be sure to leave adequate space between the silver pieces to avoid short circuits or bridging over by tube-prongs when tube is being inserted or removed from socket. If the piece of silver on the plate spring is got too close to the adjacent

Continued on page 56

FADA Radio



FADA Neutroceiver No. 175-A
Mahogany cabinet. Inclined panel and roomy battery shelf. 5 tubes. Price (less tubes, batteries, etc.) $160.

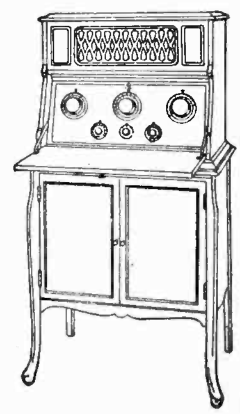
Indecision vanishes when you hear the FADA

RADIO shopping ends triumphantly when you find the FADA. People who know radio and have conducted comparative tests say that the Neutroceiver is the best they have ever tried. Have the FADA Neutroceiver demonstrated in your home. Listen to its marvelously faithful reproduction. Tune in a distant station yourself loud and clear and see how easy it is. Observe the beautiful cabinet design. You will exclaim: "At last! This is just the set I have always wanted!"

If you prefer a set with self-contained loud speaker, the FADA Neutrola Grand meets your desire in this respect, as in all others. Whether FADA Neutrodyne receivers are the first or the fifteenth make you investigate, they will be your final choice. You need look no further. Through the FADA Neutrodyne your radio wishes become realities. See your dealer.

F. A. D. ANDREA, INC.
1581 JEROME AVENUE NEW YORK

FADA Neutrola Grand No. 185/90-A
The five-tube Neutrola 185-A, mounted on FADA Cabinet Table No. 190-A. Price (less tubes, batteries, etc.)
$270.00



LICENSED BY
NEUTRODYNE

Continued from page 54

filament spring, you might construct a death trap for your tube. Silver contacts on the socket springs alone will usually eliminate all trouble with faulty contacts. If it does not, solder similar pieces of silver onto tube prongs. These may be removed and soldered onto new tube when old one is discarded.

The filament ammeter on this set measures current supplied to the detector tube only. It is not essential, but is convenient. The best operating point can be quickly returned to every time the set is lighted. A filament ammeter would be of less value on amplifier tubes, as they are easily adjusted to maximum signal or music volume. By having tubes front-mounted excessive incandescence of the filaments may at once be noticed and the current reduced accordingly.

For the most efficient operation of this receiver over all waves, two aerials should be used. For waves below 500 meters, an aerial of 150 feet in length will give best results. On long waves an aerial of one or two wires from 300 to 900 feet long will be found extremely good. If only one antenna can be used an over-all length of about 175 to 200 feet from set to the farthest free end will give the best all around results. The cost of the parts for the set shown in the photograph was about $110, less tubes and batteries. By using lower priced variocouplers and secondary condenser, this cost could probably be reduced to about $75 or $85. The third variocoupler (second feed-back coupler) could be dispensed with by winding a fixed coil of No. 20 or 22 DSC wire tightly around the bank winding of the secondary inductance. This coil would be connected into the plate circuit in series with the single rotating feed-back coupling coil inside the secondary variocoupler. The exact number of turns to be used in such a coil cannot easily be stated in advance; but they should be between 75 and 150, on a 4 in. bank-wound inductance. If too much fixed tickler is used, the set will over-regenerate and oscillate even at zero coupling of the rotor tickler. If too little, the set will not oscillate over a sufficient range of wavelengths. The simplest way to proceed would be to wind on about 150 turns of wire in four or five layers, bringing out a tap at every fifty turns, and later ascertaining by experiment which tap will give best results. Another method would be to wind additional wire on the feed back rotor inside the secondary variocoupler, so as to increase its inductive effect. The small clearance of some variometers will not permit doing this, and the stator winding is liable to be loosened when such modification of the instrument is attempted.

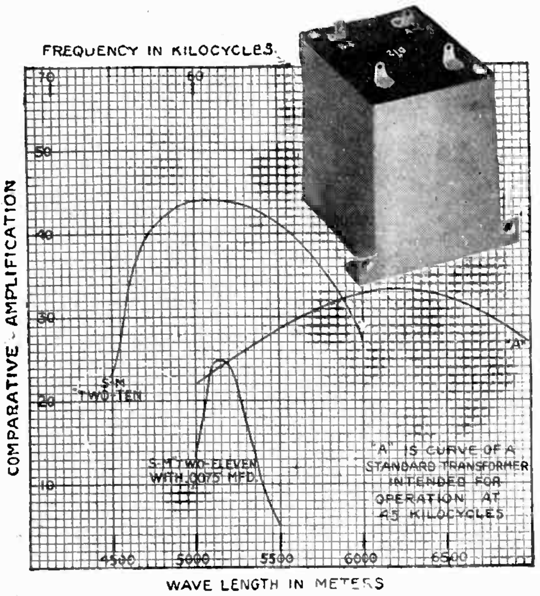
Continued on page 58

Silver-Marshall.inc.

RADIO

Follow the Engineer—

Be Guided by THE CURVE



If you could enlist the services of a radio engineer to test your inter-stage transformers before putting them into your set, you would know in advance what results to expect. Such measurements, however, have not been available.

But NOW, for the first time, you can have the full benefits of such laboratory measurements, made in the S-M laboratory. The curve of each **TWO-TEN** and **TWO-ELEVEN** inter-stage transformer is plotted, and recorded directly upon the tag that is atached to every instrument. It shows the peak frequency, the side-bands passed, and the amplification to be expected in any circuit. No guesswork is necessary—no long experimentation with possible disappointment—no extra expense for a new set of transformers.

The individual **CURVE-SHEET** that goes with each **TWO-TEN** and **TWO-ELEVEN** transformer is there for your guidance and protection. It refers to the particular transformer you purchase, and to no other.

Insist upon getting the **CURVE-SHEET**.

(TWO-TEN and TWO-ELEVEN are essentially the same transformers as those incorporated in the S-M 401 Unit, but immeasurablye superior, owing to small but important improvements.)

TWO-TEN

Iron-core intermediate frequency transformers. Passes 11 kilocycle sideband without distortion. Peak—5000 meters. Provides 1½ to 2½ times the amplification obtainable with any other transformer.

TWO-ELEVEN

A sharply tuned (filter) transformer. Equally suitable for input or output. Peaked at 5000 meters. Supplied with matched tuning condenser.

Both **TWO-TEN** and **TWO-ELEVEN** Inter-stage Transformers are supplied in individual aluminum cases. They are suitable with any tube in from one to four stages. Supplied in sets of two, or three, **TWO-TENS**, and one **TWO-ELEVEN**, each with identical peaks and a separate **CURVE-SHEET**.

PRICE OF EITHER TYPE, EACH $8.00

(Circulars on these transformers and other S-M products will be sent upon request.)

The "WHY of SILVER-SUPERS"

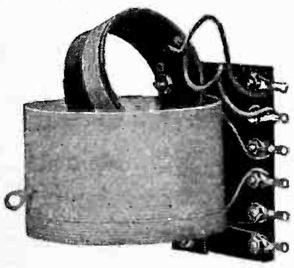
Send for the "Why of Silver Supers." It's FREE. It tells the story behind the set that gives coast to coast reception on a loop with loud speaker volume.

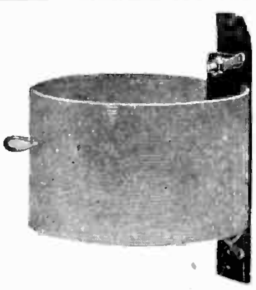
THE BOOK

McMurdo Silver's book, "The Portable Super-heterodyne," is a detailed account of the development of the "Seven-tube Wonder Set." Photos, diagrams, drawings—all you need to know to build the "Electrical Masterpiece."

Price 50c

THE FOUR-TUBE KNOCKOUT





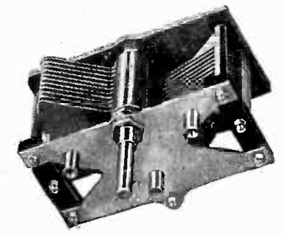
Here are the parts for the FOUR-TUBE KNOCKOUT set, just as they are described in the February issue of Radio Broadcast. This set is extremely simple to construct, inexpensive, and it will do on a seventy-foot antenna all the super will do on a loop. Its exceptional performance is due to sound "Silver design" and the use of low-loss air-core inductances. Although specially designed for the FOUR-TUBE KNOCKOUT, they are recommended for use in any set calling for low-loss parts of this type.

Send for McMurdo Silver's newest book, "THE FOUR-TUBE KNOCKOUT." It will interest you whether you intend to build this set or not. Price 50c

Type 105 Low-Loss Coupler

Suitable for use in KNOCKOUT SET, three-circuit, tuned R.F., and others. Coils are self-supporting with minimum of dielectric material in their fields. Range—200 to 550 meters with .0005 Mfd. condenser.

Price, each $5.00



Type 205 Low-Loss Antenna Coil

Indispensable in KNOCKOUT SET. Recommended for tuned R.F. and other circuits calling for low-loss inductances. Self-supporting windings. Range—200 to 550 meters with .0005 Mfd. condenser.

Price, each $2.50

Silver Low-Loss Condenser

Straight-line, low-loss, grounded rotor variable condenser. Supplied only in .0005 Mfd. capacity.

Price, each $4.50

Silver - Marshall, Inc.
110 So. Wabash Ave., Dept. B
CHICAGO, ILLINOIS

Eastern Distributor
20TH CENTURY RADIO CORPORATION
102 Flatbush Ave. Brooklyn, N. Y.

(*Continued from Page* 56)

Operation

The tuning of this receiver is simple. For short waves set the primary and secondary inductance switches on the first taps, turn the coupling dial and the two regenerative dials to maximum, and then rotate the primary and secondary variable condensers. When signals or CW beat-notes are found, the regenerative coupling and primary secondary coupling should be reduced; detector and amplifier rheostats, potentiometer, and grid-leak adjusted, until best results are obtained.

On the shorter waves the adjustment of the grid-leak and potentiometer is easy; but on long waves, especially above 15,000 meters, the settings of these devices become rather critical for maximum signal strength. Good signals may be received on all waves with grid-leak and potentiometer indifferently adjusted, but upon finding the critical points the signal strength may often be greatly increased.

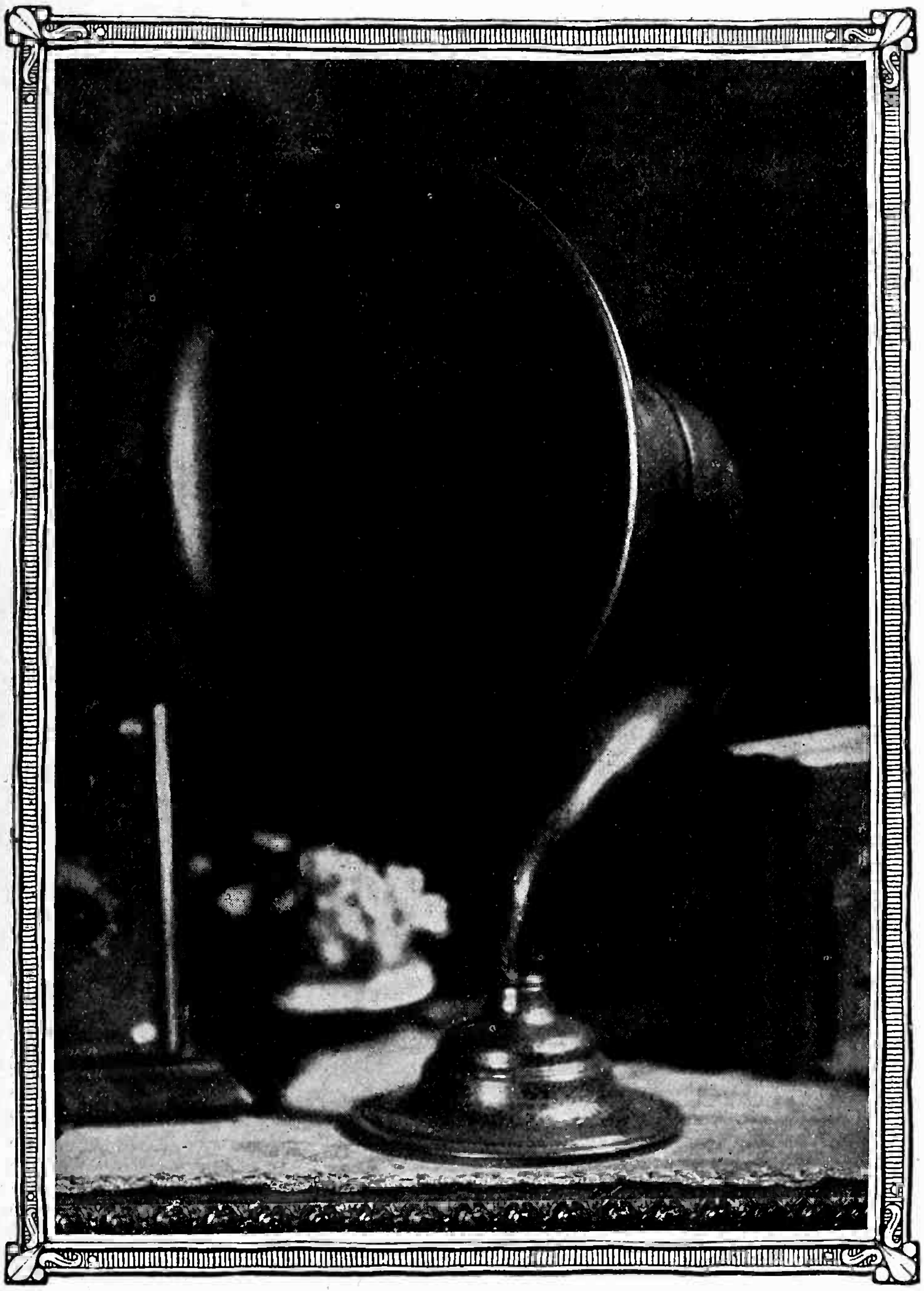
If the set refuses to operate, test for the following errors and defects. Wrong polarity of *A* or *B* batteries; too much or too little detector *B* battery; fixed tickler inductances and fixed tickler honeycomb coils connected into the plate circuit backwards; circuits grounded somewhere on the copper panel-shielding; circuits connected wrong or left open at some point. As every experimenter with regenerative sets is aware, reversed tickler connections are frequent. The proper connection is usually found by experiment; if it is not right the receiver will not oscillate, though it may receive music and spark signals. The rotating tickler coupling coils should be connected so that maximum regeneration is obtained with the dials at the 100 mark, not at the zero mark. Reverse leads from rotor to plate circuit if the regeneration occurs the wrong way.

Be sure that tubes make good contact on all socket springs. Sometimes three springs have good tension against tube prongs and the remaining one is weak and should be bent up a little.

In general, primary and secondary inductance switches should be set on corresponding taps when searching for any station not yet located. After the station has been found, a modified setting of the inductance switches may give better results. A log may be kept of the best tuning adjustments for any given station by assigning identifying numbers to the different dials and switches as has been done on the working diagram and then writing opposite these numbers the proper dial settings and "on" or "off" positions of the various radio switches. Returning to these recorded settings will always bring back the station originally heard on them.

For music reception this receiver will give as good results as any other three-

(*Continued on Page* 60)



The **UTAH**
Trade Mark Registered
Made In Salt Lake City
$25.00
Phono-Speaker $10.00

GUARANTEE
Buy a UTAH and use it for two weeks. Compare its tone with the best others are able to produce. If the UTAH does not give at least 50% better reception, return it to your dealer and he will cheerfully refund your money.

NOW! Radio Music as You Never Heard it Before

YOU never heard such tone! You cannot guess the wonderful musical possibilities of radio reception until you hear UTAH reproduction.

Rich, mellow, natural tones of instrumental music—the delicate shadings of the human voice—satisfactory volume from a weak and distant station—or big volume from a strong station, without the rasping and blasting that big volume has always caused—That's UTAH reproduction!

The new UTAH Speaker is the latest triumph of acoustical and electrical engineering—the result of two years work by the leading experts in sound reproduction.

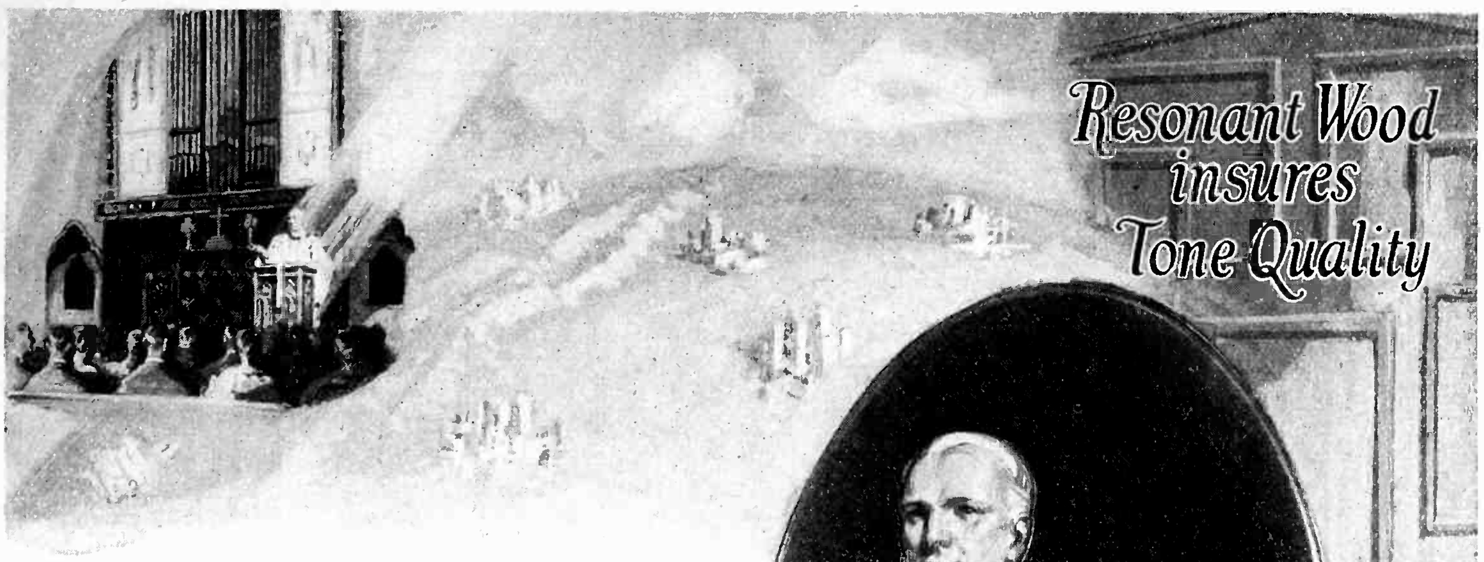
Hear It!

Go at once to your dealer's store and ask for a demonstration. Or better yet, take a UTAH home with you and enjoy it for two weeks under our unprecedented guarantee.

UTAH Radio Products Co., 1427 Michigan Ave., Chicago

circuit regenerative set with similar two-step amplifier. It is, of course, not equal to a neutrodyne set. It is a strong "blooper," if mishandled. This blooping business does not mattter in the least in telegraph work; but when using such an instrument for music reception in a congested district, the detector tube must never be allowed to oscillate. This can easily be done by keeping the amount of tickler or feed-back coupling properly reduced. Better quality of music will result thereby, and the other radio folks in the neighborhood will not be needlessly infuriated.

This receiver will bring in all the transoceanic high-power radio stations of the world, without regard to their location or to the location of the receiver. At San Francisco, loud, clear signals can be tuned in at any time of the day from all the long-wave transmitters of France and Germany. By connecting on a power amplifier, somewhat similar to the one described in Paul Oard's article in August, 1924 RADIO, and a loudspeaker, I have tuned in German stations so loud that the signals were readable fifty feet away from the instruments. This receiver should also prove suitable for picking up the new high-power trans-Atlantic radio telephone transmitter now being built at Rugby, England, with which it is stated efforts will be made to connect New York and London by telephone, and which probably will operate on very long wavelengths.



"With the Tongues of Men"

HUMAN voices pulsating with life, vibrant with emotion, speak from Music Master rich and clear, as in the church, miles or hundreds of miles away.

In the comfort of your own home---near or far---you hear the sermon, the organ, the singing, the entire church service, as though you were seated among the congregation.

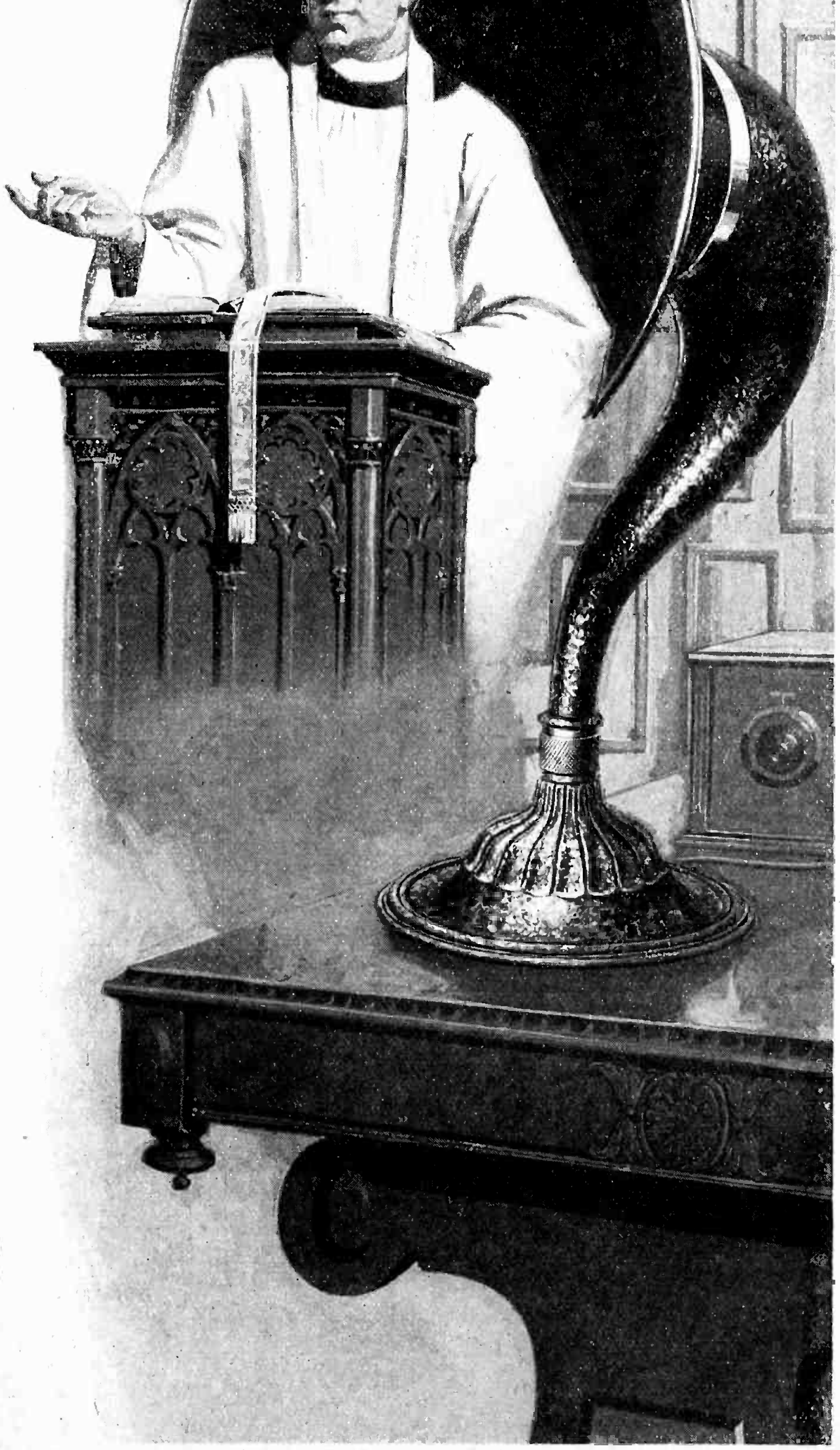
The reproducing element of Music Master responds to the faintest radio impulses; the heavy cast aluminum tone chamber eliminates blast and distortion; the amplifying bell of natural wood---like the violin and the cello---reproduces in tones that are full, resonant and life-like.

Your dealer will be glad to send Music Master to your home to be tried and proved with your own set.

Dealers Everywhere

Connect Music Master in place of headphones. No batteries required. No adjustments.

MODEL VI—14-inch	$30.00
MODEL VII—21-inch	$35.00
MODEL VIII—Cabinet Type with "Full-Floating" Wood Horn	$35.00



Music Master Corporation

Makers and Distributors of High-Grade Radio Apparatus

10th and Cherry Streets

Chicago **PHILADELPHIA** ***Pittsburgh***

Music Master
RADIO REPRODUCER

C. Q. WATTS
(*Continued from Page 23*)

"Want a job?"

It was not the first time the sheriff had asked that question. With him, it was the acid test. His subsequent actions always depended on the manner in which those he questioned made reply. He claimed by that question alone to be able to pick the professional hobo with unerring precision.

"You bet your cock-eyed life I do," said Pokerchip Watts with emphasis. "I'll take any kind of a job that pays in food and smokin' tobacco, the way I feel right now."

"How does $75 a month and found strike yuh?"

"Right between the eyes. What do I do, and where?"

The sheriff stood up and held out his hand.

"Son," he said, and there was real warmth in the words. "Yore workin' right now. Come with me."

He led the way out of the long shed used as a chow house by the construction company, and across to the company office. A short fat man in a dingy eye-shade poked his hand out of the door.

"Hello Mike!" he challenged. "Bringing me a man?"

The sheriff nodded.

"This young fellow's lookin' fer a chance to shoot Injuns," he chuckled.

"Oh, he is, is he? Well, we might find a couple of Slovaks." He pulled out a pencil and a card with a quick nervous motion.

"Write your name down there and I'll tell you where to go," he said jerkily, and disappeared within.

"Name's Joe McGee—white man," explained the sheriff, with a jerk of his thumb toward the office. "Time keeper."

"Suits me," said Pokerchip. "Thanks for the recommendation. The way I see it, there's quite a number of white men around."

A flush of near embarassment sprang to the sheriff's face.

"Shucks," he said. "I been hungry m'self!"

But he gripped Pokerchip's fingers with something akin to real feeling, and turned on his heel. Pokerchip watched him mount his "paint" and trail down the slant of the hills. Then he turned back to the office, and his heart was light within him.

"All ri', Joe ol' top," he sang out. "Let's go!"

PABLO gorge was what hydro-electric engineers called a "natural water site." Situated at the upper end of a long valley, it resembled the playground of a berserke Cyclops who had swung a mastodonic hammer with ruthless effect. Crags and granite outcrops were shattered in all directions. Sharp canyons debouched into sharper coulees.

Continued on page 64

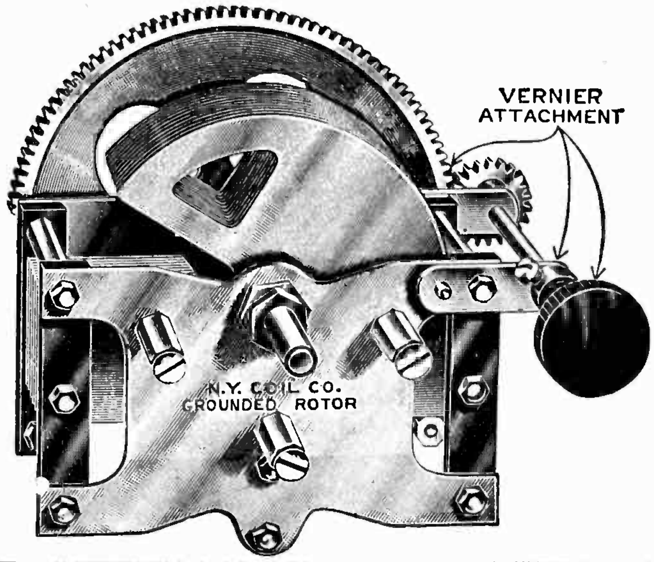
The Supreme Pleasure of Radio is secured only from a set constructed by yourself, *but* be sure to use *reliable* parts

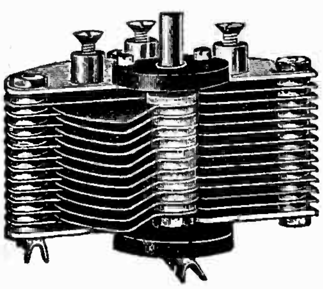
IN THE NEW YORK GROUNDED ROTOR scientific designing, together with the highest grade of materials and instrument workmanship combine to produce a condenser that is in a class by itself---no other condenser manufactured incorporates so many *actual improvements.*

.0005 (23 plate) without Vernier **$4.50**

Geared Vernier attachment, complete, $1.50

OUR STANDARD NON-GROUNDED CONDENSERS are made in four sizes with or without vernier — are universally recognized for their efficiency, workmanship and low price—made possible by large production.





Price with Vernier Knob and Dial, 23 Plate, $3.50. Without Vernier, 17 Plate, $1.80. 23 Plate, $2.00. 43 Plate......$3.00

New York Distortionless Audio Amplifying Transformers are the standard by which others are judged. 4¼ to 1 ratio correct for all style tubes.

Price $4.00

Tuned Radio Frequency Transformers, with 17 Plate Condenser attached $4.50

BY PASS CONDENSERS

.05	$ .90
1 Mfd.	1.25

NEW YORK PRECISION MICA FIXED CONDENSERS

"More Uniform Capacity"

Type B

Type A—No Clips

Adopted by leading Heterodyne manufacturers on account of truthful capacity rating. This is the only laboratory precision-built condenser on the market, yet sold at a commercial price. It is standard equipment with some of the largest and most discriminating set manufacturers.

Guaranteed for capacity and against leakage or breakdown.

The following sizes always in stock:

Capacity	Retail Price
.0001 Mfd.	$ .35
.00015 "	.35
.00025 "	.35
.0005 "	.35
.001 "	.40
.002 "	.40
.005 "	.60
.006 "	.75

.00025, with Grid Leak Mounting Attached, 45c list Type C

NEW YORK COIL COMPANY

338 Pearl Street, New York City, N. Y.

PACIFIC COAST MARSHANK SALES COMPANY, 926 Insurance Exchange Building, Los Angeles, California, also San Francisco, Portland

Continued from page 62

A mountain stream tumbling down from higher levels acquired terrific velocity in the gorge and there man had started a dam that was to chain its potential force to herculean toil.

The thing was being accomplished by the genius of dreamers whose saga was the grind of concrete mixers and the thunder of machine drills. Out of the fabric of their imagination, heavy muscled men had built a giant staging that towered above the floor of the gorge like a tower of Babel, and within its lattice grip had poured a wall across which a king's army could march abreast.

At the foot of this wall lay the power-house, in which whirling turbines, driven by the drop of the falling water, were soon to furnish light and power for the industries and homes in the valleys beyond. The dam was almost finished, and the final work at the power house was under way. As Joe McGee explained it to Pokerchip Watts in a brief conversation, he had arrived in time to "see hell break loose if it was going to."

There was considerable behind this simple remark. In all dam construction the critical moment is that of the reservoir's fullness—when the vast pressure of the huge impounded lake is turned against that huge concrete face for the first time, when natural forces are tested against the mathematics of man, who has dared their outermost limits. There is nothing out of which an engineer gets quite the thrill as that particular time, unless perhaps when the lock beam of a giant bridge swings into place over a whirling stream.

Pokerchip Watts was introduced to the giant project just two months before this epic moment. He went through the days that followed in something of a daze. Building dams has no part in the life of a radio operator and it was all new stuff to a man born and raised on the Gulf stream. But Watts was American and within fewer weeks than he himself expected he was an integral part of the Pablo construction company. Started as a common laborer, his shipboard experience soon landed him a job as assistant to Joe McGee and a fast friendship sprang up between the lanky operator and the little fat man.

On Sundays they went hunting. There was small game in the hills and Watts was a dead shot and could handle a rifle with the expertness of long practice. Once when he had knocked over a cottontail with a hip shot, Joe McGee sat down suddenly.

"Listen, Poke," he said. "This construction job is pretty near done. The dam is all set, and our part of it is through. We may not get another like this for a year. How'd you like to stay on here as a guard? You know, these things have to be patrolled."

Continued on page 66

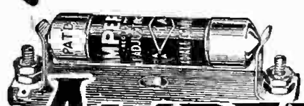
NOW -its the "SELF ADJUSTING" RHEOSTAT

No more guessing and uncertainty as to your tube filament voltage. AMPERITE inside your set, one for each tube, automatically gives just the right current to bring the most out of every tube. Simplifies wiring and operation. Increases set compactness. Lengthens tube life. Tested, proved and adopted by more than 50 set manufacturers. The set you buy or build will not be up-to-the-minute in effectiveness without it

$1.10 Everywhere

RADIALL COMPANY
Dept. R-7, 50 Franklin Stret, New York

Write for FREE Hook-ups



AMPERITE
REG. U. S. PAT. OFF.
"means right amperes"

VOLUME

IF you want volume without distortion use Supertran Audio Transformers. They are shielded assuring absolute protection against damage to the coil while mounting

Distributed by **$6** AT ALL DEALERS

Philip Chandler & Co., Boston, Mass.
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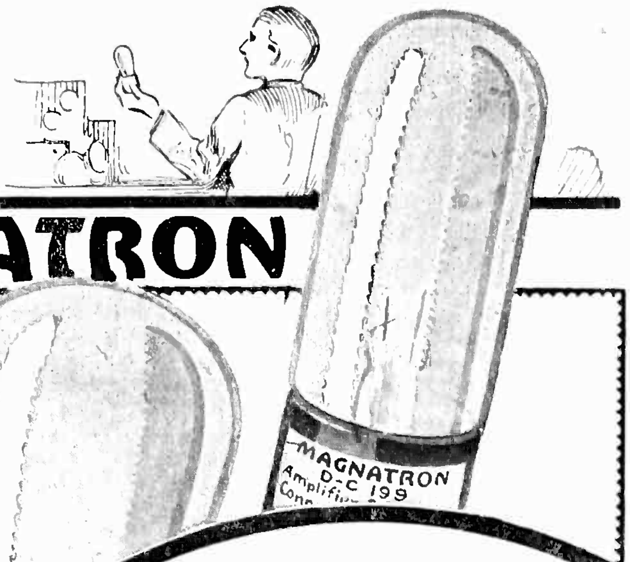

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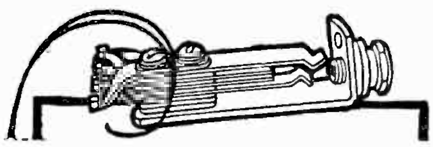

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Continued from Page 64

Pokerchip stared out over the hills, where the turquoise was melting into the topaz of evening. There was the smell of sage in the air—of sage and mesquite. Off yonder the sun would sink down presently, a ball of crimson, and the stars would come out in brilliant gleaming balls of fire. There was width there—space, room for a man to move his elbows. No ship's cabin with one's own feet in one's lap. . .

"Joe, I think I'd like it like a cat likes cream," he said simply.

The little timekeeper laughed.

"You sure got to be a Westerner plumb fast for a bird that never saw a mountain before," he chuckled.

Pokerchip's face flushed.

"I guess it's got me, all o. k., Joe," he said. "I was just measurin' the width of a berth by—this!" He waved one hand at thirty-five miles of valley, that faded into the gathering dusk over the rim of Devil's Rim. McGee nodded.

"Yeah—I know," he said. "I was a bookkeeper in Boston once, m'self."

It was a month later that Pablo dam was pronounced finished and the first trickle of water admitted into the big bowl that was to mark a revolution in hydro-electric affairs of the state. Big officials, power men, reporters, movie cameramen, and engineers without number were present to witness the event. Not least among the throng were representatives of the various cities and towns down Pablo valley which would benefit from the project.

It was a great occasion. Pokerchip, by virtue of being an assistant time-keeper, was regarded as a semi-official. He rode into town and bought himself a sombrero and a fancy vest in honor of the event. Everybody was dressed for the occasion and the town band of Blanchard played the "Star Spangled Banner" as a background for speeches by three mayors and a state senator.

But it was not all "cheers and oysters" as Joe McGee put it. Like all small towns, there was an element in the Pablo valley cities that foresaw forthcoming disaster in the giant concrete dam. One such, Old Man McCracken, a New Englander and a big land owner in that section, predicted trouble.

"She'll never stand the pressure when the winter rains set in," he croaked. "She'll let go, sure's sin and we'll all be wiped out overnight."

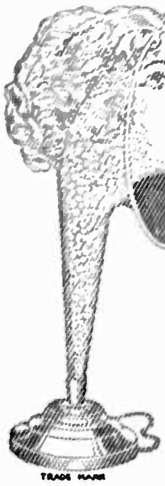
Joe McGee poked Pokerchip in the ribs and glared at the aged prophet.

"If it wasn't illegal, I'd get that old raven so pie-eyed he'd be cheering at his own funeral. Can you beat that line of stuff?"

Pokerchip stared up at the massive white wall, gleaming like a white cliff in the sunshine.

"I wonder," he said to himself.

Continued on Page 68



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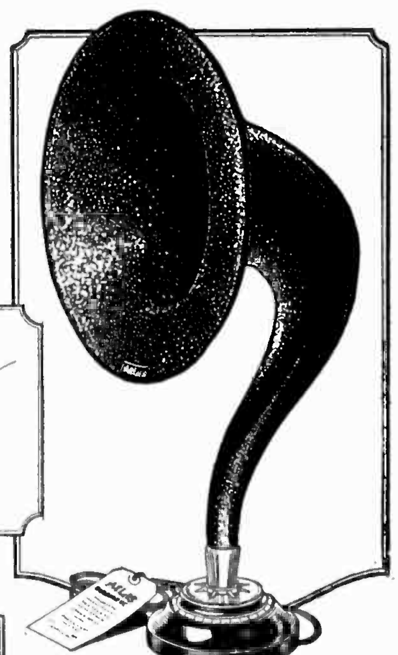
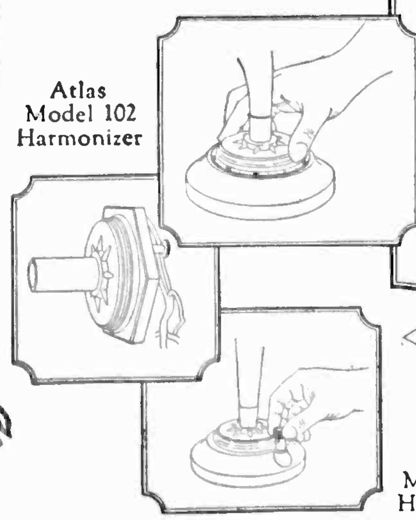
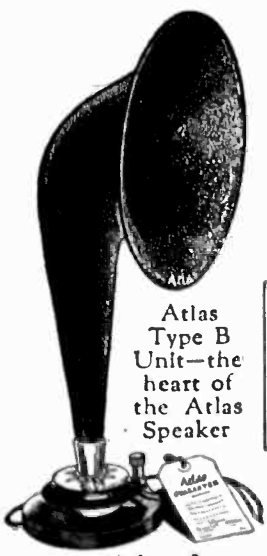




Atlas Model 102 Harmonizer



Atlas Type B Unit—the heart of the Atlas Speaker

Atlas Model 101 Speaker

Atlas Model 101 Harmonizer

Atlas Model 102 Speaker

Continued from Page 66

The doubt that Old Man McCracken implanted in his mind as to the ability of the great wall to withstand the pressure of the winter water, refused to be ousted. Pokerchip knew something about the force of water. He had "pounded brass" on a destroyer in convoy service on the Atlantic during the world war. He recalled one winter sea that had twisted steel masts until their yard arms pointed fore and aft, and waves that ripped off bridges and riveted deck plates. Smooth, rolling waves they were, with the strength of giants in their impact, and they left destruction and wreckage in their wake.

As he looked at the great dam that towered above him he found himself wondering if it would withstand that water force once it got into action. There were safety gates, and valves to guard against that very thing, and yet . . . One day he flipped a coin, heads to win, tails to lose, caught the down plunging coin, and then abruptly thrust it into his pocket without reading the result. Somewhere, down in his soul Pokerchip Watts had learned not to dare Fate.

OCTOBER came and went and November closed in. With it came the first of the rains. The Pablo engineers watched the dam like a mother tends her young, feeling its pulse, studying its respiration, eyes on gauges, on pressure pipes, on controls. Down in the power-house the generators hummed with the steady drone of bees, as the whirling turbines whipped the generators into a mad dance of alternating current.

Far down the valley, gleaming lights in homes, in show windows, in streets, told the story of a great feat successfully accomplished. Pokerchip used to watch those lights as he paced the upper bulk of the great dam, rifle on shoulder, through the long nights, and something within him responded to the thrill of the thing that had been done. It was man-harnessed power—an invisible force trapped by guile, snared by intellect and set to work to do man's tasks, and yet remained a thing unseen. It was one of life's mysteries and it awed him.

Pokerchip's job was important but not dangerous. The patrolling of the dam was not only to protect the dam itself from some sudden weakening, but also against outside vandalism. Power companies always have that fear, that some demented individual, warped on the subject of capital and corporations, will dynamite a dam because of its potentiality. Pokerchip had orders to shoot first and ask questions afterward. But he never had occasion to use his weapon. Nature had too well protected Pablo gorge with impassable entrances to lure even a rabid fanatic to that point.

It was late in November when the

Continued on Page 70

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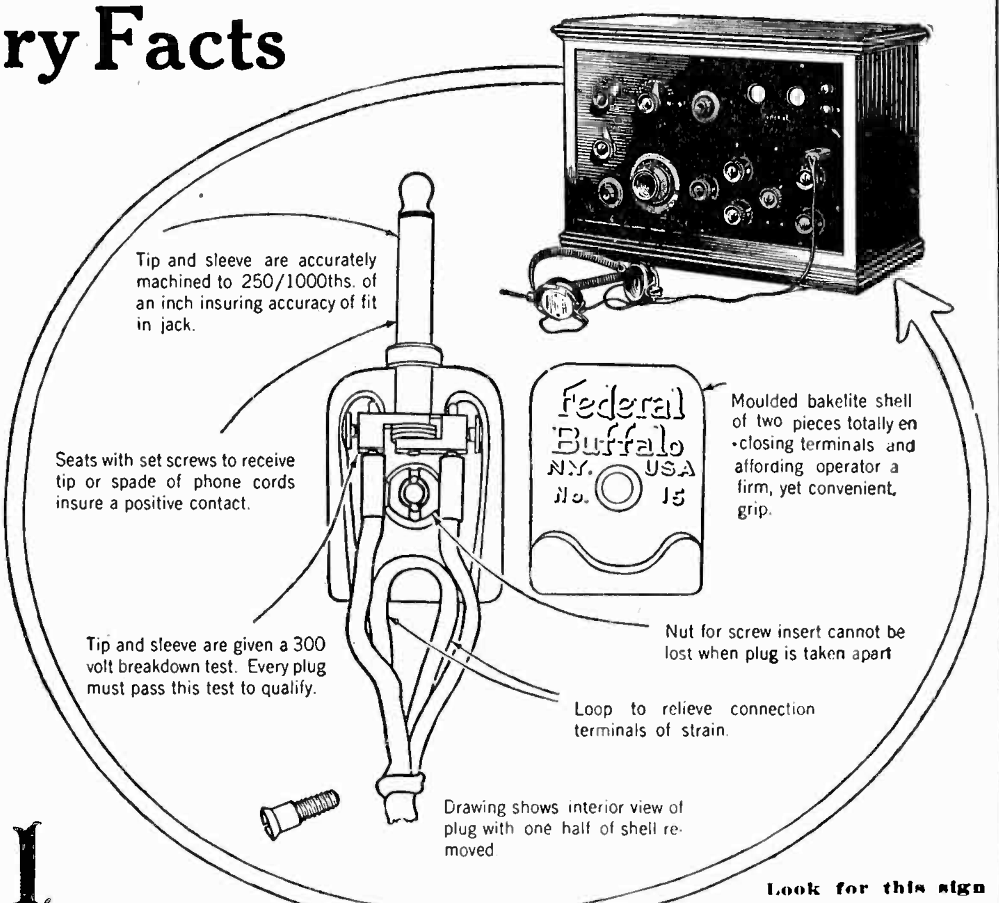

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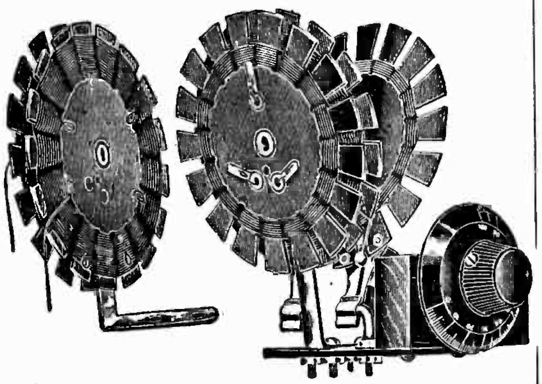

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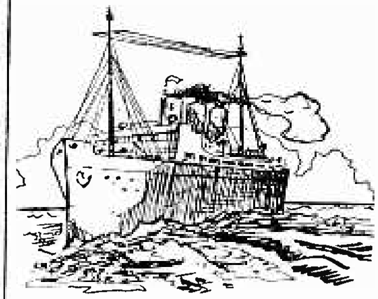

Continued from Page 68

rains began to come, and with them worry lines in the faces of the men whose task it was to guard the giant reservoir. More than the usual amount of water was falling and despite the fact that the overflow valves were run almost constantly, there was a feeling that the dam was "getting restless."

Bently, a big blonde electrician in charge of the power-house, was the first to use that phrase and it struck Pokerchip Watts as particularly apt.

"I dunno," said Bently one night, as the relief man went on Pokerchip's patrol and he and Bently sat huddled around the little iron stove in the office, with an eye on the switchboard. "I may be crazy but I've got a feeling that that blamed dam's getting restless. It is not sense to say that about a hunk of concrete, but sometimes I'd swear she kinda wiggled."

He swung about and stared up at the huge face of it, high above them, illuminated by a bank of lights that carried far up into the night. Pokerchip nodded solemnly.

"Yeah, I know, buddy," he said slowly. "Almost like she groaned, ain't it?"

"You said it," said Bently. "I wonder if a thing like that knows when it's reached a limit."

"Shouldn't be surprised," said Pokerchip. "I've heard old tars say a ship kinda moans before she goes on the rocks, like she had a hunch she was gonna get it. . ."

The young electrician shrugged nervously and threw on another shovelfull of coal.

"Hell of a night," he muttered.

The rain beat on the windows, drumming a steady tattoo with the sharp, brittle violence of mountain storms. Now and then the distant crack of thunder sounded in the far hills, and a blue flare lighted the sky. The glares increased in number and frequency as the storm came closer, until suddenly there was a blinding flash and a deafening crash as a tree was struck not half a mile away. The lights brightened and dimmed crazily as the lightning arresters on the power line took the surge of the shock—and held.

Pokerchip was due to turn in and sleep but something kept him awake. He strolled over and picked up a checker board. As he did so, there came the sound of running feet.

Bently jerked open the office door as a lineman, drenched to the skin, staggered in from the bunkhouse, some hundred feet distant. The man's face was white and for a moment he seemed unable to speak.

"My God!" cried Bently, "What's happened?"

The lineman gesticulated inarticulately, waving his hands. After a moment the words came:

Continued on Page 72

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Continued from Page 70

"The dam . . . she's bulging. . ."

He pointed upward. Watts and Bently jumped to the door and stared up through the falling rain. What they saw drained the color from their faces, leaving them numb and shaken. The great dam was towering over them, out of plumb, bulging, as the lineman had said.

" . . . Blanchard, Crossley . . . the folks down there. . ." It was Bently speaking, in a whisper, scarce heard above the drone of the generators and turbines. They're—right in the path—My God! 'Phone them."

The lineman shook his head.

"It's no use. I just tried. That last lightning stroke put the telephone line completely out."

"She cracked when I was coming out of the door. I swear I saw her move!" The lineman's teeth were chattering.

Eyes sought eyes as three men visualized what would happen when that swaying face of concrete, gradually bending under the weight of water behind it, gave way and the accumulated might of Pedro reservoir became a roaring wall of destruction, racing down on the helpless towns beyond. There were five thousand human beings directly in the pathway.

"A man on horseback. . ." began Bently, but the lineman shook his head.

"Not a chance—she's due to go any minute, now. . ."

Watts was standing with his hands clenched, his face tense. There must be some way to warn all those people, secure in their belief in safety, with death ready to sweep down upon them. Oh that the telephone was working, a siren—anything, he thought. Suddenly something struck him—hit him with the impact of a fist. He fairly staggered and then he gave a shout.

"By God. . . there's a chance. . .I'm going to take it!"

He broke from the room on a run followed by the other two, infected by his quick excitement. Watts was running toward the giant switchboards that controlled the turbine station, from which ran the electric light feeders into a score of valley towns and ranches. When Bently and the lineman reached the control room, Watts was clawing at the main switch.

The generators were humming their steady drone, unconscious of the disaster high above them, ready to be unleashed at any moment. Watts yanked the great copper switch, arcing a streak of blue flame. The lights went out in the power house—in Blanchard, twenty miles away, in Crossley, twelve miles beyond.

As the others stared in amazement, not unmixed with terror, Watts, bathed in the eerie blue light that snapped and crackled all about him, began to jerk the giant switch in and out.

"Keep back!" he screamed at the others. "Keep away from me. . . I'm playing with death, but it's a chance. . ."

Back and forth went the huge switch. On and off flickered the lights in towns up and down the valley. Great streaks of blue sizzled in the control room, and circuit breakers went out with a crack like shotguns fired in close quarters. Now and then Watts would pause long enough to smash one of these protective devices back into place, and again the switch would go in and out.

"The man is mad!" Bently screamed in the lineman's ear, but the latter shook his head as comprehension began to dawn. The next moment he was dancing with excitement, screaming with a frenzy as mad as that of Watts himself.

"Atta boy, Watts—stay with it, boy. We're ahead of the game, so far." He ran to the door and stared upward at the huge bowing mass of the Pablo dam as it hung over them in dire menace.

FAR down at Blanchard, folks were just getting ready for bed when the lights began to flicker. At first there was a growl of discontent, as evening papers went down. Then as the flickering continued, people began to wonder. It was little Eddie Morton, eight-year-old son of Train Dispatcher Morton of the Spur Line system, that got it first.

"Dad!" he called excitedly, "do you get it? Do you get it?"

Morton senior peered over his glasses.

"Somebody's signalling on the lights," the boy shouted. "He's writing CQ CQ over and over again. See, there it is, C.. . . . Q."

It meant nothing in Morton senior's life. But to Eddie Morton it meant a whole lot. Night after night Eddie sat in with his little one-tube set and listened to amateurs talking over their radio sets over half the United States. Besides Eddie was a Boy Scout, and Scouts must know the radio code.

"CQ means everybody copy—that somebody has something to transmit!" His voice was shrill with excitement.

His father stared at him. Then something registered far back in his brain. He was an old-time telegraph man, and he had seen and heard strange tales in his time. He co-ordinated quickly.

"Can you copy it, son?" he asked.

"Yes, if it isn't too fast," the boy answered.

The train dispatcher thrust a paper and pencil into the lad's hand. With one motion he grabbed a candle off the mantel and lighted it. The electric lights began to flicker now and Morton could see that it was definite and precise—code coming through in Continental Morse, a Morse he did not know.

"The dam is giving way! Run for your lives. Watts!"

Morton, reading over the boy's shoulder as the lad copied the slow, steady flashes of the electric lights, sent by the frantic hand of the night patrol guard, far up Pablo canyon, grew cold all over.

"Good Lord!" he muttered. "The dam!"

The long expected had happened. And Watts, good old Watts, had signalled them; taken a chance that somebody would get it. It was to Morton's credit that he never hesitated, never doubted. He had been an emergency railroad man too long for that.

The flashes continued, but they were but repeats of the original message. "The dam is giving way. . . run. . ."

Blanchard had a bank, a neat little concrete structure. It stood on the main street, just around the corner from the Morton home. There was a signal siren in front, one that operated on a tank of air from a garage. It was placed there to arouse the townspeople in case of bandits. Crossley, twelve miles away could hear it on a quiet night. At Crossley there was another, which would notify other towns farther down the valley. Such was the trap the farmers had devised to protect their money. Such was the device Morton now used for another purpose.

He left Eddie copying the flashes—coming steadier now—and ran to the siren. The roar of the whistle shattered the echoes of the night. People poured from houses, armed, hatless, running—looking for trouble. In a few words Morton told them what had happened—explained the lights, the warning.

"Somebody get Crossley on the rural wire and tell them to pass the word along," he said. "And for God's sake, move quickly."

It was a strange race that began out of the town of Blanchard at 9 o'clock that night, a hurrying cavalcade of men, women and children. Every soul was accounted for. Down at Crossley, and at Miner, at Orath, at half a dozen others, similar scenes were being enacted. There was no time to stop for clothing, for household belongings. It was hitch and run, or crank and run. Those that had no transportation grabbed a hold with those that had.

From far up on the hillsides of Pablo canyon they huddled around fires of sputtering, water-soaked wood, and waited for the Thing that was to come—the Force, that but for the narrowest margin would have blotted them out. Minute after minute, and far into a long, lone hour the lights up and down the valley flickered steadily—flickered on and off. Now and again little Eddie Morton, sleepy but excited hero of the occasion, would spell out the words again—". . . the dam is giving. . ." for the curious that packed around him.

Continued on Page 76

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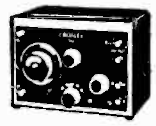

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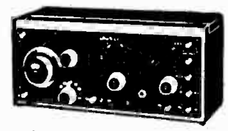

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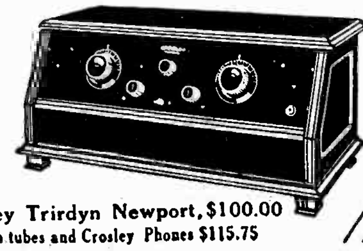

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Address_______________

Continued from Page 74

And then—the lights flickered, wavered and went out. The refugees held their breaths and listened, as the whole valley was plunged in darkness. Dimly at first and then with a mighty roar that turned into a grinding crescendo of sound, it came—the thunder of the broken dam, and the awful reverberation of pouring water. Huddled in horror, they clung to each other as a great, grey wall, house-high, boiled through Pablo valley, wiping out homes and barns, flipping buildings upside down like chips, and leaving devastation and destruction behind it.

Millions of gallons of water roared past as the contents of Pablo reservoir raced down the slope of the mountains toward its level at the sea, passing forever into the limbo of engineering failures. On the hillside, in the rain, hundreds of people knelt in a prayer of thanksgiving for the loss of life that had been averted through the heroism of a night patrol guard, and the alertness of a little Boy Scout.

And up on the rim of the broken reservoir, where great hunks of concrete lay in shattered pieces, as though smashed by a giant blow, a man with scorched hands, and a body wracked by the crisping viciousness of a searing blue arc, clung to a smoked marble switchboard and sobbed in sheer relief, because the dice he had thrown with Death had won.

It was the man a brakeman had kicked from a gondola on No. 6 at Babcock six months before—Pokerchip Watts, ex-operator and soldier of fortune—forevermore, to Pablo valley, in measureless gratitude, "CQ" Watts—hero!

SEE PAGE 71—
IT WILL INTEREST YOU

SELECTIVITY

Continued from page 32

the higher will be this apparent resistance as a frequency trap. Also the lower the C/L ratio the higher will be this apparent resistance. Thus a low loss coil and condenser make the best frequency trap. Here as before the same conditions hold for selectivity, low R and low C/L ratio.

It is often observed that despite the high selectivity of the best makes of receivers they will respond very distressingly to interference from powerful radio telegraph signals or to static phenomena such as caused by violet-ray machines. This means merely that a very powerful impulse will set the antenna circuit oscillating *at* its *own frequency*. If this antenna circuit be adjusted to the incoming desired wavelength then the interference and the desired sound will beat identical wavelengths and can of course not be differentiated. If we attempt to detune the antenna then both interference and desired signals suffer proportionately and there is no net gain. Thus for interference of this type there is no solution at present. Loops will help to some extent but not enough. It seems likely that the ultimate means to perfect broadcasting 365 days a year is Super power.

The N. Y. Central Railroad, in an endeavor to speed up its marine traffic in New York Harbor is experimenting with radio communication between one of its tugs and WNY at Bush Terminal, Brooklyn. If these tests are successful 43 tug boats and lighters will be equipped with radio transmitters and receivers.

MECHANISM OF RADIO PHONE RECEPTION

By L. R. Felder

The difficulty that many find in understanding how the radio frequency waves are converted into audio frequencies can easily be cleared up by a brief consideration of a few facts. A 600-meter radiophone transmitter, for instance, sends out a fundamental frequency of 500,000 cycles. This is called the carrier wave because in effect it carries with it such audio frequencies, 100 to 10,000 cycle, as may have been impressed upon it by the modulating tube at the transmitting station. These low audio frequencies cannot be as efficiently radiated from an antenna as can the higher radio frequencies.

The effect of impressing or superimposing these audio frequency currents on the carrier is to give two new series of radio frequencies, equal to the main carrier frequency plus the audio frequency and minus the audio frequency respectively. Thus when the audio frequency of a single 1,000-cycle note is added to the carrier frequency it gives frequencies of 501,000 and 499,000 cycles. In the same way sound frequencies between 100 cycles and 10,000 cycles result in the similar individual radio frequencies being transmitted for each individual audio frequency.

The function of the receiving set is to unscramble this tremendous number of radio frequency currents and reproduce them as sounds corresponding to those at the transmitter. For the sake of simplicity assume that a single 1,000-cycle note is to be transmitted, giving radio frequencies of 501,000 and 499,000 cycles, which, with the 100,000-cycle carrier wave, are picked up by the radio set. By what is known as the phenomenon of beats or heterodyning, the 501,000-cycle combines with the 500,000-cycle wave to form two frequencies, one of 1,000 cycles and the other of 1,001,000 cycles. The latter is inaudible, due to its high frequency, but the former is the original 1,000-cycle note sent out from the transmitter. In the same way the carrier wave beats or heterodynes with the 499,000-cycle wave to form an audible 1,000-cycle note and an inaudible 999,000-cycle note.

Each of the other super-imposed audio frequencies beats in like manner with the 500,000-cycle frequency so as to combine and give a frequency corresponding to the original sound. This explanation naturally leads up to the subject of distortion.

In the same way that the carrier frequency beats or heterodynes with each of the side frequencies to produce an audio frequency corresponding to the original signal transmitted, so the reader will recognize that it is also possible for two side frequencies to beat with each other to produce an audible

Continued on Page 81

Continued from Page 79

frequency. Let us go back to our simple example given above. The carrier frequency of our assumed transmitter is 500,000 cycles, and the transmitted signal is a 1,000-cycle note. This resulted in two additional radio frequencies being transmitted, 499,000 cycles and 501,000 cycles. When each of these heterodynes with the carrier frequency of 500,000 cycles the original 1,000-cycle note is produced. But suppose that the two side frequencies 499,000 cycles and 501,000 cycles heterodyne with each other. From the explanation given above the resultant beat frequency produced is the difference of the two radio frequencies, which is 2,000 cycles, in other words double the original sound frequency. Thus a double frequency distortion is produced, which means that the original sound is accompanied by a sound of twice its frequency which is not initially present in the sound.

This explanation for a simple single audio frequency applies equally well to a complex sound having a combination of numerous frequencies in it. Just as the side frequencies produced by a single audio frequency will heterodyne to produce a distortion of double frequency, so will the large number of side frequencies resulting from a complex sound beat with one another to produce distortions of double, triple, quadruple and other multiples of the original frequencies. Thus frequencies not originally present in a sound are introduced at the receiving end.

This type of distortion is entirely apart from the double frequency distortion produced by the vacuum tube detector due to its curved charactertistic, or to distortions introduced by transformers, etc. The former type of distortion is entirely due to the transmitter end of the radio system, whereas the latter are due largely to the receiver end of the system. In general it may be said that the distortions introduced at the receiver are more serious than those introduced at the transmitter end. The transmitter end of the radiophone system may be constructed so that it is relatively free from distortion. By properly taking care of the modulation at the transmitter, the double and triple and multiple frequency distortions described in this article may be made so small that they do not affect appreciably the quality of speech or music. The receiver end of the system, however, introduces distortions which do affect quality considerably, and hence this aspect of the entire radiophone problem requires more study and development.

Ever happen to think that an electrolytic rectifier, such as are in common use in amateur transmitting stations, can be also used on lower voltages, with a good filter, to supply the power to a receiving set amplifier?

ARE THE SHORT WAVES NEW?

Continued from page 14

Hertz, the German physicist who was first to measure the length of a radio wave. He also invented the "Hertzian Oscillator," a device that enabled him to generate radio waves a few meters in length and transmit them to the other side of his laboratory where he received them on crude apparatus.

Now, after all these years, we are building "Hertzian Oscillators" for use in our latest short wave experiments. There is only one important difference; Hertz used a spark coil to energize the radiating circuit and a pair of spark balls as the receiver—we now use vacuum tubes for transmission and reception, which are infinitely better.

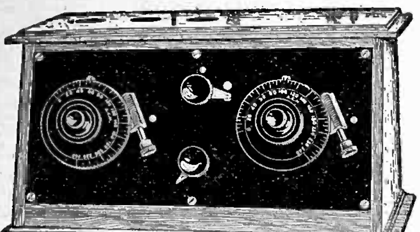
After Hertz' experiments short waves were forgotten for they were believed to be of no practical use. As radio became man's servant in the transmission of intelligence it was required to transmit over greater distances. To transmit over greater distances more powerful stations with larger antennas and transmitting on longer wavelengths were built. So the general trend was away from the short waves.

The use of short wavelengths was re-established in a small way during the world war when sets working on short wavelengths were used for short distance communication by the various armies. The good results obtained no doubt is partly the cause of the present day intense interest in short waves. The long distance records made in recent years by amateurs working on wavelengths in the vicinity of 200 meters has also been a factor in drawing the attention of commercial companies and others towards the shorter wavelengths.

What are the advantages of using short wavelengths? you ask. The main advantage is the high radiation efficiency gained. For the same input power stronger waves will be sent out from the antenna the shorter the wavelength used. Static effects are greatly lessened at short wavelengths, one reason being simply because the antennas used at the receiving end are not large enough to pick up an appreciable amount of static from the atmosphere. Short wave transmission has disadvantages, however, in fading and daylight and night effects, which are more noticeable than they are in the use of the long wavelengths. Though the present interest in short wave work is opening a great field for future experimentation and activity there is no danger of any of the large stations tearing down their antennas and starting in business again on two or three meters.

The use of short wavelengths is not new. Much of the "latest dope" can be found in books dealing with the results of the earliest of radio experimenters.

A. C. H. Three-Tube Concert Receiver



SELECTIVITY

Using sensitive instruments in connection with two A. C. H. Worm Drive Sharp Tuning Instruments. Can be used as one or three tube Receiver. Operates on 199 or 299 dry cell tubes. Batteries Amplifier 90 volt B. Detector 22½ volt B. A battery, three dry cells. C battery, one dry cell. All connections on back.

Installment Plan. No References.

WRITE US AS FOLLOWS:

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Gentlemen:

Enclosed please find $20.00. Send me one A. C. H. Three Tube Receiver. Upon receipt of same I agree to pay you $1.00 a month for fifteen months until the total amount of $35.00 is paid. This Receiver is to remain your property until full amount is paid. You guarantee this set to operate on the air.

SIGNED.

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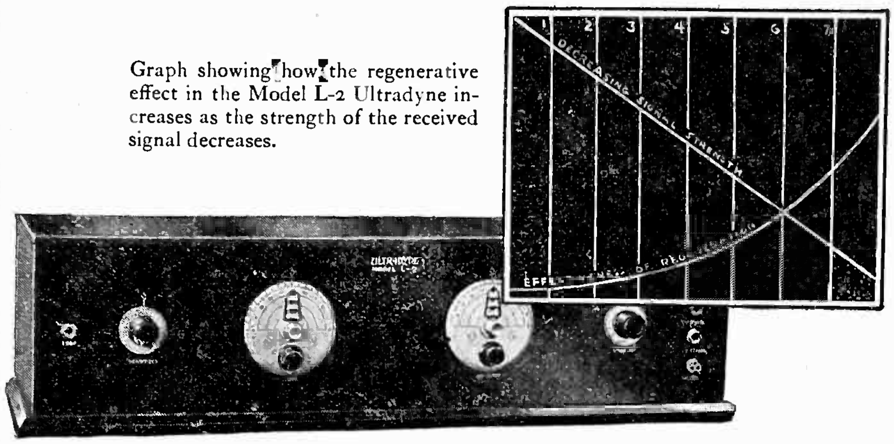

Graph showing how the regenerative effect in the Model L-2 Ultradyne increases as the strength of the received signal decreases.

Why the ULTRADYNE Gets Distance on the Loud Speaker!

Ultradyne Kit

Consists of one low loss Tuning Coil, one low Loss Oscillator Coil, one special low loss Coupler, one type "A" Ultraformer, three type "B" Ultraformers, four matched Grid Condensers. The Ultraformers are new improved long wave frequency transformers especially designed by R. E. Lacault, Consulting Engineer of this Company and inventor of the Ultradyne. To protect the public, Mr. Lacault's personal monogram seal (R. E. L.) is placed on all genuine Ultraformers. Ultraformers are guaranteed so long as this seal remains unbroken.

$30.00

Unlike other Super-radio receivers, the Ultradyne, with its exclusive use of the "Modulation System" and special application of regeneration, is capable of detecting and regenerating the faintest signal, making it audible on the loud speaker.

The regenerative effect in the Ultradyne increases as the strength of the signal decreases, until the signal becomes so weak that no amount of amplification will make it audible.

A radical advance in radio engineering and the latest development of R. E. Lacault, E.E., A.M.I.R.E., Chief Engineer of this Company and formerly Radio Research Engineer with the French Signal Corps Research Laboratories.

You will marvel at the unusual selectivity, sensitivity and range of this new Model L-2 Ultradyne.

Write for descriptive circular.

HOW TO BUILD AND OPERATE THE ULTRADYNE MODEL L-2

Send for the 32 page illustrated book giving latest authentic information on drilling, wiring, assembling and tuning the Model L-2 Ultradyne Receiver.

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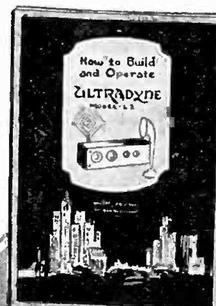
ULTRADYNE

MODEL L-2

PHENIX RADIO CORPORATION

9 Beekman St. New York City

R E L



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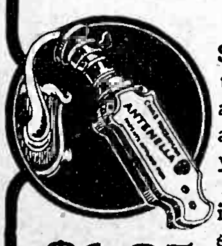

Why pay $10.00 or more to have an aerial spoil the appearance of your home? *Antenella* eliminates all unsightly wiring, lightning arresters, etc., and precludes the possibility of dangerous grounding on a power line. It also stops "canary bird" reradiation from nearby oscillating sets interfering.

$1.25

ANTENELLA is not only a real distance getter but also successfully overcomes static annoyances.

At your dealer, otherwise send purchase price and you will be supplied postpaid.

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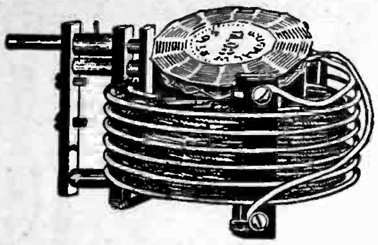

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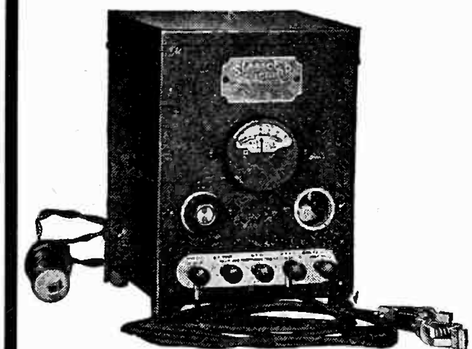

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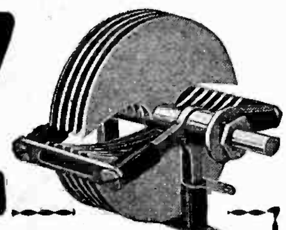

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What makes a good condenser? Send for this free folder and post yourself on today's requirements. This article is full of meat. It makes plain all the electrical as well as the mechanical qualities of a good condenser.

If you are planning to build a receiving set or to bring your present one up to date, go to your dealer and ask to see the new

Premier "CROFOOT" Variable Condenser

"CROFOOT" has all the necessary electrical and mechanical features. It is a real low loss instrument. It has the lowest minimum capacity yet attained—.000005 M. F. and the greatest tuning ratio—1 to 74. Made entirely of brass and hard rubber giving remarkably low skin resistance and low insulation leakage. Semi-straight line plate construction. All plates soldered; a feature identified by the "red stripe." A sturdy, smooth acting, compact and graceful instrument. Mounts with one hole. Ratios 1 to 19, 1 to 42, 1 to 53 and 1 to 74. Price from $2.75 to $3.75. Vernier attachment with dial 75 cents additional.

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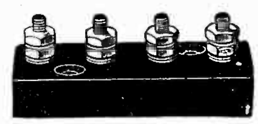

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KENNETH B WARNER EDITOR

Oct. 28th, 1924.

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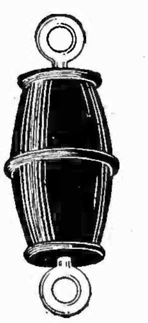

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Best Super-Heterodyne Kit $77.57
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SHORT-WAVE, LOW-LOSS TUNER

Continued from page 19

for a given wavelength range will depend on certain constants within the set and on the size of your condensers with their maximum and minimum capacity values. The number of turns given here are on the basis of an 11-plate (.00025 mfd.) condenser and for waves not over 200 meters. For 23-plate (.005 mfd.) proper changes may be made by a little experimenting. For broadcast waves the values of turns must be considerably increased. Because of the clip arrangement at *X, Y, Z,* several coils may be made up for trial.

It is well to vary the turns in the *YZ* portion of coil *K* for a given number in *XY*. Distribute a few twist connections for experimenting and after the proper value is found the excess turns may be clipped off and removed.

A variable grid leak is a positive necessity, as unusual howling may be experienced with a fixed leak of wrong value.

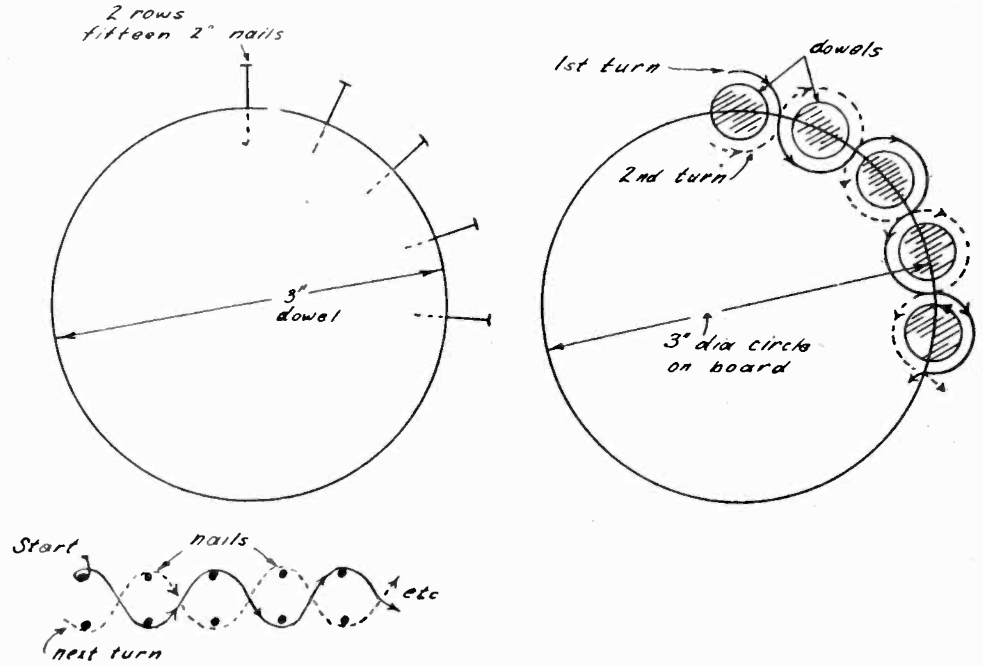


Fig. 3. Constructional Details for Various Types of Coils

CALLS HEARD

(Continued from Page 48)

By 9AUY and 9CEK on a trip to Yellowstone Park

Heard in Cody, Wyo., on a bedspring for aerial and water pipe for ground, July 6th—5fm, 6crs, 6rv, 6awt, 6adb, 6km, 6bwl, 6chl, 7it, 7mi, 7afo, 7wm, 7co, 7alk, 7agl, 9ahz, 9zg, 9efm, 9aey, 9dpx, 9dxy, 9cms, 9ddp, 9dkl, 9nu, 9dge, 9dmt, 9dfz, 9cpu, 9caa, 9dlm, 9abk, 9zt, 9amb, 9bxg, 9djf, 9chc, 9aau, 9bnu, 9djp, 9bvo, 9dma, 9dms, 9auy, 9eae.

Can.—3ni, 4aj, 4cb, 5gg, 5fm, 9aim, 9ckd, 9dpx, 9dqn, 9amb.

Heard in Otis, Colo, with aerial 3 ft. off the ground—6cbb, 6rb, 6dno, 6cgw, 6adm, 6jp, 6kb, 7akk, 9aal, 9dkl, 9ali, 9bew, 9doe, c5gg, 6fo, 7zu, 9dkv, 9dsa, 9eam, 9aob, 9cgy, 9cfi, 9bkk, 9cyg, 9eam, 9aby, 9cpb, 6rm, 6bwl, 6brf, 5apt, 7gk, 7qc, 9dkv, 9ql, 9vm, 9ckj, 9xbb, 9dmj, 9ary, 9ash, 9cht, 9dng, 9eam, 9bjk, 9doe, 9mf, 9aal, 9aei.

Can.—3ni, 5akn, 5rg, 6ajh, 6cbb, 7gr, 7ij, 8vy, 8hn, 9dng, 9aud, 9ayk, 9aaw, 9bpt, 9brx, 9abt, 9dhj, 9ako, 9ayo, 9doe, 9ejn, 9cfi, 9ado, 9axo, 5sg, 5rg, 5ge, 5oq, 5iq, 7no, 9avm, 9caa, 9eam, 9eae, 9dng, 9aal, 9aob, 9wo, 9emf, 6aja, 6cek, 6cqe, 9cpu, 9dhs 5agn, 5sd, 5aex, 5iq, 6crs, 7co, 9eko, 9cee, 9aob, 9cfy, 9cpu, 5aex, 5ame, 5agn, 5ajh, 5awa, 5sg, 6crs, 9dkv, 9amb, 5gk, 9dng, 9caa, 5aqw, 5acl, 5amw, 7no, 9dkv, 9aob, 9eam, 9caa.

For cards QSL to 9AUY, QRK, 9AUY or 9CEK?

By James Bonelli, 141 Park Ave., Brooklyn, N. Y.

1al, 1at, 1aw, 1ck, 1cm, 1da, 1ef, 1gw, 1ana, 1bdh, 1bhm, 1cme, 1xak, 3ks, 3oq, 3add, 3cjn, 3cyj, 4al, 5ck, 5nn, 6ab, 6chx, 6xad, 8cm, 8pl, 8tp, 8vt, 8vq, 8ze, 8add, 8cci, 8bce, 9cz, 9ep, 9hk, 9zt, 9chi, 9cii, 9dbp, 9dng. Canadian's—2ct.

(Continued on Page 90)

CALLS HEARD

(*Continued from Page* 88)

By 2AHI, 365 New York Ave,, Brooklyn, N. Y.

(1aar), 1adn, (1agt), 1avx, 1awq, 1azr, 1bhs, 1bjo, 1bye, (1rr), 1rv, 3bnu, 3buy, (3cdk), (3cdu), 4ea, 5vv, 7boq, 7du, (8aem), 8bdw, 8boy, 8bpu, 8jz, (8kc), 8qd, 8rj, (8tt), 8wz, (9cbz), 9dhg, 9dlw, 9dpc.

Will those wrkd pse QSL gldy QSl hr—

By 6AMM, Bruce Stone, Rt. 2, Bx, 124, San Jose, Calif.

2eat, 4aj, 4cr, 4kp, (5aaq), 5aar, 5aaw, 5acm, 5ado, 5aex, 5aij, 5aiu, 5akn, 5aky, 5alz, 5amo, 5fy, 5jj, 5ka, 5nw, 5qd, 5rg, 5rp, 5sd, 5xd, 5zh, (6amw), 7abb, 7abk, 7acb, 7acf, 7aci, 7ada, 7adf, 7ads, 7aek, 7af, 7afa, 7afe, (7afn), (7agz), 7ahs, 7aif, (7aim), 7aip, 7aiy, 7ajd, (7ajq), 7ajt, 7ajy, (7akk), 7alc, (7alk), (7av), 7bj, (7by), 7ca, 7cb, 7co, 7dm, 7dn, 7el, 7eo, 7ez, 7fb, 7fg, (7fr), 7ft, 7fy, 7ge, 7gj, (7gr), (7gv), (7hj), 7ho, 7ie, (7ix), (7jq), 7js, 7ke, 7kv, 7kz, (7ly), (7ma), (7mf), 7mj, 7no, 7nw, 7nx, (7ob), 7od, (7oh), 7ok, 7om, 7oy, (7pm), (7pz), (7qc), 7qd, 7rk, 7rr, 7rw, 7ry, (7sf), (7tq), 7ve (7vn), 7wg, (7wm), 7yl, 7zf, 7zl, 7zm, 7zu, 8ak, 8brc, 8bwb, 8cbu, 8cgo, 8coj, 8dae, 8dg, (8die), 8djd, 8er, 8tt, 8yd, 8yu, 8zl, 9aau, 9abc, 9abf, 9ado, 9aep, 9afm, 9agl, 9ahz, 9amf, (9aog), 9aou, 9ap, 9atn, 9avu, 9awt, 9awu, 9axx, 9bch, 9bdq, 9beo, 9beu, 9bez, 9bfy, 9bjh, 9bjk, 9bkb, 9blr, 9blt, 8bpn, 9bqq, 9bqy, 9bre, 9brk, 9bto, 9bvn, (9byc), 9ccm, 9ccs, 9cfi, 9cga, 9cgu, 9chg, 9chp, 9cht, 9cji, 9cju, 9cpu, 9ctg, 9ctr, 9cyz, 9czg, 9czn, 9dat, 9daw, (9ded), 9dfn, 9dfp, 9dgi, 9dig, (9dip), 9dkq, 9dkv, 9dky, 9dl, 9dmt, 9dni, 9dnp, 9doe, 9dr, 9drp, (9drx), 9ds, 9dsw, 9dun, 9vv, 9dwz, 9eam, 9eeg, 9efu, 9eha, 9ehg, (9eky), 9hd, 9ij, 9lz, 9wo, 9yam.

Canadian—4co, 4dq, 4fn, (5an), 5at, 5ba, (5cn), (5ct), 5ef, (5gf), (5gg), (5hg), (5hs).

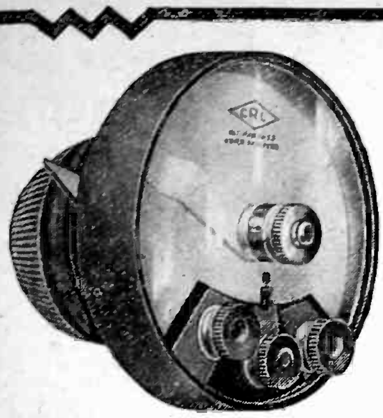
By C. E. Duncan, 6ARB, 3020 Acton St., Berkeley, Calif.

(1gv), (1kc), 1ow, 1py, (1sw), (1tb), (1te), (1aac), (1abf), (1bep), (1bgq), (1cmp), (1xw), (1xav), (2ku), (2mu), (2rk), 2xd, (2aay), (2ana), (2bqb), (2brb), (2brc), (2cee), (2cqz), 2crd, (3bh), (3bhv), (3bdo), (3bsb), (3cdg), 4gt, (4io), (4ku), (4my), (4qf), (4sa, Porto Rico), (5dw), 5ek, (5jf), 5mi, (5ph), 5sd, (5uk), (5za), (5aai), (5aaq), (5abe), (5ags), (6bdt, Honolulu), (7zm), 8jq, 8pl, (8ve), 8qv, (8abm), 8ada, 8avx, (8axf), 8brc, (8bpa), (8byn), (8dea), (8dhw), (8zah), (9vz), (9xi), (9azj), (9azr), (9bcd), (9bdu), 9bmk, (9caa), (9cbf), (9ccm), (9ccx), 9cie, (9ctr), (9ded), (9dxr), (9eld), nfv, (nkf), lmo, wgh.

Canadian—(3aa), 3fv, 3ly, (4cr), (4cw), (4dq), (4gt), (5an), (5ef), (5go), (5hh). 6arb is a 250-watt bottle, input 475 watts, all districts worked regularly on 76 meters.

By 2AEY, R. Groebe, 338 El Moro Ave., Elizabeth, N. J.

1abp, 1abt, 1adu, 1aea, 1aeu, 1agh, 1ahi, 1aid, 1aja, 1ajl, 1akz, 1all, (1ams), 1apu, 1aqm, 1arc, 1atj, 1aur, 1avj, 1azl, 1bai, 1bfq, 1bgc, 1bgt, (1bhr), 1blx, (1boa), 1bom, 1bqe, 1bqe, 1bqk, 1bqt, 1bsd, 1bsp, 1bwx, (1caz), 1ac, (1bc), 1qb, (1gh), 1ii, (1om), (1rq), 1se, (1ve), 1vf, 1xu, 1zz, 3aay, 3acr, 3acy, 3adb, 3aeg, 3aeq, 3afs, 3aha, (3ahp). 3aoj, 3ari, 3bhv, 3bif, 3blu, 3bml, 3bmz, 3bqp, 3bsb, 3btu, 3buy, 3buv, 3bwj, 3bwt, 3ccx, 3cfc, 3cgc, 3cgd, 3chc, 3cjn, 3cjw, 3as, 3bg, 3bu, 3bz, 3dq, 3ds, 3du, 3eh, 3ff, 3fu, 3nd, 3hg, (3hm), 3hq, 3jo, 3mb, (3mf), 3mk, 3mo, 3oo, 3rg, 3rs, 3tf, (3ti), 3tj, 3tt, (3uq), (3uy), 3uz, (3vu), 3vw, 3wb, 3zm, 3zo, 4ai, 4bq, 4cu, 4du, 4dy, 4ea, 4eg, 4eh 4eq, 4fs, 4fy, 4gw, 4hr, 4io, 4ja, 4ka, 4kk, 4kl, 4lp, 4lx, 4mb, 4mi, 4my, 4oa, 4og, 4pd, 4pi, 4qf, 4qw, 4rl, 4rr, 4sa, 4sb, 4si, 4tj, 4un, 4us, 4ux, 4vi, 4vn, 4xe, 4zd, 5aai, 5aaq, 5acm, 5aeq, 5agj, 5ago, 5ail, 5air, 5ajn, 5akw, 5alr, 5alt, 5ame, 5amf, 5amh, 5ac, 5aw, 5cn, 5ek, 5gk, 5ka, 5lh, 5ot, 5ah, 5qi, 5rg, 5rh, 5vv, 5xa, 6xad, 6cgw, 8abf, 8abm, 8acn, 8add, 8aey, 8afn, 8ahq, 8ahr, 8aig, 8aih, (8ajf), 8aju, 8akk, 8akr, 8ale, 8alf, 8ali, 8alk, 8alw, 8alx, 8aly, 8amq, 8ams, 8anb, 8apn, 8apo, 8apr, 8aqp, 8aqu, 8arn, 8asz, 8atp, 8atz, 8avd, 8avj, (8avx), 8awa, 8axa, 8axf, 8axo, 8ayw, 8bau, 8bbm, 8bbw, 8bdv, 8bff, 8bgz, 8bjt, 8bjz, 8bkm, 8bky, 8blg, 8bmi, 8bmy, 8bnu, 8boq, 8boy, 8bqi, 8bsc, 8bsf, 8bsu, 8btf, 8bwk, 8bxp, 8bym, 8byn, (8bzf), 8bzg, 8cbm, 8cbp, 8cci, 8ccn, (8ccw), (8cfv), 8cko, 8cmt, 8cng, 8cni, 8cnl, 8cqh, 8cse, 8cta, 8cuk, 8cvh, 8cvm, 8cwl, 8cwx, (8daa), 8dal, 8daw, 8dbl, 8dbo, 8dbp, 8dcz, 8dea, 8dfo, 8dga, 8dgo, (8dgt), 8dhb, 8dhg, 8dhj, 8dhs, 8dlz, (8dki), 8dmh, 8doq, 8dqv, 8dzi, 8xba, 8ah, (8aq), 8bf, 8bn, 8bo, 8bp, (8dn), 8ef, 8es, 8fg, 8fs, (8fu), 8gz, 8jq, 8kj, 8mc, 8na, 8nz, 8oa, 8pj, 8qd, 8rc, 8rj, 8rv, 8uq, (8ut).



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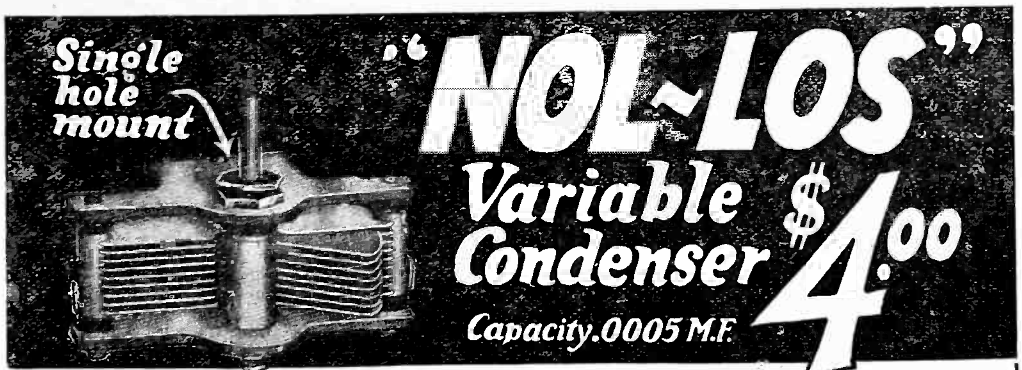

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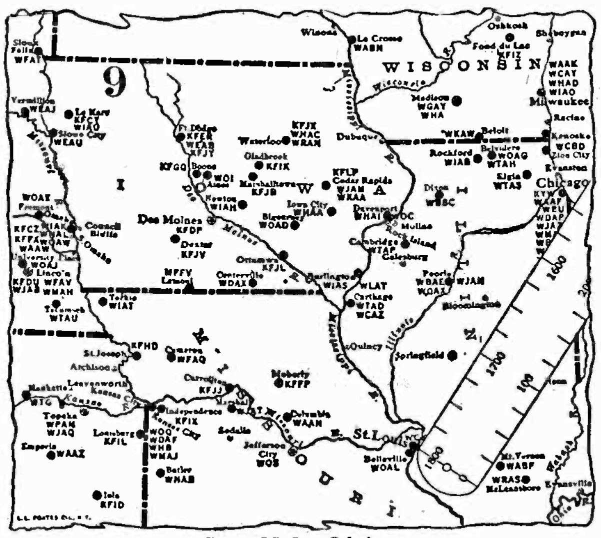

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ELEMENTS OF TUNING

Continued from page 36

The greater element of complication in the use of the loose coupler is compensated for by the freedom from interferance that it gives. The coils should be as loosely coupled as is possible with any given signal if the latter result is hoped for; it is customary to place a variable condenser between points *C* and *D* to assist in tuning the secondary circuit.

Fig. 4 illustrates the method of reducing capacity in any given number of condensers. When they are connected in series the capacity between points *A* and *D* is less than that between *A* and *B*, or *A* and *C*. Should you want to get down to a shorter wavelength place a variable condenser between the aerial lead and inductance as shown. This cuts down the total capacity.

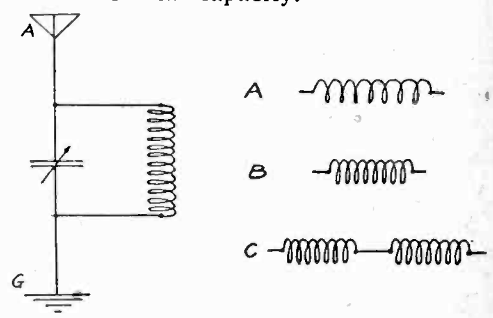

Fig. 5. Parallel Connection of Capacity
Fig. 6. Variometer Principles

When the variable condenser is placed as shown in Fig. 5 the wavelength is increased as the capacity of the condenser is added to that of the aerial. So we see that when capacities are connected in parallel the total capacity is equal to their sum.

The most efficient form of variable inductance is the variometer. When the magnetic action of a coil is to be heightened the various turns are brought closer together. This is shown in Fig. 6. *A* represents a widely spaced coil, and *B* a closely spaced one; the inductance of *B* will be greater than that of *A*. In *C* is shown two coils wound in the same direction. As they are brought nearer the inductance is increased. When they are completely opposed, as is possible with a variometer which turns one on a shaft inside the other, the total inductance is as near zero as an inductance can be. This arrangement provides a means of varying it with the greatest economy of signal strength.

Don't forget to put about a 50 or 100 watt lamp in series with your *B* battery, when you install it. This often will save you the burn-out of a whole set of tubes, if things get short-circuited.

Fuses in the *A* battery lead, when using a storage battery, will sometimes save a lot of damage. They are cheap enough not to be left out of any set.

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The rate per word is eight cents net. Remittance must accompany all advertisements. Include name and address when counting words.

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AGENTS WANTED TO ADVERTISE OUR GOODS and distribute free samples to consumers; 90c an hour; write for full particulars. American Products Co., 2132 American Bldg., Cincinnati, O.

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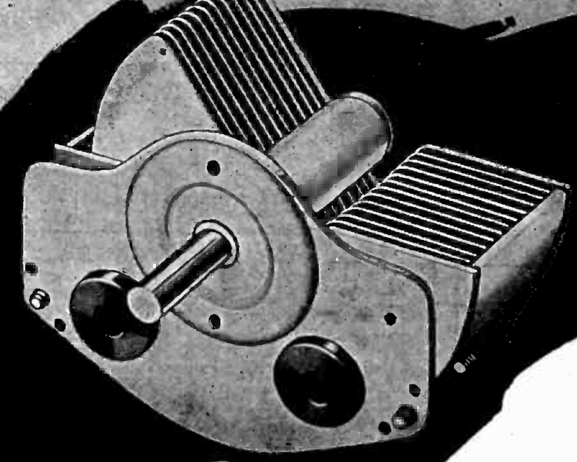
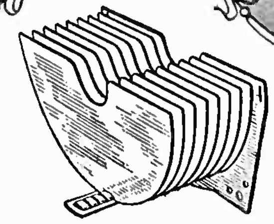
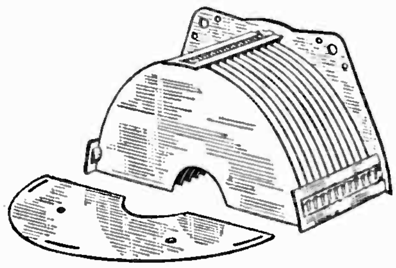
Making the New Bradleydenser



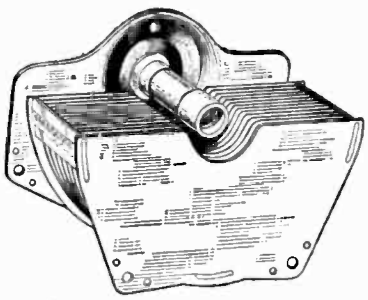
Brass Plates
Low Loss
Low Minimum



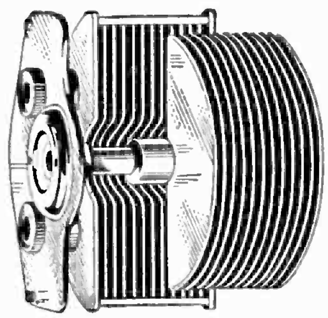
The brass stator plates are soldered to notched spacer bars that maintain perfect alignment.



Plates, spacer bars and end plates are all soldered into a solid unit.



The bearing stud, attached to the stator mounting plate, supports the rotor. See illustration at bottom of this page.



Rotor revolves on a double bearing that is independent of the dial shaft.

NEW and distinctive features are embodied in the design of the Bradleydenser. For instance, the rotor revolves on a long double bearing that preserves rigid alignment and yet eliminates the extra outer end-plate. This reduces the amount of di-electric material and increases the efficiency.

Every joint is soldered. This, combined with the use of brass plates, further increases the operating efficiency. Another feature is the dust cap over the stator plates; it is removable without tools.

The Bradleydenser is made in four sizes: 0.00025 M-f. at $4.50; 0.00035 M-f. at $4.75; 0.0005 M-f. at $5.00; and 0.001 M-f. at $6.00. Leading radio dealers are showing them, now.

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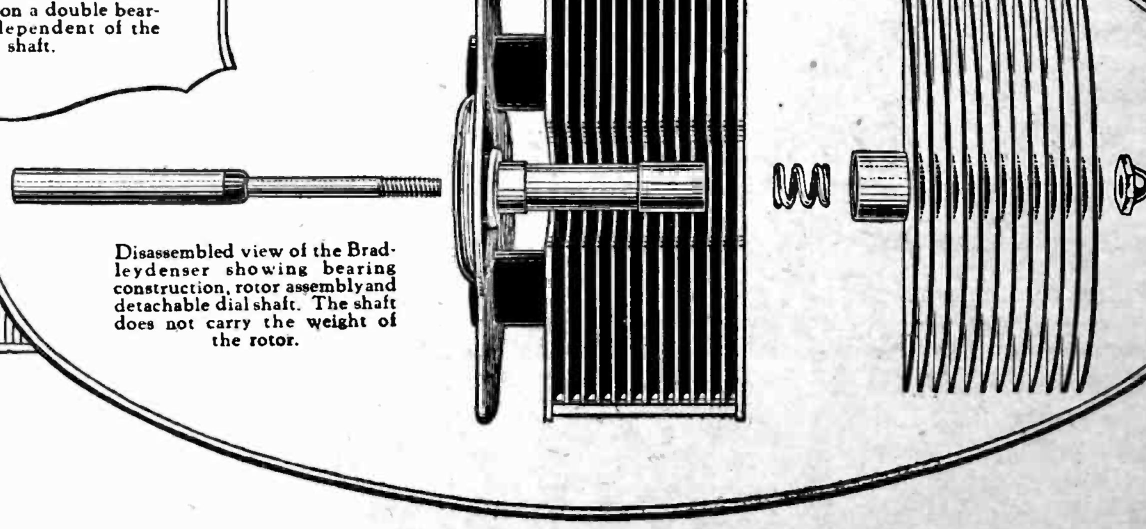

Disassembled view of the Bradleydenser showing bearing construction, rotor assembly and detachable dial shaft. The shaft does not carry the weight of the rotor.