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VOLUME IX MAY, 1927 NUMBER 5

CONTENTS

Forecast of Contributions for June Issue

I. M. Ingerson has adapted G. M. Best's "L. C. Circuit" for installation in a phonograph drawer 13 x 17 x 2⅜ in. The clever manner in which he has utilized this space for housing a most efficient four-tube set may inspire others to do likewise.

— : —

G. M. Best has worked out the dimensions for home-built transformers and choke to be used in an *ABC* socket power capable of supplying 350 milliamperes at 220 volts. It uses a new tube as a rectifier.

— : —

Lieut. Jennings B. Dow, U. S. N., in an article entitled "Why the Grid Leak?" answers many questions about the purposes and limitations of grid resistances and condensers.

— : —

Alexander L. Sherwood describes the development, the characteristics and the practical use of the condenser microphone.

— : —

Manfred von Ardenne discusses recent foreign developments in foreign multi-valve tubes, especially the Lowe duplex and triplex valves.

— : —

For the guidance of the experimenter Everett W. Thatcher illustrates and describes a laboratory transmitter of unusual flexibility and range. It is particularly well adapted to 20, 40, and 80 meter transmission.

— : —

D. R. Lane tells of the Pacific Air Transport's plane equipment with radio direction finders in connection with radio beacons.

— : —

Harry R. Lubcke explains how to measure most of the constants of an alternating current circuit with a wattmeter, voltmeter and ammeter.

— : —

The next installment of Samuel G. McMeen's series of articles on Experimental Shop Methods is concerned with such minor tools as a spring-winder, sanding machine, scale, microscope, and pendulum.

— : —

P. S. Lucas has provided some unusually good material for the commercial brass-pounder. Many readers advise that they enjoy this department although not in the commercial game.

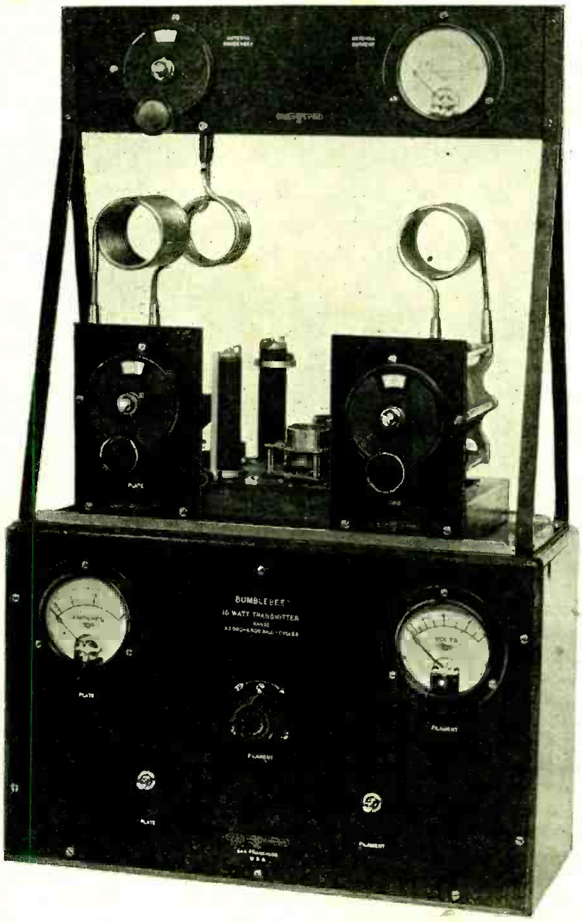
— : —

The fiction feature is a story by Armstrong Perry entitled "DX Love."

BUMBLEBEE

THE IDEAL "HAM" SET

Described In This Issue By Gerald M. Best



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2	Leak Mountings, Daven	.75	1.50
2	Resistances, Allen Bradley, 10,000 ohms	.75	1.50
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2	Panels 4x6x3/16 for condensers, Bakelite or Formica	.48	.96
1	Panel 5x6x3/16 for tubes, chokes and cond.	.60	.60
6	Binding posts with strip 1x8, Eby	1.50	1.50
10	Coils with 1-2-4-5-7-8-9-10-11-12 turns with 2 inch center diameter	1.50	15.00
6	Special jacks for mounting coils	.25	1.50
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But those days are gone forever. Our radio is no longer just a magic plaything. Whether we buy our set, or prefer the fascinating pastime of building our own, we now demand that the radio receiver of today be a satisfactory means of entertainment.

This change in public viewpoint and other changing conditions, like the multiplication of broadcasting stations and the greatly increased power of many of them, have brought forth new problems to be solved and set up a new standard of requirements for the modern radio receiver.

First, the quality of reproduction must be unblemished. The tonal quality must be true and harmonious with all overtones and harmonics present—an actual re-creation of the selection broadcast.

Second, it must possess the quality of selectivity in a satisfying degree, especially when operated close to a powerful broadcasting station. Nothing is more distressing when listening to a distant program you want to hear than to have a local station always breaking thru in the background.

Third, the receiver must be capable of producing the maximum volume desired without the slightest trace of distortion. This volume must be smoothly adjustable down to the faintest whisper, to suit the operator's mood or the occasion.

Fourth, while most people are satisfied at first to listen to the programs of nearby stations, it is seldom long before the average user is dissatisfied with a receiver on which he is limited to local programs. Therefore our ideal receiver must have distance-getting ability.

Fifth, a high degree of amplification must be obtained on all wavelengths, and not at only the lower wavelengths, as with so many of the ordinary variety of receivers.

Sixth, the ease of tuning should be in accord with the idea that any member of the family, from the six year old to the grandfather, should be able to tune in most stations without the slightest semblance of trouble.

Seventh, the circuit must be of such design that there will be no manifestation of what is commonly known as oscillations: unearthly squealing and howling noises that so often upset the peace of a neighborhood.

That's the kind of a radio receiver you and I have always wanted!

Now it doesn't take much heavy thinking to come to the conclusion that such a set would be the product of:

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(c) efficient tubes, proper plate voltages, and a good loud speaker.

Wonderful steps have been made this last year in audio amplification. The new audio transformers now available, the much improved design of resistance and impedance coupled amplifiers, or the remarkable double impedance Truphonic, together with the new amplifier tubes that have been developed solve one part of our problem in designing the radio receiver we have always wanted. Loud speakers, while still far from perfect, have been improved to a remarkable degree. Good B eliminators are now available to give us proper and constant plate voltages.

There remains but the problem of a powerful, selective and distortionless radio frequency amplifier.

When Wanted

the Radio You Wanted

AND NOW I come to the point I have been leading up to. Recent laboratory developments make it possible to have just such a radio frequency amplifier, and better still you can easily install it in place of the less efficient one now *in your present set.*

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Two models of Quadraformer radio frequency transformers have been made available to the radio fan in the last two years and remarkable results in comparison with other coils were obtained by their use.

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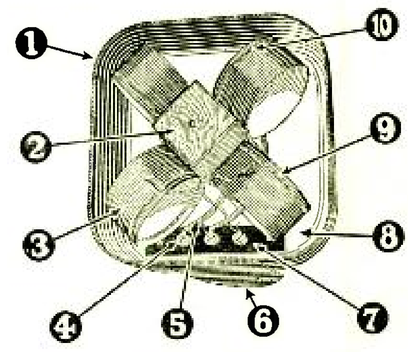
Inside Facts on the New Quadraformer Coils



1. A scientifically designed shield against impact reception and electrostatic coupling. Heavy drawn copper, handsomely finished in natural copper lacquer, trimmed in gold.
2. The Quadraformer coil sections are self-supportings, being mounted on a single central insulating block. This gives the lowest possible dielectric losses and the least insulating material in the field. It is the elimination of just such losses in the new *Quadraformer* coils that keep the high frequency resistance at a minimum, securing increased selectivity, volume and natural tone quality.
3. This shows one of the four windings making up the complete secondary. Special triple insulated heavy copper (No. 28) magnet wire is now used in both primaries and secondaries. The extra heavy insulation separates the turns more than is usual and reduces the inter-turn capacity greatly. The resulting complete transformer has the highest inductance combined with the lowest distributed capacity of any closed magnetic field coil.
4. All connections between the windings and the terminal binding posts are first securely fastened mechanically and then firmly soldered, using rosin flux, for permanency.
5. All primary leads, which carry the *B* battery voltage, are protected by genuine Italian flame-proof varnished insulating—the highest grade "spaghetti" that can be bought.
6. The mounting bracket is of sturdy construction and holds the completed transformer firmly in place on baseboard or sub-panel.
7. The binding post terminal strips are genuine Celoron.
8. An accurate laboratory determined air-space separates the Quadraformer windings at all points from the shield. All interstage Transformers are accurately matched on a master oscillator and packed in matched pairs for most efficient operation with dual condensers.
9. The primaries are now wound with the same heavy wire used in the secondaries. The primary windings will stand a load of 3 amperes without heating, and are *positively guaranteed not to burn out.*
10. A heavy insulating string separates each primary winding from its associated secondary winding, eliminating the bad effects (broad tuning, for one) of the capacity coupling between primary and secondary present in most transformers. It is also a further guaranty against burn-outs.

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RADIO

WITH WHICH IS INCORPORATED "RADIO JOURNAL"

VOLUME IX MAY, 1927 No. 5

Radiotorial Comment

Standard Radio Terms

Standardization of radio nomenclature has always lagged some years behind the progress in the art. The latest term to be officially adopted into the vocabulary of approved terms is "socket power." This, as defined by the radio division of the National Electrical Manufacturers' Association is "any device suitable for supplying *A,B,* and (or) *C* battery voltages to a radio receiving set from the house lighting supply circuit by the throw of a switch." This term is so much better than the various negative designations which have been used, such as battery eliminator or batteryless, that it will probably be widely adopted.

While there is not much likelihood that radio users will ever dispense with batteries entirely, socket power is gaining wide acceptance as a convenient source of plate voltage. It is less generally used to supply filament current and before it is fully perfected will find a formidable rival in the a. c. filament tube which will be an integral part of several 1928 model receivers.

Another phase that is sadly in need of standardization is the nomenclature for vacuum tubes. The present alphabetical and numerical designations are without rhyme or reason. The vacuum tube committee of the Radio Manufacturers' Association recently proposed a simpler and more logical system where each letter and number means something in describing the amplification factor, purpose, voltage and current of a tube. While this report has not yet been adopted, it represents a forward step in the march of progress. There is hope that international agreement will be reached on this important matter.

While the subject of standards is under discussion, it is interesting to note the general adoption of standard sizes in radio parts. There is no need for a multitude of odd sizes. Such practice is not only annoying to the constructor but wasteful of material. The Standard Section of the Radio Manufacturers' Association has made definite recommendations for all of the units used in receiver assembly. Most of these are already used by the members and final ratification of all of them is scheduled at the association's convention in June.

The Language of Radio

The meysteries of radio, to the uninitiated many, are locked up in incomprehensible language and diagrams. Even when freed from the shorthand symbolism of mathematics, the full meaning of the language of radio is difficult to understand. It requires a peculiarly progressive type of mind and many hours of study to grasp the intricacies of the subject.

Unlike the priesthood of the ancient Egyptian or Grecian mysteries, the modern high priests of radio do not intentionally try to confuse or awe the listener. While the result may be the same, and while it must be confessed that some self-styled radio experts sometimes try to conceal their own ignorance by parrot-like prattling, the real radio engineers are merely unfortunate in not being able to convey their thoughts in simple, every-day English.

The fault lies not with them but with the listener whose vocabulary does not contain words which express the exact meaning of the phenomena explained. Radio applies the principles of a science whose words were not in the common speech of ten years ago. Just as there are certain shades of meaning in French or German for which there are no English equivalents, just as American slang cannot be interpreted by a foreigner who has learned English, so there is a language of radio which must be learned to be understood.

Many radio expressions are almost identical in spelling and pronunciation in different languages. An American radio enthusiast can glean much information from a French, German, Spanish or even a Japanese radio magazine, of which there are many. The word "radio" appears in some form in all of them. "Capacity" is easily recognized under its variations in spelling. The French use "self" for self-inductance and for inductance in general. The Germans have their microphons. The Japanese use the same mathematical symbols.

Nevertheless, technical words are the curse of scientific writing. If the object could be seen or pictured directly instead of being portrayed in words, how much simpler and clearer it might appear! Photographs and pictorial diagrams are an aid to the understanding of actual construction but seldom can be used satisfactorily to show the action of radio circuits.

Furthermore the true scientist must often use a protective armor of technical words when his statements may in some way be misconstrued by technical critics. Standardized terms which have been defined and adopted by any particular branch of science are so precise or concise that they aid clear thinking by the specialists for whom they are written.

But they certainly be-fuddle the general reader. Their use in popular writings is to be deplored. The real masters of any science are generally able to translate technicalities into the layman's language. Otherwise the secrets are just as effectively guarded as before the realms of nature were opened up by the mind of man.

Yet anyone who really wants to understand radio must be prepared to learn its language. An amateur who can build and operate a short-wave transmitter has studied harder than any student who masters a subject ordinarily taught in the schools. As was yesterday, as is today, and as will be tomorrow, there is no royal road to learning.

The British Columbia Radiophone Service

Whereby Commercial Communication is Maintained with Forty Log Tow Tugs and Isolated Canneries

By James Montagnes

"GET me the tug *Sea Lion*," its owner told the radiophone operator in the Merchants' Exchange Building at Vancouver.

And from the other side of the counter the operator put his headphones on and spoke into the microphone, "Vancouver calling the *Sea Lion*." The tug was sixty miles away, towing a long line of logs, some 800,000 board feet in all. After three repetitions of his call the operator heard in his headset: "This is the *Sea Lion* calling Vancouver. Have you any orders?"

"Yes," replied Vancouver. "You are to proceed direct to Station Two instead of Vancouver. Is all well on board?"

To which the *Sea Lion* came back with an "O. K., got your message. All well here. *Sea Lion* speaking," and signed off.

The owner of the line of tugs to which the *Sea Lion* belonged, walked back to his office a few doors away in the same building. He had sent a message which saved him hundreds of dollars in time and actual cash, since he was thus able to deliver his goods before his competitor and get a better price for them.

Thought of the radiophone service did not enter his head. To him it was as natural as the long distance telephone service is to the majority of people: a matter of course. Undoubtedly it was a great invention, he would have agreed if anyone had ventured the opinion, but that it was a necessity and as regular as his meals, he was certain.

Had he been told that it was the first service of its kind in the world he would have been surprised. What? No one else think of such a simple expedient to keep in touch with tugs and other ships? Absurd. Yet notwithstanding this thought, the fact remains that Canada was the first to consider such a service as a necessity and was the first to make such a success of it.

To J. H. Hamilton, manager of the Vancouver Merchants' Exchange, belongs the credit for this service. He induced the Radio Branch, Department of Marine and Fisheries, to install such a service in the building, and subsequently at three other stations on Vancouver Island.

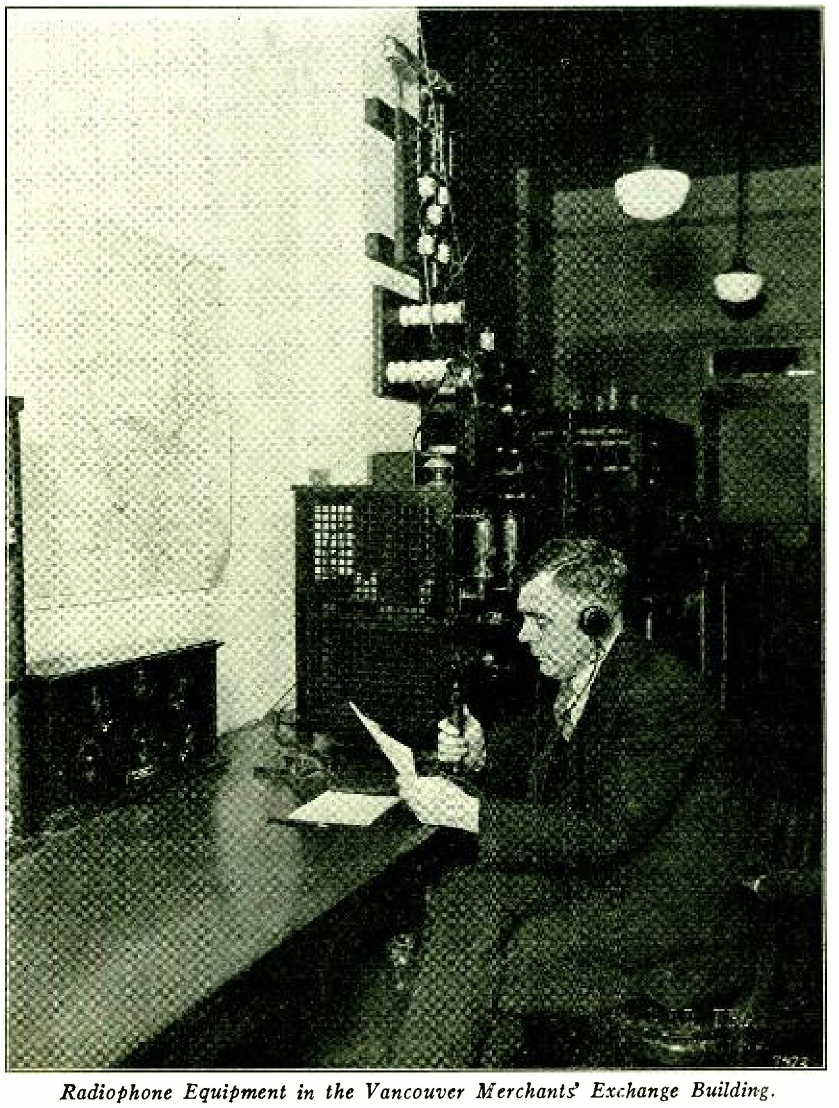
Some forty tug boats have been equipped by the Canadian Marconi Company with radiophone sets on a rental basis. These sets are simple to operate, being tuned and all ready for voice operation on 199 meters when installed. They are so built that a government certificated operator is unnecessary, but can be used by the captain or chief engineer.

Both the land and tug sets are of 50-watt power, operating from a small generator. Their average day range is at 60 miles, while they are capable of doing 140 miles under favorable circumstances.

What the service has meant for British Columbia shippers can be realized when it is known that owing to the irregular and indented coast line, land telegraph and telephone is out of the question. Thus, a tug was previously out of touch with its port unless it carried a costly radio transmitter with a licensed operator. The same applies to a cannery or lumber camp, of which there are many in the coast province.

The average tug, when towing anywhere from 1 to 30 sections of lumber, measuring on an average of 40,000 board feet to a section, can make but one mile an hour progress. Thus a three hundred mile trip is apt to take all of 300 hours to complete. Formerly this meant that a tug would receive its orders at departure, and if there was a change in these orders after the tug had left, the chance of catching up with it was very remote.

Now when a lumber dealer is sending a load down one of the many waterways which crisscross the province, he may have in mind a certain port to which to send his lumber. During the trip he may sell this lumber, and instead of having the tug go to its first destination, he calls her on the radiophone and gives new orders for delivery.



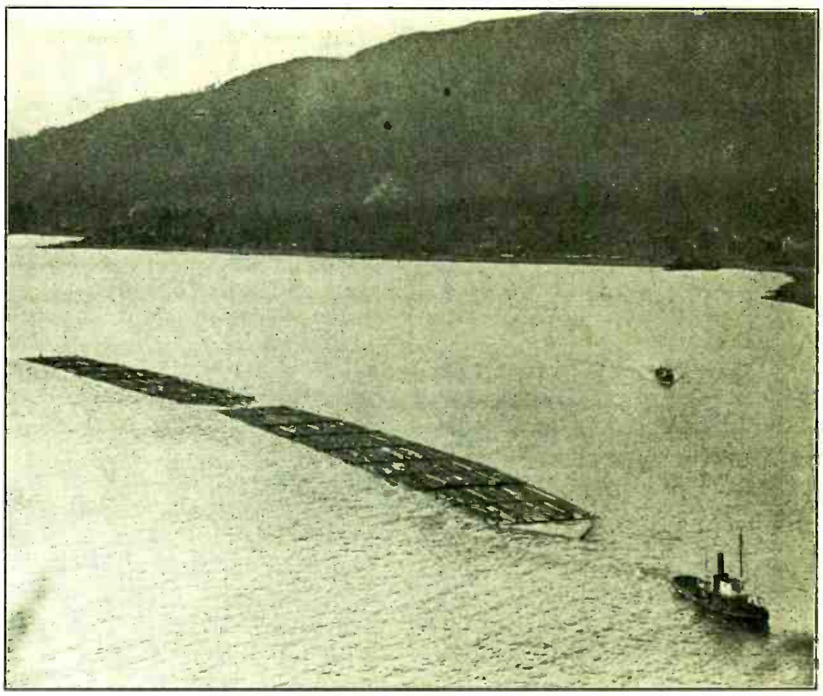
Radiophone Equipment in the Vancouver Merchants' Exchange Building.

A lumber camp is usually situated a hundred miles from Vancouver. In many cases the camp or cannery may be farther away. Should any part of the machinery break down, or a serious disaster overtake the camp, it is impossible without the use of radiophone to get in touch with a boat or with the city. This meant, in times gone by, that a month would sometimes elapse before new apparatus arrived to replace that damaged.

These are but two cases which show that the radiophone has been a necessity for the province of British Columbia. At present there are some forty tugs equipped with the apparatus, which can be in easy touch with any of the four stations on Vancouver Island. Incidentally radiophone life-saving stations are installed at the four bathing resorts near Vancouver, and these can also be drawn on in case of emergency for the ship-to-shore work.

From the illustration it may be seen that the transmitter is practically self-contained. This greatly simplifies operation and eliminates nearly all possibility of damage. Owing to its compactness, only a minimum amount of space is required to house this unique apparatus. The transmitter itself measures approximately 18 in. by 29 in. in height.

Two tubes are used in the transmitter, one as oscillator and one as modulator, when using telephone, and both are used as oscillators when straight continuous wave transmission is required. Telephone modulation is supplied by a carbon microphone working in conjunction with a suitable microphone transformer, the output of which is impinged on the grid and filament through a high note buzzer exciting the above-mentioned microphone transformer, the keying arrangement for this circuit being an ordinary telegraph key connected to the two terminals on the panel, which are suitably marked. Continuous wave signaling can be obtained by means of the same key connected to two terminals provided. Thus it will be seen the set is designed for radio - telephony, interrupted continuous wave transmission, and continuous wave code transmission, which makes it exceptionally flexible.



A Typical Log Tow in Vancouver Harbor.

All the installations up to the present time have been equipped with loudspeakers, eliminating almost entirely the use of headphones. The master of a vessel, speaking into his transmitter, can be heard at any station within range and adjusted to receive him, not only by means of headphones but at practically all times on the loudspeaker.

When the Deputy Minister of the Department of Marine and Fisheries, Alexander Johnson, recently accompanied the Canadian Director of Radio, Lieutenant-Commander C. P. Edwards, on a tour of inspection of these stations, he was greatly pleased at the wonderful work accomplished. Station after station and tug after tug were called from aboard one of the latter, and as the voice of the operator of each came floating out of the loudspeaker in answer to a summons, the minister could say nothing but—"Wonderful! Marvelous!" The same opinion is voiced by all those in the marine trade in British Columbia because the use of the radio-telephone service has been a great help to all trades in the province.

Radiophone Equipment in "Sea Lion" Captain's Cabin.

Ball Float Hydrometers

The charge condition of a storage battery can be indicated by small colored balls whose weight is predetermined so as to indicate the specific gravity at full and partial charge and at complete discharge. These balls may be cut with a sharp knife or razor blade from small pieces of cork about ⅛ in. diameter. Dip these in melted sealing wax until water tight, holding them on a pin point. Put one ball of wax covered cork into the solution from a fully charged storage battery of the lead acid type. Add or remove wax until the ball barely floats. Make a similar ball that will just sink in the solution from a nearly discharged battery, testing say 1.175. A third ball may be prepared in the same way to test 1.250 or thereabouts. By using balls of different shapes or preferably different colors of wax, the balls can be distinguished. This type of hydrometer can be used inside a battery having a transparent case, by putting the balls in a test tube open at either end, but with the end-openings partially "plugged" so the balls cannot slip out; the test-tube being permanently left in the battery.

A Compact Portable Superheterodyne

Directions Whereby An Experienced Constructor Can Assemble An Eight Tube Set in Exceedingly Small Space

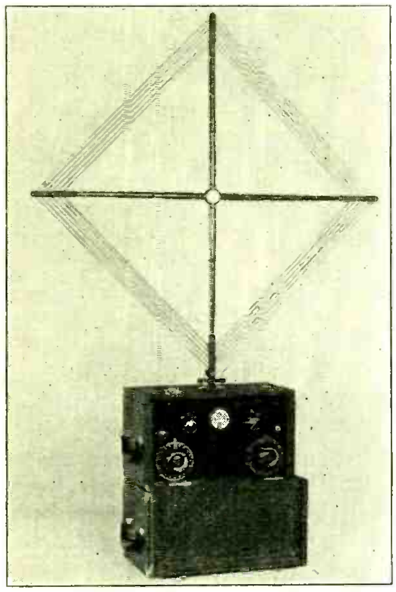
By H. W. Armstrong

FOR vacation use, the ideal set is a really portable superheterodyne with a collapsible loop antenna, such as is here illustrated and described. The set is carried in one case and the batteries in another, connections being made by plugs and jacks which fit together when the set is placed on top of the battery case.

The unusually compact arrangement of the parts requires that shielding be used to insure the fine tone quality and sensitivity of which the set is capable. Consequently its assembly is not a job for the novice and should be undertaken only by an experienced constructor able to read a circuit diagram without a pictorial wiring diagram.

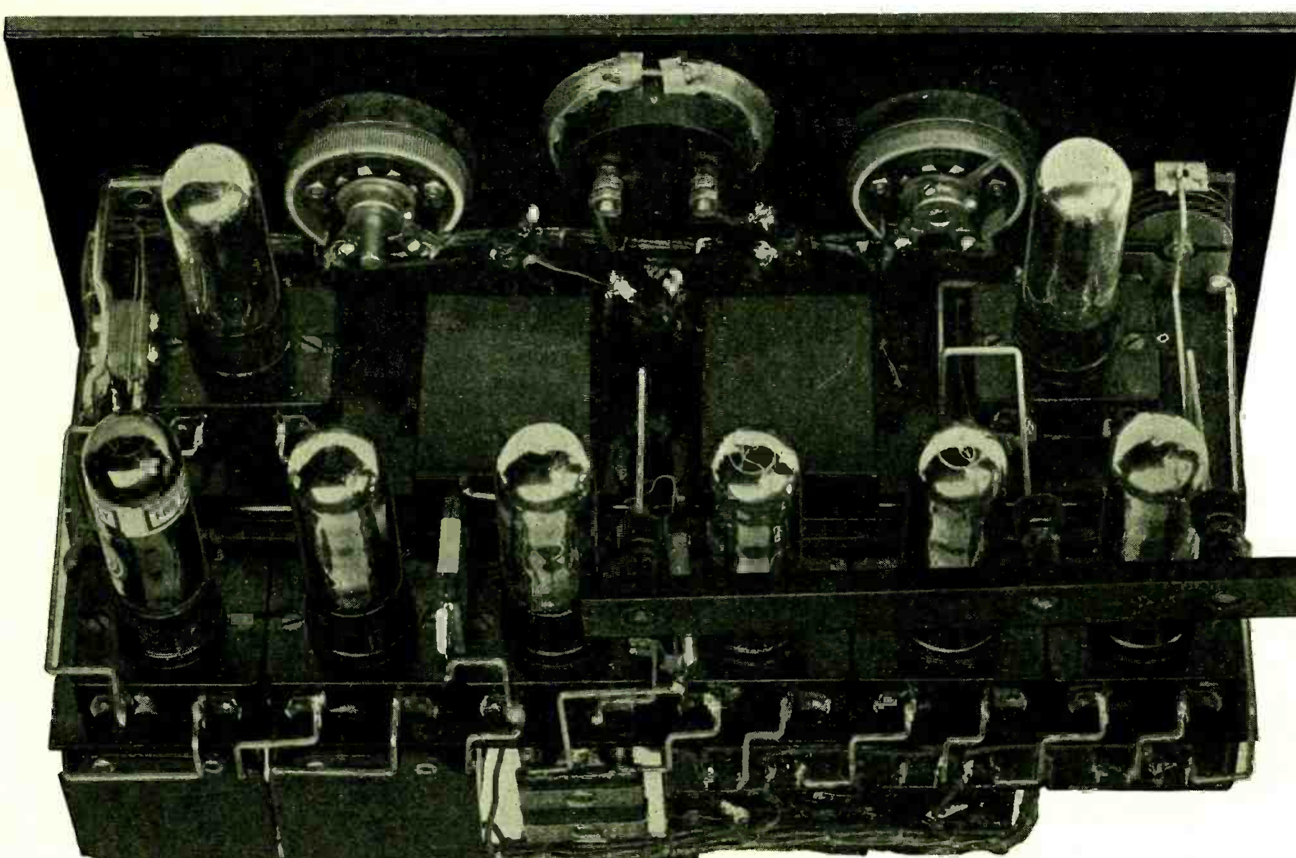
The pictures show the general layout. The circuit, as shown in Fig. 1 is the regular Best superheterodyne, except that *C* biasing resistances are substituted for *C* batteries. A type 120 power tube is used in the last audio stage.

The shielding includes the tube supporting shelf, the several partitions, and the panel backing, 1/16 in. sheet brass being used, of sizes as specified in the list of parts. Fig. 2 gives the dimensional details. The 7 x 13½ in. piece forms the vertical 7 in. line in the endwise view. Its drilling is the same as the bakelite panel. The 7x12½ in. piece is bent to form an angle 3⅝ by 3⅝ in. with ¼ in. for the bend, being fastened to the front panel shield by means of two or three right-angled flaps cut in the horizontal edge of shield and drilled to pass an 6-32 machine screw. The 3 by 12½ in. piece is bent so as to have a ½ in. flange and is mounted to the angle shield as shown in the diagram. The 3⅝ by 3⅝ in. piece is placed as a shield between the two variable condensers.



Portable Superheterodyne Assembly.

The compact arrangement requires that the intermediate transformers be of the shielded closed-iron-core type, except that the air core filter may be unshielded. This requirement may be met by rewinding a General Radio No. 271 transformer, which is ordinarily peaked at 30 kilocycles, so that they will peak at 47 kilocycles or some other frequency which causes the least interference between the upper and lower side-bands of dominant stations in any locality. Furthermore, to fit into the small space available, the side terminals must be removed and the lead-in wires brought to a small bakelite strip fastened to one end of the transformer, so that the connecting wires to the tube sockets will be very short.



Rear View of Receiver.

Fig. 3 shows one of these transformers with the coil spool removed. This is done by removing the metal plate on the bottom of the transformer, heating the transformer in an oven until the paraffine filler is melted down, pouring off the paraffine, and removing the coil with a pair of pliers. The core is of the H type, the cross piece of the H being inside the spool, and coming out with the spool without interfering with the window of the core. The average number of turns on the transformer, for 30 kilocycles, is 1200 primary and 4000 secondary, so that for 47 kilocycles, the turns must be reduced to 500 primary and 2000 secondary. It is best to carefully unwind both coils, taking care not to damage the wire, and then wind on the required turns. The coil is then replaced in the core, the terminal wires soldered, and the paraffine melted and poured on the coil, to seal it in place.

The filter transformer spool is shown in Fig. 5, being made from dry hardwood or bakelite. The primary is wound in the $\frac{3}{16}$ in. slot, using No. 30 silk or cotton covered wire, and the secondary is placed in the ¼ in. slot, using No. 36 single silk wire. A table of windings for various intermediate frequencies is given below, together with the size of the fixed condenser to be placed across the primary winding.

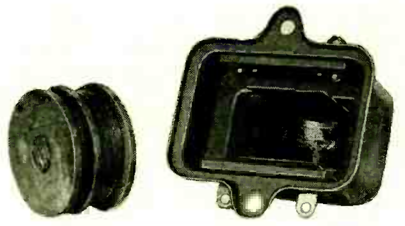


Fig. 3. Construction of Intermediate Transformer.

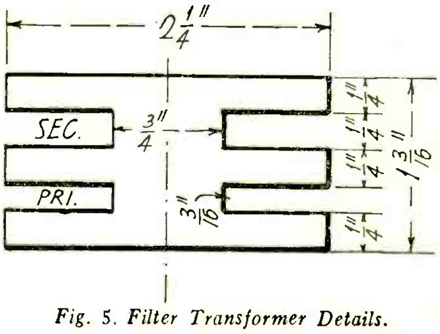


Fig. 5. Filter Transformer Details.

Frequency in Kilocycles	Primary Turns	Secondary Turns	Primary Fixed Condenser
27	375	2100	.0075
32	375	2100	.006
37	333	1950	.006
42	295	1775	.006
47	250	1500	.006
52	200	1250	.006

While the rewound intermediate transformers will probably peak within 1 kilocycle of each other, it may be difficult, without measuring apparatus, to judge the exact frequency at which the filter should be peaked. So that if a 47 kilocycle filter is used, with the rewound 47 kilocycle intermediates, and a double hump is observed for each setting of the oscillator condenser, it may be advisable to try different fixed condensers across the primary, trying first a .005 and then a .0075 in place of the .006 mfd. specified, to see if the two humps can be made to coincide.

In wiring the set, flexible insulated wire was used for all filament, *B* and *C* voltage leads, the wires being cabled together with lacing twine after they were all in place. The high frequency leads were all run in bare wire; most of them are not more than 1 in. long.

As the oscillator coil is mounted upside-down in a plug-in base, several of the coil terminals should be soldered to the base, to prevent the coil from falling out when the set is jarred. The coil consists of two 45-turn stator windings of No. 24 enameled wire wound on a 2 in. form, and a 25-turn rotor coil of No. 29 silk wire wound on a 1 in. tube, placed inside the stator. The two center terminals of the stator are connected to the *B* and *C* circuits, and the two outside terminals to the plate and grid of the oscillator tube. The bypass condenser in the oscillator compartment is connected to the two center terminals. The pickup coil in the oscillator circuit is placed in the center tap of the loop antenna, as is shown in Fig. 1.

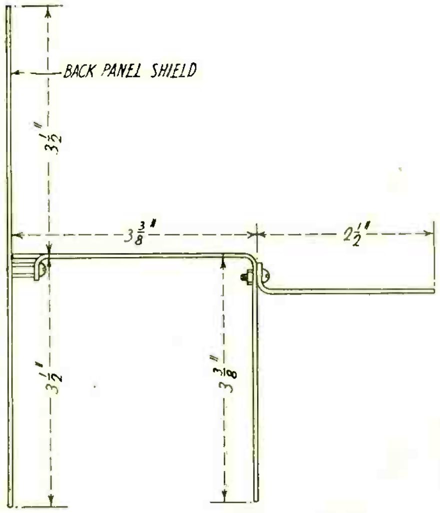


Fig. 2. Details of Brass Shield.

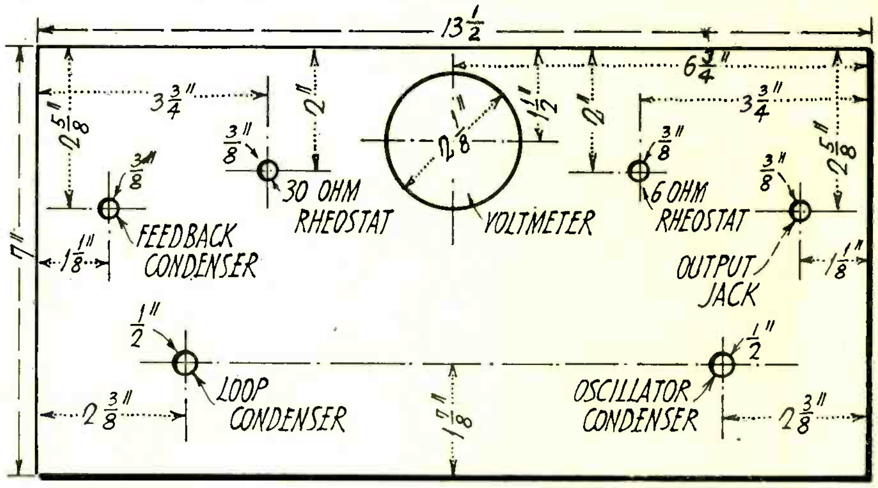


Fig. 4. Panel Drilling Dimensions.

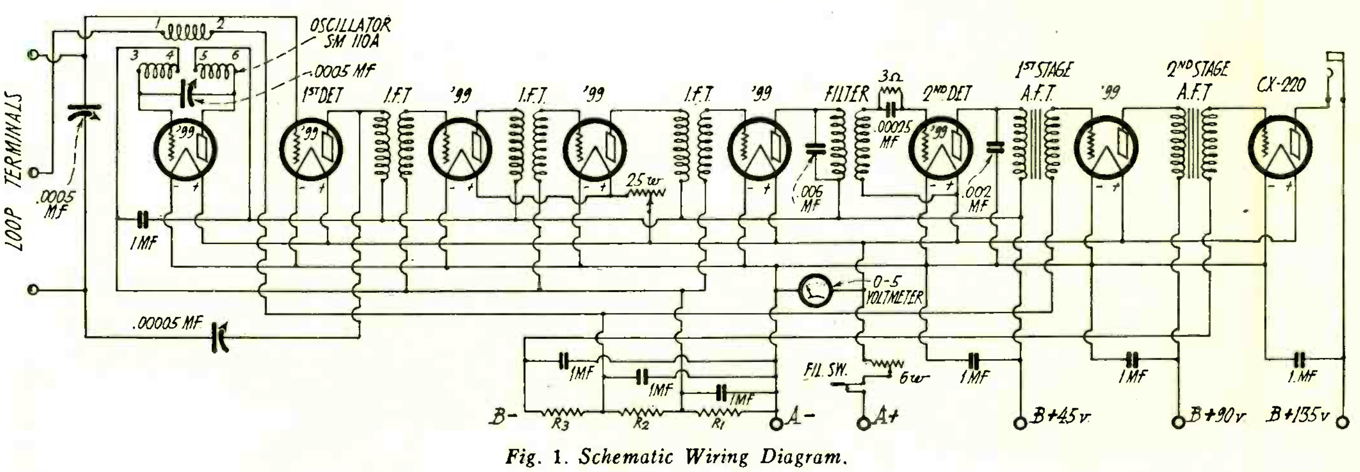


Fig. 1. Schematic Wiring Diagram.

The battery terminals on the set itself consist of two Western Electric 3 terminal connector blocks such as are used in ordinary telephone desk stand installations. Kellogg or other connector blocks of the same general design can be obtained from almost any electrical supply house handling commercial telephone apparatus. From these connector blocks, six flexible wires are run to the six General Radio jacks placed on the bottom of the receiving set box. Into these jacks are fitted the six contact terminals mounted on the top of the battery box, and by this means the battery voltages are supplied to the set without the necessity of connecting the batteries every time the set is used.

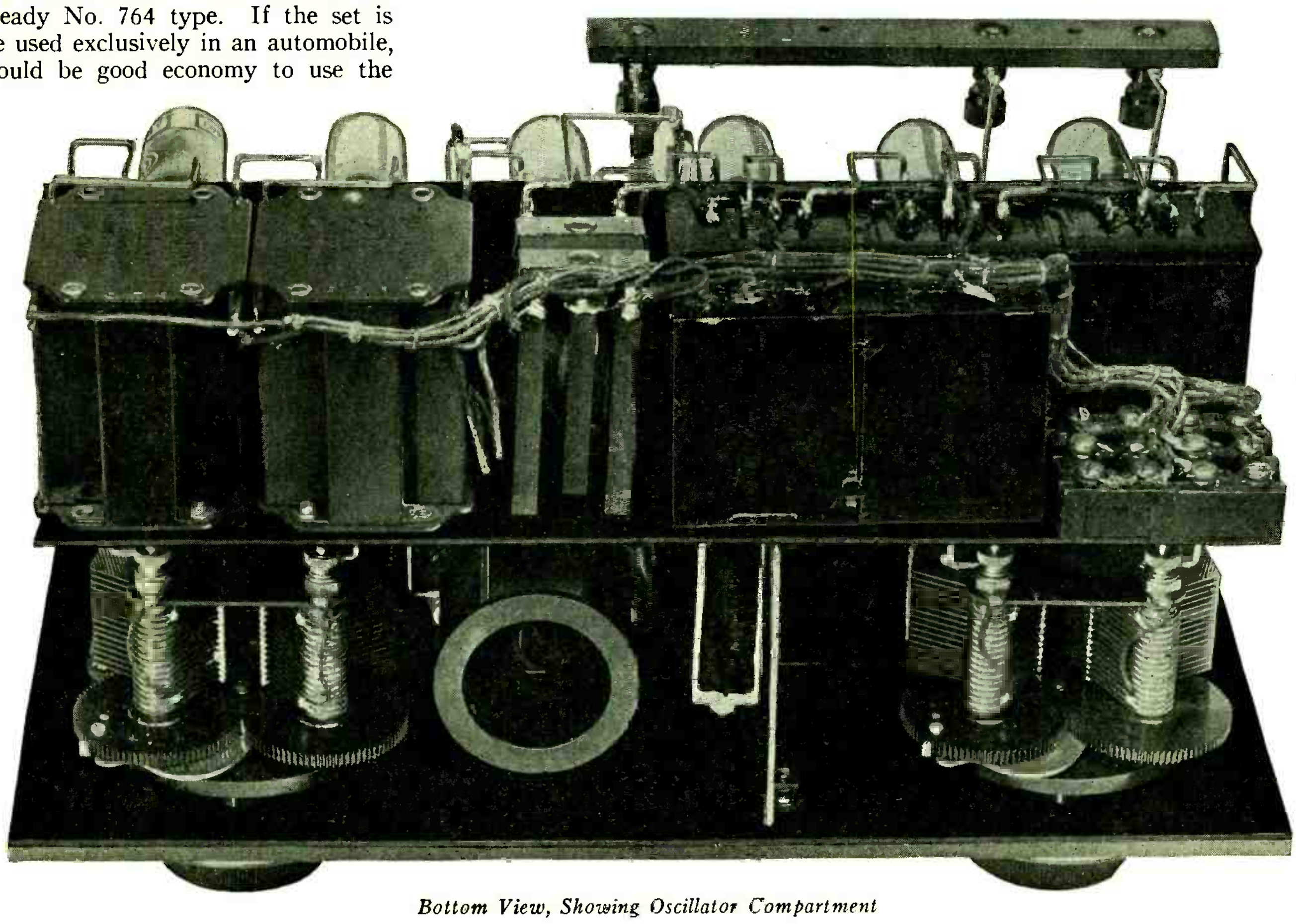
Drilling directions for the panel are given in Fig. 4. The dials on the Remler condensers, being too large for the compact size of the set, were turned down in a lathe to a diameter of 3⅜ in., the paper dials being cut down to fit the metal dial. The inside dimensions of the cabinet are 6¼ x 12¾ in., the lid being hinged at the back, and the front hinged at the bottom, the front being built out by a total of 1½ in., so as to clear the condenser knobs. This makes the outside dimensions of the receiving set box 8¾x14½x8½ in. high, with the battery box the same size except that the height is 7¾ in. The latter opens on one side only, as shown in the picture, and houses six No. 6 dry cells for the filaments of the tubes, together with six 22½ volt *B* units of the Eveready No. 764 type. If the set is to be used exclusively in an automobile, it would be good economy to use the storage battery in the car, reserving the battery box for *B* supply only.

Arrangement of Batteries in Battery Compartment.

By placing the *C* biasing resistances in the negative *B* battery lead, between the *B* battery and the connection to the minus *A* circuit, the plate current flowing through the resistances creates a voltage drop across the resistances which is equal to the current flowing through it multiplied by the resistance in ohms. Thus by proper choice of resistances, it is possible to secure any *C* voltage desired, within limits. In the problem at hand, we have three different *C* potentials to secure; 1½ volts for the oscillator, and three intermediate amplifiers; 4½ volts for the 1st detector and 1st audio tubes, and 16½ volts for the power tube. You may wonder why with 135 volts *B* battery, the *C* voltage for the 220 tube is not 22½ volts as specified by the manufacturer. But it must be remembered that due to the voltage drop across the *C* biasing resistances, we lose 16½ volts from the *B* battery total, reducing the effective plate voltage to 119½ volts. For the latter *B* voltage, 16½ volts *C* is correct for the 220 tube.

As the total current drain in the set is 13 milliamperes, the resistance required for 16½ volts drop is $16.5 = .013\,R$, whence $R = 1269$ ohms. For the 1½ volt bias, 115 ohms is the exact value required, but for all practical purposes, a 100 ohm Carter resistance is satisfactory. The 4½ volt bias is obtained from the 1½ volts already mentioned, plus 3 volts additional from a 200 ohm resistance in series with the 100 ohm, making a total of 300 ohms. Subtracting the 300 ohm value from the 1269 ohm total leaves 969 ohms to be added to make the required amount, and a 1000 ohm Carter resistance will be just about right for the job. Thus a total of three resistances in series, with the 100 ohm resistance next the *A* minus terminal, and the 1000 ohm resistance next to the *B* battery, is required. In the circuit diagram, Fig. 1, R_1 is 100 ohms, R_2 is 200 ohms, and R_3 is 1000 ohms. Bypass condensers placed as shown in the diagram will prevent the set from oscillating due to the presence of these resistances.

(*Continued on Page* 38)



Bottom View, Showing Oscillator Compartment

Experimental Shop Methods

Directions for Making and Using A Galvanometer, Wheatstone Bridge, Electromagnet, and Arc Lamp

By Samuel G. McMeen

An essential part of the equipment of any shop where electrical work is to be done is the group of instruments used for measuring electrical current, resistance, inductance and capacity. The type of such instruments depends upon the work to be done and may be determined from the catalogues of the makers.

However there are two electrical instruments which can easily be made in a shop equipped as heretofore described: a direct current galvanometer and a Wheatstone bridge. The former is used for measuring feeble currents and, in combination with the latter, for measuring resistances.

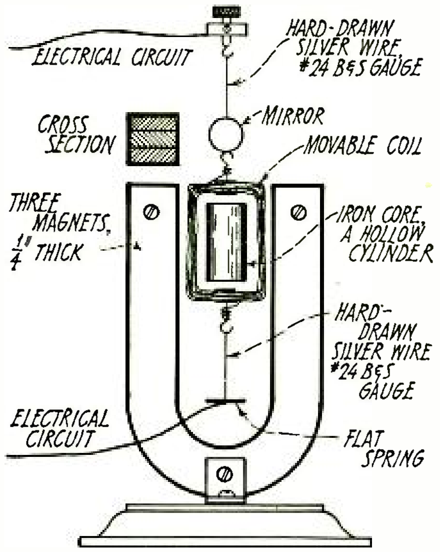


Fig. 1. D'Arsonval Galvanometer.

Fig. 1 pictures a useful d.c. galvanometer of the permanent-magnet, moving-coil type. The permanent magnet is formed of three similar pieces of the shape shown in the drawing.

They may vary considerably in their dimensions, depending on what steel is at hand, but a good size is 5/16 in. thick by 1 in. face, making the compound magnet nearly an inch square in section. This is supported from the base of the galvanometer by angle braces as shown, and if preferred, the base of the magnets can be mortised into the baseboard and the erect support provided by means of ferrule cement flowed into the joint.

The heart and center of the device is the moving coil which is wound on a cardboard form 1/8 to 5/32 in. thick by about 1/4 in. wide. As it is wound the coil is painted with thick orange shellac, and when finished is baked in an oven until the alcohol of the shellac is distilled away. When the shellac is dry the coil will cool into a hard, rather rigid element. Its two winding ends should be kept clear.

Two pieces of mica are bound to the coil at its upper and lower ends, at the points where the silver wire joins, as shown in the drawing. These are attached by means of shellacked silk thread. Through the outer slip of mica is inserted a hooked pin—and to this the silver wire is soldered. The silver wire joins to a rotatable pin at the top and to a spring at the bottom.

When the coil is mounted on the silver wires and the latter are strained between their supporting points, the coil embraces a cylinder of iron or mild steel, either hollow or solid. It may well be made from a piece of iron pipe. Its purpose is to shorten the air-gap in the magnetic circuit, and to bring the breaks in that circuit as nearly as possible to the mere space occupied by the movable coil.

The silver wires can probably be bought in the market, but can be readily made. To do so, borrow a drawplate from a jeweler friend, hammer out a coin into a rod, and successively draw the rod through the holes in the draw-plate. Anneal the wire occasionally until the last two drawings, which leave it hard drawn, the condition desired for best results.

A mirror is attached to the upper hook, or to the wire immediately above that hook, by means of cement. The purpose of this mirror is to form the pointer by which the readings of the galvanometer are taken. There are two ways in which this can be done. One is to place an incandescent lamp in position such that the image of one leg of its filament is reflected from the mirror to a scale, forming a bright line across that scale. The other is to view the image of a small scale in the mirror by means of a telescope. The telescope should be of the astronomical, inverting type, giving an image upside-down and reversed, by the joint action of the mirror and the viewing glass. The scale is thus drawn reversed and placed wrong-side-up, and comes out to the eye in correct position.

Fig. 2 illustrates the principle of the Wheatstone bridge. A and B, the bridge arms, are fixed resistances of known value; R is a variable resistance and X the unknown resistance to be measured. G is the galvanometer, F a battery, and K a key. By either adjusting the variable resistance R or by adjusting the relation of A and B, until the galvanometer shows no deflection (no current flowing) X may be computed from the equation $X = BR \div A$.

Fig. 3 shows a simple form of practical bridge in which the balancing of the galvanometer is done by varying the relation of the two bridge arms, A and B. These are the two portions of a single wire as determined by a sliding contact adjusted so that there is no deflection of the galvanometer. The number of such divisions on the B side

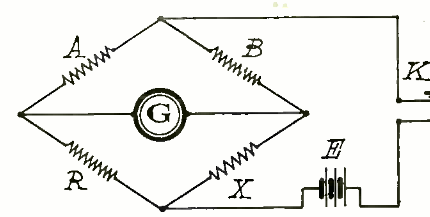


Fig. 2. Principles of Wheatstone Bridge.

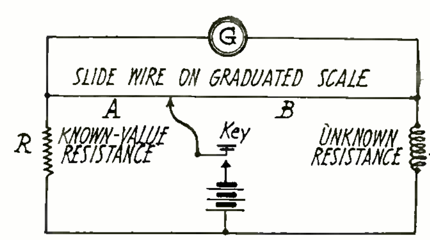


Fig. 3. Slide Wire Wheatstone Bridge.

multiplied by the value of R in ohms and then divided by the number of divisions on the A side, gives the unknown resistance X.

A convenient slide wire bridge of this type can be made with a 1 meter length of No. 18 German silver wire and a scale of the same length graduated in millimeters. Both can be tacked on a board. The sliding contact should be formed to a slightly dull knife edge, not sharp enough to nick the wire but not so dull as to leave any doubt about the point of contact. R may well be a 200 ohm coil, although, theoretically, any fixed resistance of known value may be used.

When the fixed and unknown resistances are about equal, the position of the sliding contact when the galvanometer shows no deflection will be about the middle of the graduated scale on the wire. Moving the sliding contact one or the other way from the "null" point will move the spot of light or the telescope image one or the other way from the zero point. Thus one can tell positively in what direction to seek for the null position.

For the production of powerful magnetic fields and for general use in making permanent magnets, the electromagnet shown in Fig. 4 is a useful tool.

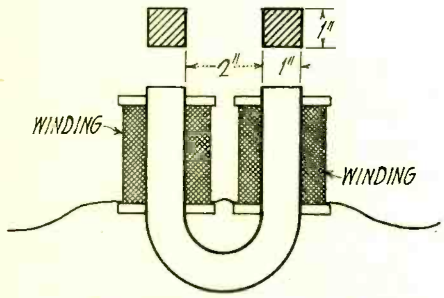


Fig. 4. Shop Electromagnet.

Its core may be a solid bar, or may be built up of strips of sheet iron or mild steel. An inch square in cross section is a good dimension. The size of wire for the winding depends on the exciting voltage. If the (direct current) exciting voltage is as high as 110 volts, the winding may well be of rather fine wire, say No. 32. If the exciting voltage, on the other hand, is low, say six volts, then the winding may well be of No. 18 wire.

Further in the line of electrical tools, a simple source of strong light is often useful. Particularly is this true in photographic processes such as zinc etching, where the requirement is that the light shall be constant. Sunlight is a good agency for photographic processes, but varies constantly from dawn to sunset. It is much better in such printing methods, to have available a constant source of light.

The simple hand-feed arc lamp shown

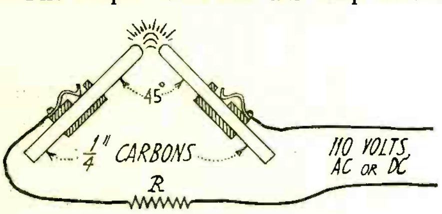


Fig. 5. Hand-Feed Arc-Lamp.

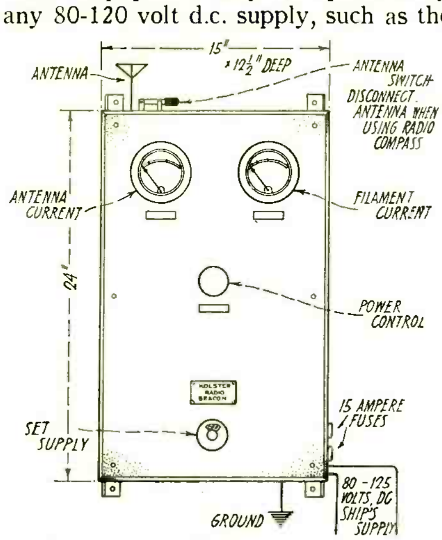
in Fig. 5 fulfills all the requirements of a laboratory lamp for such high illumination. In it the carbons are set at an angle of 45 degrees with each other, and are fed by simply sliding them forward by the fingers, through the sliding fit of the mounting. This sliding arrangement may even be made of a helix of spring wire. To start the operation of the lamp, slide the carbons forward till they touch, then retract them. Feed from time to time as they burn away. In the interest of personal physical comfort it is well to touch the carbons one at a time. In viewing the arc it is also well to interpose ruby glass, or other obscuring medium, as otherwise one may waken with an excruciating pain in the eyes.

THE MOBILE RADIO BEACON

Safety at sea has been still further enhanced by radio with the recent development of the mobile beacon. This transmits a continuous characteristic signal from a vessel moving in fog or thick weather as a warning whereby other vessels equipped with radio compasses can take bearings and avoid collision. It serves the same purpose as does a lighthouse beacon on land. It may be heard on 850 meters.

The Kolster beacon, as perfected by the Federal Telegraph Co., is illustrated herewith. Its signal consists of a series of one-second dashes during the first half of each minute, followed by a half-minute of silence, this cycle being automatically repeated indefinitely.

The equipment may be operated by any 80-120 volt d.c. supply, such as the



Connections of Kolster Radio Beacon.

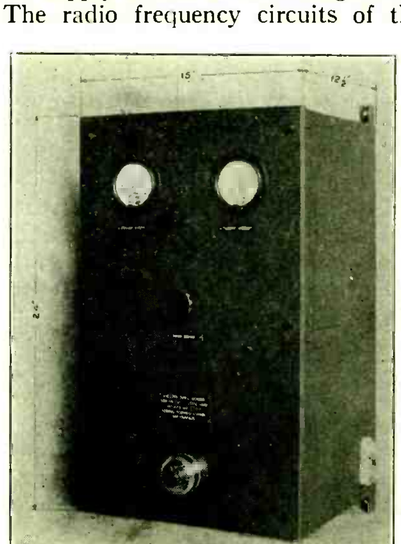
usual ship power generator. This is changed to 750 cycle a.c. by a converter transformer and interrupter whose two primary windings are so connected that current flows alternately through each and thus induces an alternating voltage in the secondary. Its output is fed to a closed core transformer which delivers proper voltages for the plate and filament supply of the transmitting tubes.

The radio frequency circuits of the beacon transmitter consist of an antenna circuit inductively coupled to a local oscillatory circuit in the plate supply of the tubes. A rheostat is connected in series with the power supply and the "converter transformer" in order to control the power output of the transmitter. The power output can also be controlled by the coupling between the antenna and local circuits. When the transmitter is in operation, the radiated power should be just sufficient to enable a signal to be picked up at a distance of approximately ten miles. In most cases from .2 to .3 amperes will be sufficient. This is for the purpose of reducing any interference to a minimum.

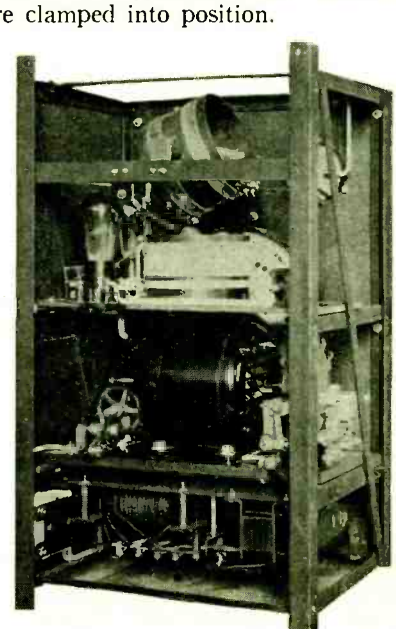
The antenna for the beacon need consist of but a single wire not over 50 or 60 ft. long and in any case should not be larger than is necessary to give the desired results. A switch is provided for disconnecting the antenna when it is necessary to take radio compass bearings on a ship provided with both beacon and compass.

The transmitter is operated by a single snap switch on the lower part of the panel. Turning the switch to the first position marked connects the interrupter motor to the ship's supply and starts the automatic signaling device. As soon as the motor attains full speed, turning the switch to position marked "1" - "2" places the transmitter in operation. Ammeters at the top of the panel indicate the antenna current and the filament supply to the tubes. The filament current should not exceed 2.5 amperes. Turning the switch to the third or *Off* position disconnects the power supply and stops the transmitter.

The total load taken from the ship's generators is about 3 amperes with a power consumption of approximately 300 watts. The wavelength adjustment and the coupling between the antenna and local circuits when once fixed are clamped into position.



Panel View of Kolster Radio Beacon.



Side View of Kolster Radio Beacon.

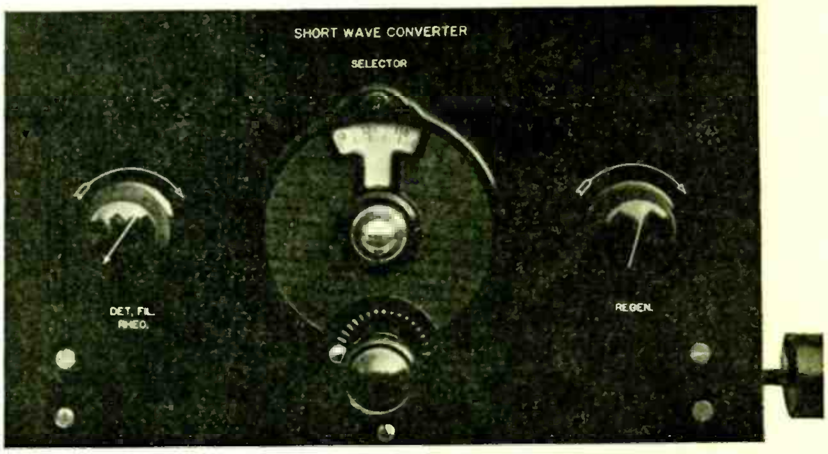
Short Wave Converter

Directions for Building a Simple and Easily Operated Tuner Enabling any Broadcast Receiver to Get the Short Waves

By Perry S. Graffam

FOR those who wish to explore the short wave band from 15 to 125 meters, several ways are provided. However, most of them require changing the connections of the present broadcast receiver over to the short wave set. This arrangement has many drawbacks as all of the family may not be contented to listen to the short wave reception. By the time the receiver is restored to normal, the program you most desired has stopped. But any set may be converted instantly, and at will, into a short wave receiver by the use of the short wave converter herein described.

No change is necessary in the receiving set, nor are any of the battery connections disturbed. To convert the receiver, it is only necessary to disconnect the aerial and ground wires from the receiving set and attach them to the two binding posts of the short wave converter. Remove the detector tube from the receiver and place in tube socket of converter. The cable plug from the converter is connected into the detector socket of the receiving set. No other tubes are removed, nor are the battery wires disturbed, and the loud speaker remains as usual. The tuning is all done from the one dial on the converter. The tuning controls on the receiving set are not used. This unit is easy to build and simple to operate. No trick circuit is used and no tricky apparatus is employed.



Panel View of Short Wave Converter.

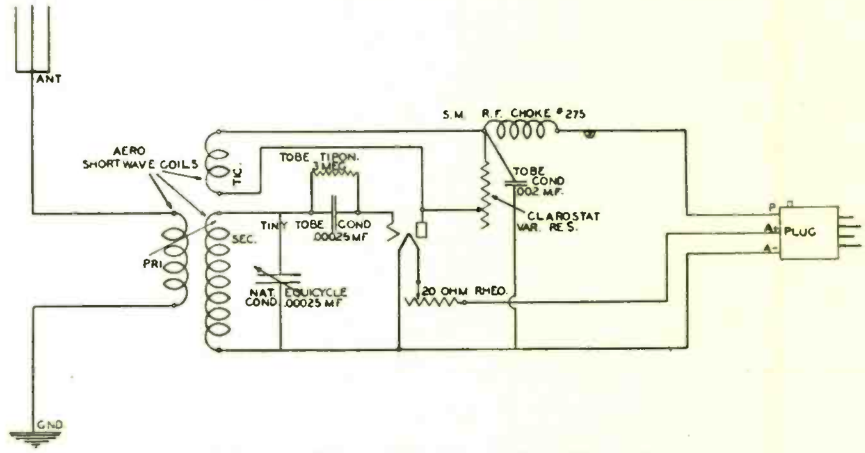
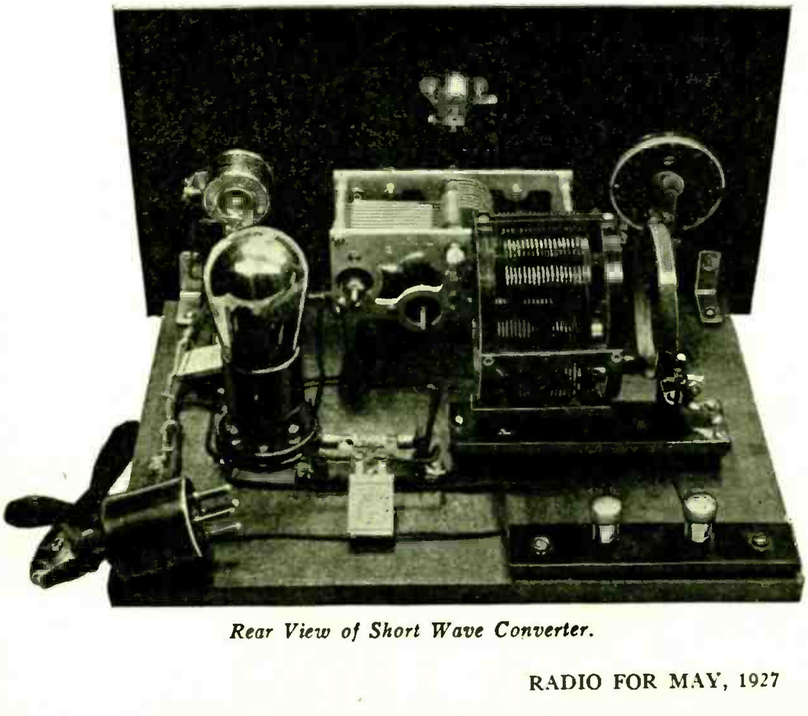


Fig. 1. Schematic Wiring Diagram of Short Wave Converter.



Rear View of Short Wave Converter.

The converter is really a short wave set, consisting of a regenerative detector and a simple attachment-plug for connecting to the audio end of the present receiving set and a means for transferring battery supply to light the detector tube now transferred to the converter. This method of connecting the two units together consists of a five-conductor Birnbach cable (two leads not used) and an old vacuum tube, which has served its usefulness otherwise, for the plug. The glass of the latter is broken off and the base cleaned out. Three wires from the cable are soldered into the terminals of the socket, one to the *A*+, one to the *A*—, and the other to the plate terminal. To identify these terminals, hold the tube with the pin towards you; the rear two posts are *A*+ and *A*— respectively, and the left hand front post is the plate terminal. The base of the tube is now filled with some compound such as the top of a discarded *B* battery. Place

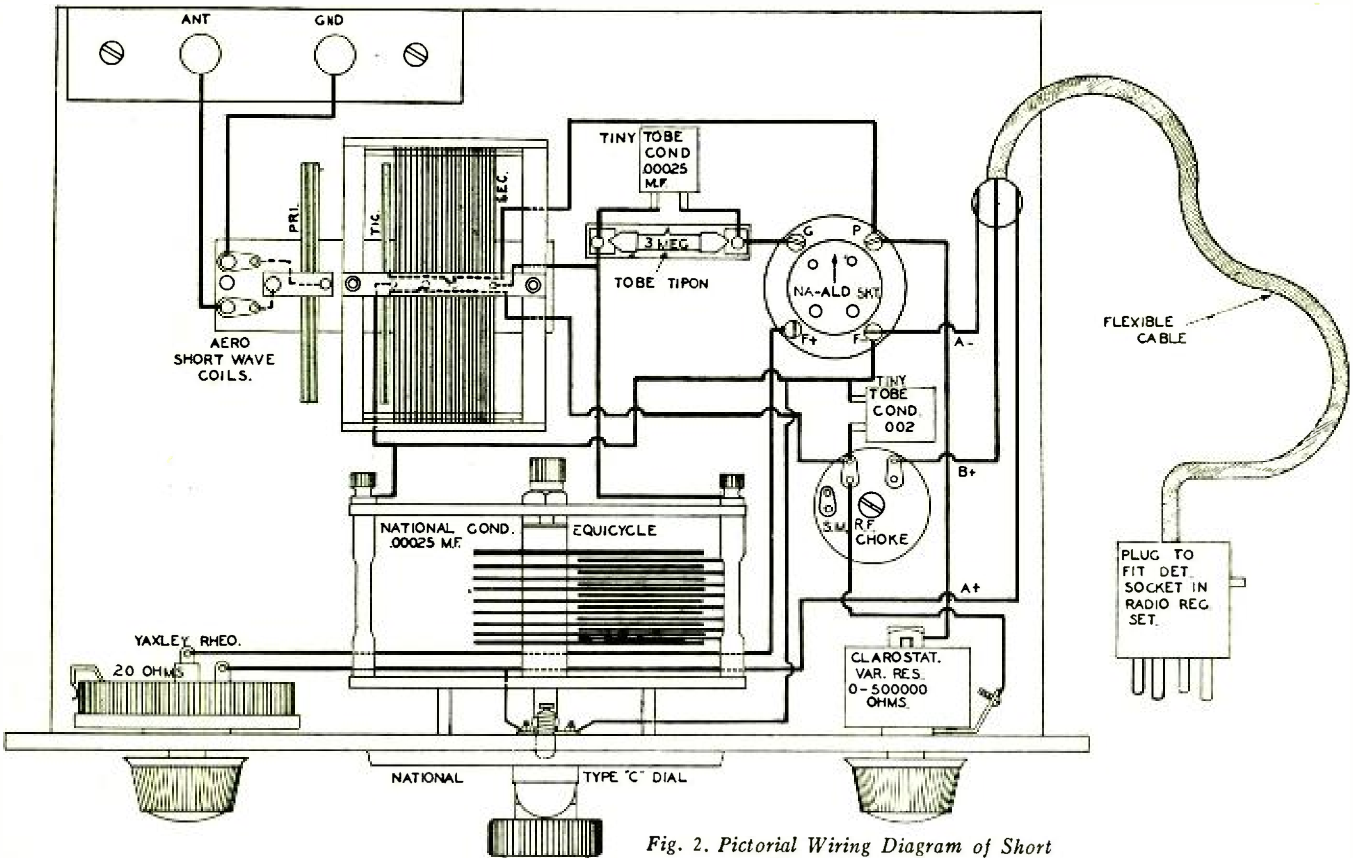


Fig. 2. Pictorial Wiring Diagram of Short Wave Converter.

small pieces in the tube, and, with a hot iron, melt them together, filling the tube base full, and allow to cool.

Regeneration is controlled by a 0-500,000 ohm Clarostat, connected across the plate and tickler. A .00025 mfd. variable condenser is used with a set of three Aero coils to tune from 15 to 200 meters. A vernier dial is necessary as tuning is sharp.

The accompanying pictures and wiring drawing give minute details on the arrangement of the parts and wiring. Busbar wire may be used, but the author has found it more desirable to use flexible wire properly covered.

The choke coil is important and must not be omitted. When by-passed with a .002 mfd. condenser it will permit the plate lead to be long enough to reach the receiving set. If a choke coil cannot be easily secured, one can be made by winding 100 turns of No. 26 D.C.C. wire at random on a wooden spool ½ in. in diameter and with a ¼ in. core.

To operate the short wave converter, select the plug-in-coil covering the wave

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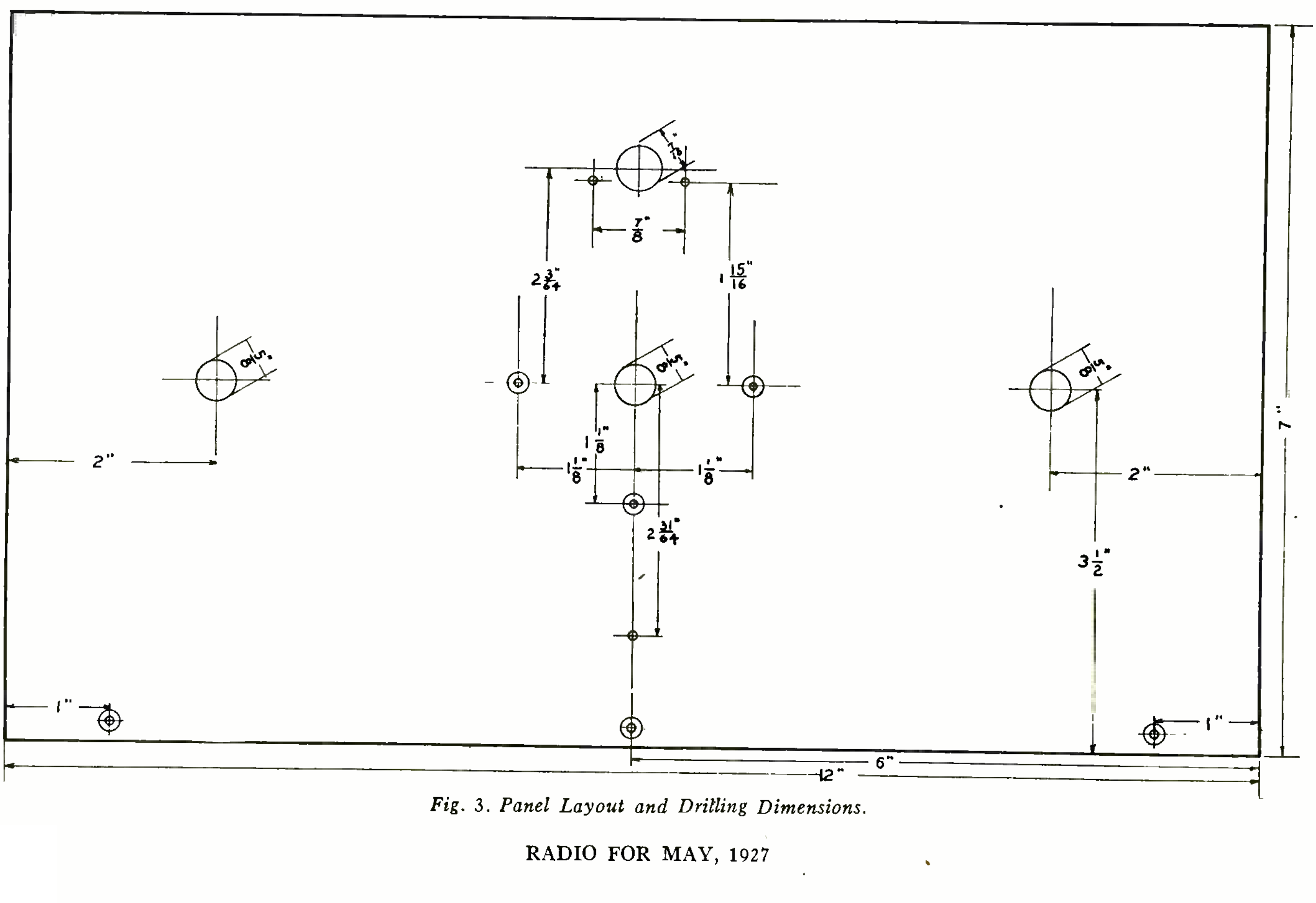


Fig. 3. Panel Layout and Drilling Dimensions.

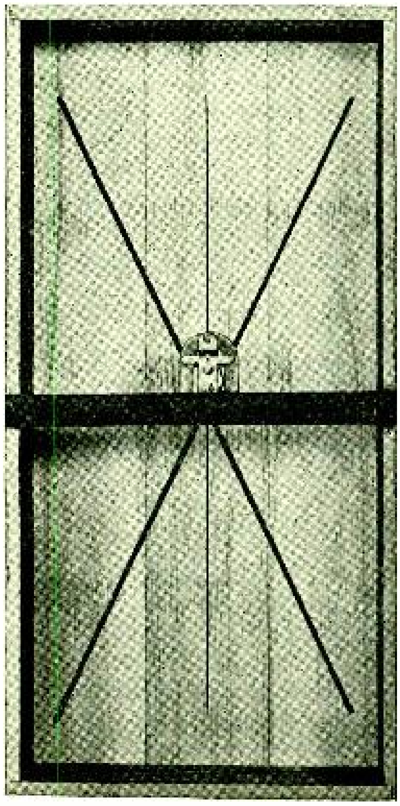
The Balsa Wood Loud Speaker

By Clinton Osborne

THE attention of the radio public has been recently attracted to newspaper articles appearing on the use of Balsa wood in the manufacture of loud speaker diaphragms. The results obtained from even the most crude experimental models of loud speakers using this wood have been so remarkable as to merit more than passing comment.

Balsa wood is found in tropical countries, particularly the northern part of South America, and is the lightest wood known to man, being approximately half as heavy as cork. It weighs about 6½ pounds per cubic foot. It is porous in structure, being a mass of closely woven air cells with surprisingly strong walls.

By mounting a very thin piece of Balsa wood in a substantial wooden frame, and coupling to its center a suitable driving unit such as is used in cone type loud speakers, the resulting loud speaker gives unusually good tone quality at the low frequencies, and yet maintains a flat characteristic through the useful audio frequency range to a point above 6000 cycles. This type of construction is much easier to work out than building a homemade cone type speaker. By following the data which has been prepared from the results of building several of these loud speakers, it will be an easy matter to duplicate the results obtained in the laboratory.



Balsa Wood Speaker, Showing Driving Unit and Ribs.

LIST OF PARTS REQUIRED

- 1 **Balsa Loud Speaker Kit.**
- 1 **Driving Unit.**
- 2 **Cross pieces for Driving Unit support, 2x18x½ in.**
- 1 **Tube Duponts Household Cement.**

A complete set of wooden parts for the loud speaker, which is shown in the picture, can be obtained from the American sales agency of Balsa wood products, or the Balsa wood itself can be obtained separately and the wooden frame and miscellaneous hardwood pieces can be made up locally, using the dimensions given in Fig. 1. This frame

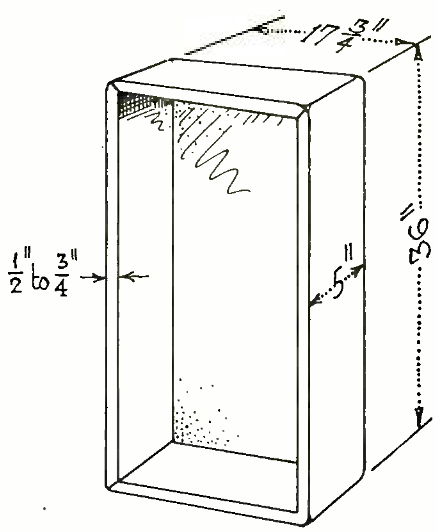


Fig. 1. Dimensions of Speaker Frame.

is approximately 17¾x36 in. outside, made out of ¾x5 in. wood, either five ply veneer, if the extra cost of veneer is not objectionable, or of some good, non-warping wood which will take a stain or will present a pleasing appearance. The frame furnished with the Balsa kit is slightly smaller, but where the pieces of Balsa are bought separately, the larger frame can be used. Three pieces of Balsa wood 6 x 36 x 3/32 in. are needed to make the diaphragm, and from another piece of the same size are cut the radial cross pieces which are glued to the back, and serve to transmit the vibrations from the driving unit to all parts of the diaphragm. The strips are already cut, in the Balsa kit.

After the frame is assembled, making sure to firmly glue all joints to insure an accurate fit, the diaphragm should be assembled. Lay the three 6x36 in. pieces of Balsa wood on a perfectly flat surface, and trim the edges of each piece lengthwise, with a sharp knife or safety razor blade, so that each piece perfectly matches its adjacent piece. Glue the three strips together along the adjoining edges, using Dupont's Household Cement, or Ambroid glue. The former is colorless, and light in weight, setting firmly in about two hours. Do not use carpenters glue or similar adhesives, as they may crack and cause rattling noises when the loud speaker is in operation. Allow the joints in the diaphragm to thoroughly harden, and then cut out the radial braces. One brace goes crosswise in the exact center of the diaphragm, and may be about ⅝ x 15½ in., being cut from the strips of Balsa wood which were not used in the diaphragm. Place two similar pieces in the center of the middle section of the diaphragm, on each side of the cross piece. Then cut four pieces about ⅝ x 17 in., and cement them in the positions leading from the center to the four corners of the diaphragm with about ½ in. space left at the center of the diaphragm for the support strip holding the coupling bushing. It is better to cement one piece at a time, holding it in place with small blocks of wood and weighting down the strips so that the cement will set them firmly.

After the braces are all in place, the coupling bushing for connecting the diaphragm to the driving pin of the speaker unit should be cemented to the support strip, which is 1½ x 1½ x ⅛ in. As it is important to cut down the weight of this material as much as possible, to prevent losses to the high frequencies, this bushing should be turned out of ¼ in. aluminum rod, drilled with a No. 45 drill and fitted with a 4-36 set screw on the side, to secure the driving pin in place.

The support strip is furnished in the Balsa wood kit, but may be made from cedar or cigar box wood if desired. Cement the support strip to the ribs so that the bushing is in the exact center of the diaphragm.

When all the joints are dry, and all cracks or checks in the wood have been mended with cement, the diaphragm can be assembled to the frame, by cementing it thoroughly around the edge. Hold the edges of the diaphragm to the frame with weights all around, and allow the cement to set several hours before doing any further work on the speaker. As soon as the cement has hardened, the

(*Continued on Page 24*)

Inductance of Flat Square Loops

By C. Albert Kulmann

THE present trend in radio receiving sets seems to be toward the use of highly sensitive receptors in conjunction with an indoor aerial of some kind, usually the spiral loop. The directional properties of such an aerial add much to the selectivity of the set. However, the radio enthusiast who builds his own often sacrifices selectivity in another way, making the aerial after something he has heard from others or by guess and then using sufficient capacitance in the circuit to obtain the desired wavelength or frequency.

As far as is known to the writer, there has never been presented any form of chart or table giving the inductance of loop aerials that is consistently accurate within 20 per cent. This is the reason for the difficulty mentioned above, since it is nearly half an hour's work to solve the equation given by the Bureau of Standards. On the other hand, starting with a desired value of inductance, it becomes a prodigious task to try out various dimensions until suitable ones are found.

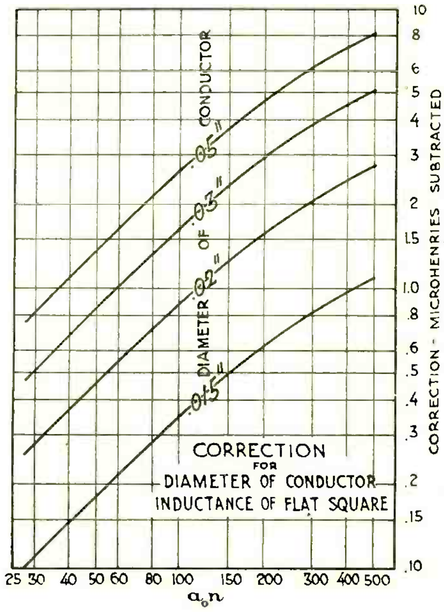
The equation mentioned, changed to English units, is given at the top of the accompanying chart, which was designed to obtain a simple, quick solution for this equation. To find the inductance of a given loop, a point is found on the left hand scale corresponding to the length of the sides of the loop. Then in the network at the right hand side of the chart is found the intersection of the line of the number of turns with that of the correct spacing between turns. A straightedge is then laid across the chart between these two points and its intersection with the inductance axis gives the value of the inductance.

The result is accurate beyond the ability to read the scales for a conductor diameter of 0.0125 in., corresponding closely to No. 26. For other wire sizes a small correction must be made, subtracted for larger wire. The accompanying graph gives this correction for all values where the error exceeds half of one per cent. In using this graph use the diameter of the conductor and not of the whole wire, except where the total inductance is so small that the connections can cause an even larger error.

To illustrate the use of the chart find the inductance of a loop of six turns of No. 16 wire spaced ½ inch between turns and having an 18 in. side. Laying a straightedge from the intersection of the line of six turns and that of ½ in. spacing to the scaling of 18 on the length scale gives a value of 31.5 microhenries. Turning to the correction graph, find the product of the length of side and number of turns, in this case 108, and find the intersection of the vertical line corresponding to this value with the curve for a diameter of .065 inches, the diameter of No. 16 wire. The correction is found to be 2.65 microhenries, which is subtracted from the value obtained earlier to give 28.85 microhenries. Solving the equation gives the inductance of the same loop as 29.27 microhenries.

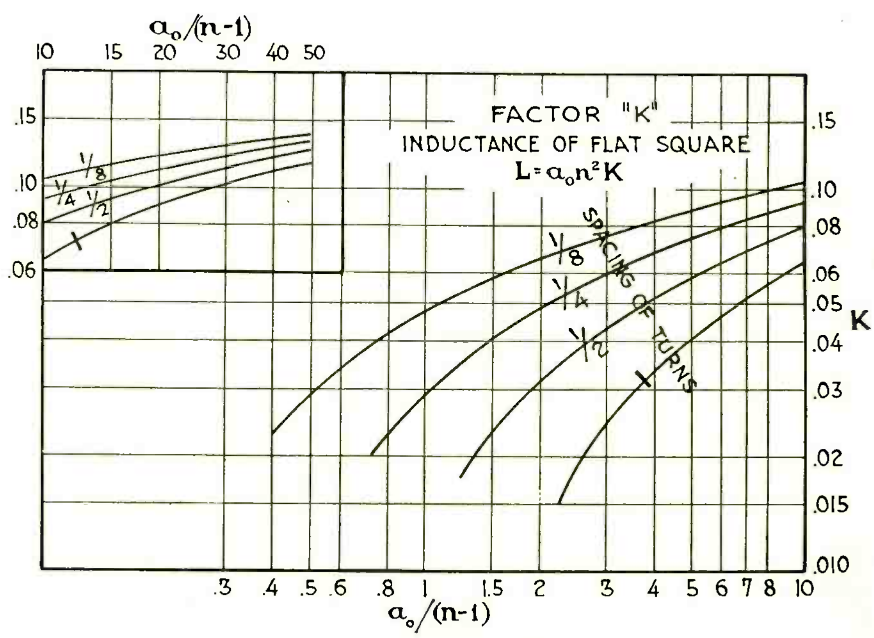
Using the chart to design a loop, suppose it is desired to find the best method to obtain an inductance of 160 microhenries with a loop whose side is 24 in. long. A straightedge on the diagram gives 9.5, 11, 13, and 17 turns at spacings of ⅛, ¼, ⅜, and ½ in. spacing respectively. If a low resistance is desired, the fewer number of turns at close spacing gives a shorter wire length, but the capacitance of the loop is slightly greater.

In working out this nomograph a much simpler solution was formulated which may be used for values not included in the chart or where greater accuracy is desired. The simplified equation is $L = a_0 n^2 K$ where the symbols have the same meaning as given on the large chart, and K is a function of $a_0/(n-1)$ and D as given by the graph. This equation must be corrected for the diameter of the conductor if larger than No. 26 is used. The use of this equation with the same values used in the first example gives an uncorrected value of 31.82 and a corrected value of 29.17 compared with the result of the longer equation of 29.27 and the chart value of 28.85 .



Correction Graph.

Piezo is derived from a Greek word meaning pressure. Thus a piezo-electric crystal is one producing a difference of electrical potential when it is compressed.



Graph for Determining "K."

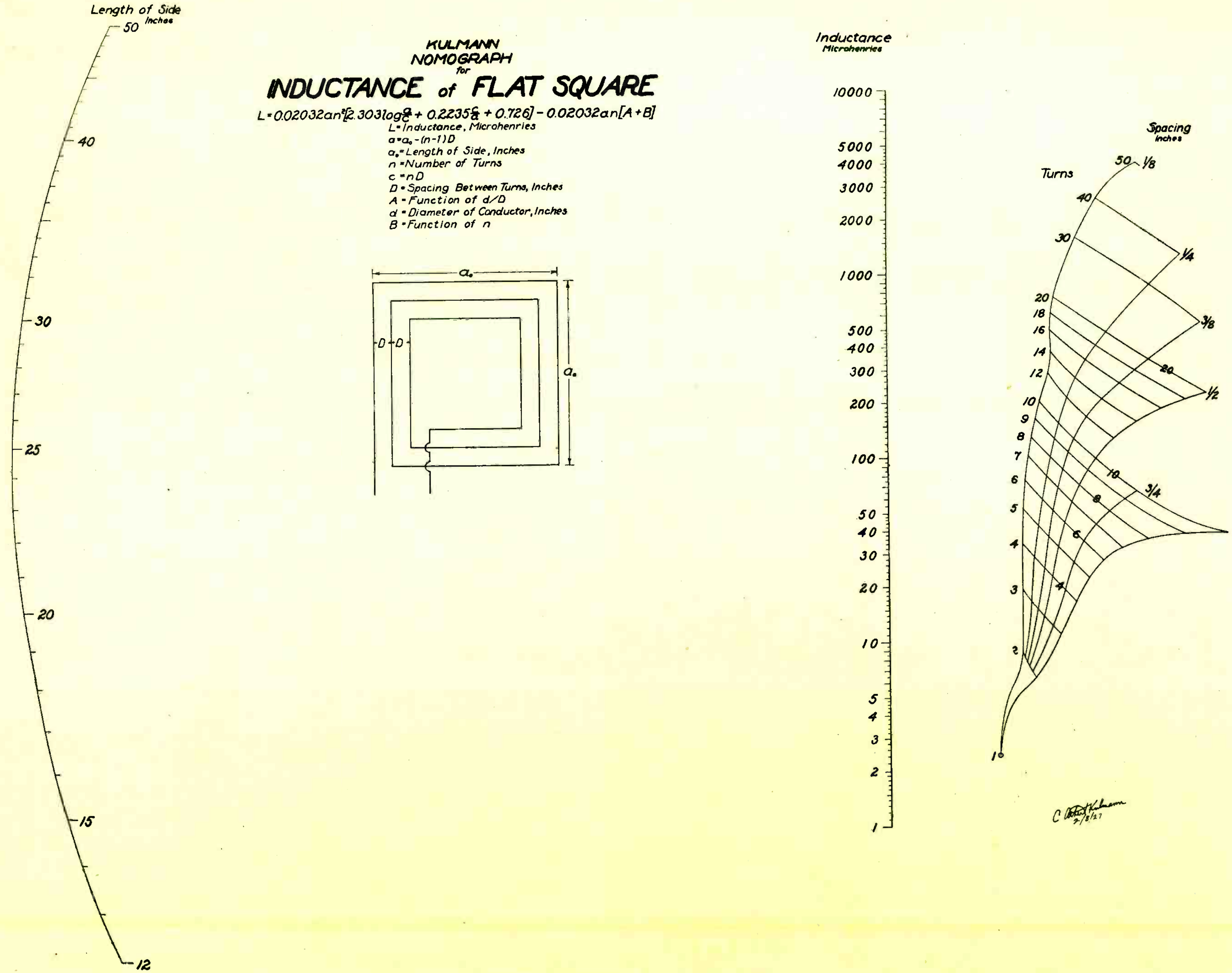


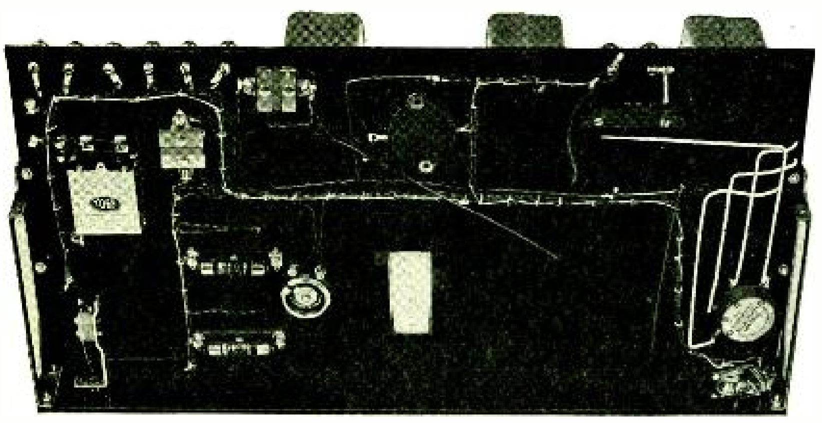
Chart for Determining Size of Loop Aerial.
(For Explanation See Preceding Page)

Quadraphase Suggestions

By G. M. Best

IN the article on the Quadraphase, a five tube single control receiver, in the April issue of RADIO, the pictorial wiring diagram showed changes and improvements to the original laboratory model which were not shown in the pictures accompanying the article.

Hence a view of the revised subpanel assembly is shown to indicate the position of the apparatus underneath the panel, and the nature of the changes made. The antenna switch, which was originally mounted on the panel, was placed on the subpanel, and may be seen at the right hand end in the picture. The antenna series condenser, in order to be made adaptable to any antenna encountered in various installations, was changed from a fixed mica condenser to a .0005 mfd, variable mica, such as the XL Model G-5. This condenser is mounted directly back of the 1st r.f. tube socket, with the set screw for adjusting the condenser projecting through the panel so that the condensers can be varied without removing the set from the cabinet.



Subpanel View, Showing Changes in Apparatus.

As many prefer to use a type CX-300-A detector tube instead of the A tube originally used, a 10 ohm variable resistance was installed on the subpanel, near the 1st audio tube socket, and in back of the drum dial. This resistance has a set-screw adjustment which projects through the panel, and is regulated with a screwdriver. The Amperite or other fixed resistance for this tube is removed, and the variable resistance set at the right value for best operation of the new detector tube. Usually a point can be found where maximum sensitivity with a minimum amount of tube noise is obtained. Be sure to connect the grid return of the detector to the negative end of the filament, instead of the positive end.

In the original description of the Quadraphase, the data on the internal construction of the Phasatrol were incomplete. This unit consists of a 10,000 ohm variable resistance and a .006 mfd. condenser, but the resistance is so arranged that it is connected between the plate of the tube and the positive *B* terminal of the r.f. transformer primary, rather than around the condenser as was stated in the text.

Questions have been asked in regard to the three gang condenser unit, which is .00035 mfd. per condenser, whereas the Quadraformers are designed to work with .00037 mfd. condensers in order to tune to a maximum of 550 meters. Where the set is found not to tune above 525 or 530 meters when it has been lined up, it can be adjusted to 550 meters by screwing down the mica trimmer condensers furnished with the condenser unit, until 20 or 30 mmf. have been added to each condenser section. These trimmers are purposely made larger than need be for making such adjustments, and while they raise the minimum capacity of each condenser section from 5 or 10 mmf. to 25 or 35 mmf., the minimum is still low enough to enable tuning the set well below 200 meters.

The experimenter who is interested in making minor improvements on this receiver may want to add a stage of untuned r.f. amplification ahead of the 5 tube set, to eliminate the necessity of adjusting the trimmer condenser across the antenna coil for changes in antenna constants, as is done in several factory built receivers. This can be easiest accomplished by following the circuit diagram shown in Fig. 1, assembling the apparatus in a small shielded can, or mounting it on a board directly in back of the set, if the shielding is not wanted. The antenna circuit is connected directly to the grid of the r.f. tube, with a choke coil connected from grid to ground, so designed that its natural period is somewhat above 550 meters. A Silver Marshall No. 276 long wave choke will do for this purpose. The output of the tube is impedance coupled to the regular antenna coil, through a Silver Marshall No. 275 short wave choke, and a .006 mfd. fixed condenser. The variable antenna series condenser would in this case be omitted, and after the trimmer condenser across the first Quadraformer coil was once adjusted, it would not have to be again touched.

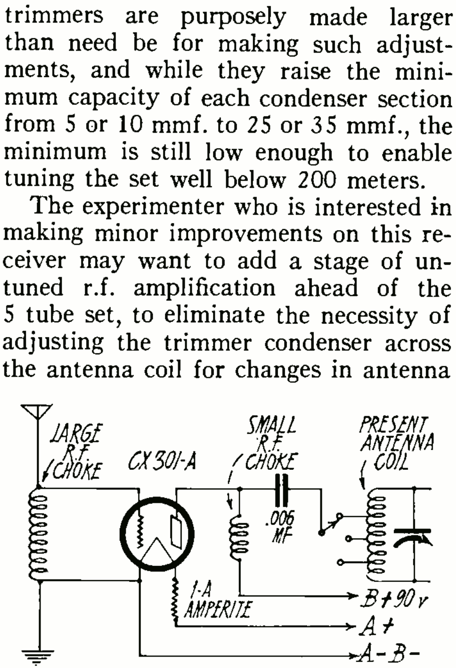


Fig. 1. Connections For Adding Stage of Untuned R.F.

The range and volume of a loop set can be increased by making a large one or two turn loop, with about a hundred feet of insulated wire, in the room in which the set is located. The turns can be run around the moulding or around the edge of one wall. The ends of this loop should be connected to a 23-plate, 0.0005 microfarad, variable condenser, for tuning it. The receiving set is tuned to a station in the usual manner, and then the large loop tuned until the signals are louder. The loop acts as a large primary winding, and, when tuned to the same wave length as the set, it transfers the considerable energy it picks up to the small loop on the receiving set. Coupling between the two loops can be varied by turning the loop connected to the set. Coupling is at maximum when the planes of the two loops coincide.

A grid leak with a resistance of 5 to 10 megohms, used with a 0.0001 mfd. grid condenser, will make a receiving set much more sensitive to weak signals; and is to be recommended for short-wave CW reception. Such a high resistance grid leak is not good for broadcast reception, though, because it not only makes the set tricky in tuning, but may cause distortion of the music. A 2 megohm grid leak and 0.00025 mfd. grid condenser are right for broadcast and general reception.

A 100 kw. vacuum tube is being used to amplify the output of a 20 kw. tube at WGY. With its waterjacket, this new tube stands 7½ ft. high and weighs 100 pounds.

It Happened Off Nicaragua

By Earle Ennis

OFFICIALLY, Soda Magee, radio operator, is dead! The log of the *Cassie Hogan* attests this fact over the signature of Captain Bruce McTavish, fighting commander of the freighter, together with the date of the occurrence—January 29—and the location, 150 miles northwest of San Juan del Sur, as the American consul saw with his own eyes. Yet, strange to say, Soda Magee still pounds brass for the Interseas Radio Corporation, dragging his famous "K" from Nova Scotia to Pago-Pago, and down on the company payroll as anything but a phantom. Odd? Aye—all of that . . .

The horrible end of Soda Magee will still be history when other tales of the sea have faded into mist over mugs of rum where strong men yarn long and lustily of red-blooded fights and hard-fisted skippers. For Soda Magee was cut off in the prime of his red-headed youth by a skipper without a conscience to save a cargo of canned Boston beans, and although the murder was known from Triangle Island to Juan de Fuca, never an admiralty court sat on the matter. A mystery? More. The subject of a wire to Washington, of a flurry in quarantine at Corinto, and a bill to the company for thus-and-so much of stove polish.

Let's begin it right—aboard the *Cassie Hogan* on a certain southbound trip with Soda Magee mangling the Continental code in the stuffy little wireless cabin under the bridge, and Babe Potts swinging the skillets in the galley. The first officer was Jasmine Hawkins, a sweet-scented ex-marine, and the crew, the hardest scrapping aggregation of salt-porkers south of the North Pole. On the bridge, flat-footed and competent, keeping a close lip and a wary eye —the skipper himself, a Glasgow fighting man. Background for anything, if you'll have it so!

There was a certain fraternity between the skipper and the crew of the *Cassie Hogan*. Jasmine Hawkins explained it in a few words, shifting his quid from port to starboard as he talked.

"They'll let him kick 'em around," he said, "because when they've got a bellyache he comes down and feeds 'em castor oil out of a spoon!" And that, in truth, was just about the situation.

This is all merely the noise level for that which follows. For the setting, picture a flat sea, colorless, empty, with a lazy black freighter ambling southward ahead of a frill of black smoke under a blistering sun that sizzled the deck plates. On the bridge, the skipper, his glasses fixed on a black smudge to the northward. At his elbow, Jasmine Hawkins, sucking on a quill toothpick.

"Whatcha think, cap? A tamale?" Hawkins indicated his fear of the presence of a Mexican gunboat.

"Uncle Sammy," grunted the captain shortly.

Hawkins whistled softly. It would be bad for the *Cassie Hogan* with her present cargo if there was a destroyer on her tail.

"How come?" he asked after a bit, unconvinced.

"Too fast for anything else," said the skipper.

On the deck one of the crew sitting in the shade of a deck house, jerked a thumb upward.

"The old man's watchin' yon," he announced.

"I've been thinkin'—'Twill be better if you're dead."

Another turned and regarded the distant smudge with interest.

"Mebbe it's a fight comin'," he said hopefully.

The first speaker, a lean individual known as Sammy, spat over the rail with meticulous care.

"Hope it's a doggoned good one," he remarked. "I done got cheated out of the last one. I was on watch. . . "

Captain McTavish picked up the tube at his elbow and whistled down to Soda Magee.

"Any chasers 'round?"

The operator consulted his log.

"The G-678 is five hundred north, southbound for Mazatlan."

The skipper dropped the tube, and turned to his second in command.

" 'Tis not a Sammy," he corrected.

The other squinted and hitched his belt. There was only one answer and they both knew it.

"We ain't outrunnin' 'em none," said Hawkins after a bit, his eye on the smudge.

"It's vera probable one of the new ones," said the skipper. "If 'twas *El Mirador* now. . ."

He left the sentence up in the air. Hawkins laughed. There had been one such episode not so long since when they had left that historic mud turtle hull down before she learned the *Cassie Hogan's* identity, for the *Cassie Hogan* was an unusually fast freighter and her engines could develop an astonishing burst of speed when the occasion arose. Such an occasion had apparently arisen now. The captain turned suddenly.

"Will ye go down and tell Mr. Jenkins to turn her over," he ordered.

Hawkins grinned and ran down the ladder. Almost immediately a cloud of black belched from the freighter's funnels and she began to vibrate from stem to stern as she practically doubled her speed. The sudden increase in the speed of the engines brought most of the crew on deck, hot as it was. They gathered in a little knot, their eyes on the distant smoke plume that, moment by moment, grew in size and extent. Into the calm silent day had come a sudden, suppressed excitement.

"That there is a Nicky tom-cat sure as shootin'," remarked Larry Weed, the second officer, using the sea-slang for a gunboat. "She's layin 'her ears right back on her neck, too."

"Reckon she's gonna bite us?" asked one of the crew.

"She's gonna git her gums full of steel stickers does she bite our canned beans," announced Sammy. There was a general laugh, for the contents of the long, carefully nailed cases in the hold was no secret aboard ship.

"Mebbe she's just gonna sniff 'round," offered a third.

"When I was in the North Sea . . ." began Sammy, but the second officer cut him off.

"When you was in the North Sea, you was soun' asleep 'cept at meal times," he interrupted. "The admiral told me so—personal."

Sammy reddened.

"Say—I never got no sleep for three days, sometimes," he defended.

"An' then again," said the second officer mercilessly, "then again you wasn't awake for mebbe a year or so. I know because the admiral never kept nothin' from me." Sammy relapsed into silence. The others grinned. The cook came up out of the galley, wiping his hands on his apron.

"Who's what?" he demanded, nodding toward the smudge.

"Here's hopin'," growled a scrawny New Englander.

"Me too," said the cook. "I aint seen no action a-tall since I come aboard. They told me this was a right good tub for it too." His tone expressed deep regret, and it nettled the second officer.

"Since when B. C., was a cook any good in a fight?" he demanded scornfully.

The cook stopped wiping his hands and stared at the speaker. The cook was a large, blue-eyed man with a round expressionless face.

"Lissen crawfish," he said softly. "You achin' to git a kittle on the coco? 'Cause if you are, you just keep on the way you're steerin', and you're gonna get ruint on a reef, the same bein' I'm." He announced it as a fact and no one seemed to doubt him. The second officer regarded him open-mouthed. A cook talking back to an officer was something new in his experience.

"Well I'm blowed!" he exclaimed. "He's hard-boiled, he is!"

"Fellah," said the cook evenly, "a wall-eyed shark aint more so."

The discussion was cut short by an exclamation by one of the men who had been watching the oncoming smoke cloud.

"Lordy but she's a comin'!" he cried.

It was apparent that "she," whoever or whatever she was, was certainly "coming." Fast as was the *Cassie Hogan,* it was apparent that the stranger on her heels was even faster. The belching plume of black lay along the horizon like the mark of a dirty finger. On the bridge Captain McTavish swung the freighter two points off her course. growling to himself.

"Vera inconvenient," he muttered.

Jasmine Hawkins heard the mutters and grinned to himself. The milder the old man was the more dangerous he was. That was history.

"Do you think she'll take the chance of stoppin' us?" he asked, after a bit. The skipper fixed him with a cold, glittering eye.

"Any one that stops us is takin' a chance," he replied obliquely.

The whistle from the wireless room thrilled in the bridge house. The operator had picked up a message.

"It's to us," he said ,"from *El Frigador*—she's a Nicky tom-cat—she says to heave to. She shot it on a chance we were listenin'. Shall I acknowledge?"

"Acknowledge nothin'," snapped the captain. He turned to his first officer. "Tak' the wheel Mr. Hawkins. I'll be goin' below for a bit."

A moment later the skipper thrust open the door of the wireless room and stepped in. Soda Magee spun a chair around with his foot, and twisted one "can" off of his ear so he could talk.

"How long's she been callin'?" the skipper asked.

"Since 6 p.m. last night," grinned Magee. "I changed wavelength and cut down my spark when I took weather from the WOX. She thought I was a limey because I used a "D" call, and I didn't correct her none . . ." He jerked a thumb at his call book. A hubbub broke out in his receivers and he took them off and hung them on his rheostat knob. "That's her," he said. "I got tired of listenin' to her."

McTavish nodded.

"She'll be alongside in a few minutes. I've been thinkin' . . . 'Twill be better if ye're dead . . . There'll be an investigation at Corinto or maybe San Juan and we'll be vera, vera surprised to know there was calls we didn't get. But with an operator dead . . ."

Soda rolled a cigarette and lighted it slowly.

"Buried at sea?" he asked.

The skipper nodded.

"Fifteen fathoms down in a canvas jacket. 'Twill be so writ in the log for the eye of the consul." He turned back at the door. "I'll put ye down as John Smith, able seaman and ye can act accordingly . . ."

"I get you," said Soda Magee slowly.

"There'll be a little somethin' in it for ye," the captain added significantly.

"Thanks," said Soda Magee and fell to studying his cigarette thoughtfully.

The second officer poked his head into the wireless room after the captain left.

"Hey Soda," he greeted, "who's the lady steppin' on our wake?"

Soda leaned back and regarded the other with interest.

"Now how the heck can I tell?" he asked. "Me—I'm dead!"

The second officer gasped.

"Gwan! What's the joke!"

"Joke? Say—you think bein' dead's a joke? Try it once, that's all I've got to say."

The second officer studied Soda Magee's face.

"Gimme a tumble," he said. "What's the idea?"

(*Continued on Page* 40)

When Interference is Necessary

A Simple Mathematical Analysis of Carrier Modulation as Applied in Radio Transmission and Reception

By Loyd E. Hunt

ALTHOUGH interference is commonly regarded as the greatest evil in the radio field, yet, without it, there would be no reception of radio broadcasting. The interference principle is the basis of all phenomena involving the modulation of a carrier wave. Whether interference is good or evil depends upon whether it is controlled or not.

By considering interference as "the modification of amplitude due to the superposition of waves" it is possible to gain a clear insight as to the how and why of the transmission of sound and of pictures and of the operation of the superheterodyne and infradyne. This study requires only a working knowledge of trigonometry and a little patience.

Thus, as is well known, a broadcasting station sends out a modulated carrier wave. The carrier wave is produced by an oscillator and may be represented by $e_1 = a \sin mt$ — (1). The modulatory wave is produced by the microphone circuit and may be represented by $e_2 = b \sin nt$. - - - (2). The modulated wave resulting from the superposition or combination of (1) and (2) is

$$e = a \sin mt + b \sin nt. \text{ -(3).}$$

Since mt is greater than nt, $mt = (nt + st)$ and

$$e = a \sin (nt + st) + b \sin nt$$

$$e = a (\sin nt \cos st + \cos nt \sin st) + b \sin nt$$

$$e = \sin nt (a \cos st + b) + a \cos nt \sin st$$

Let $R \cos \phi = (a \cos st + b)$ and $R \sin \phi = (a \cos nt \sin st)$ where $R^2 = (R \cos \phi)^2 + (R \sin \phi)^2$.

Then $e = R \sin nt \cos \phi + R \cos nt \sin \phi$ or $e = R \sin (nt + \phi)$ - - - (4). It is seen therefore that the complex wave has a sine form.

Substituting in the above equations, we have

$$R^2 = (a \cos st + b)^2 + a^2 \sin^2 st$$

$$R^2 = a^2 + b^2 + 2ab \cos st \quad (5)$$

We see that the value of R varies between a maximum of $(a + b)$ when $\cos st = 1$ to a minimum of $(a - b)$ when $\cos st = -1$.

Let us take equation (5) under investigation, and let us consider that the two waves start at the same time. Then when $t = 0$, $st = 0$.

At some later time t, the value of st is $(m-n)\,t$.

When $(m-n)\,t = 0, 2\pi, 4\pi,$ - - -
$\cos (m - n)\,t = 1$ and R will be a maximum.

When $(m-n)\,t = \pi, 3\pi, 5\pi$ - - - - -
$\cos (m-n)\,t = -1$ and R will be a minimum.

The interval between two successive maximum values of R is $\frac{2\pi}{m-n}$ and the number of maxima per second is $\frac{m-n}{2\pi}$.

This periodic variation due to the interference of two waves is called "beating," and the successive maximum or minimum values are called "beats."

Another way of looking at the problem is to manipulate equation (3)

$e = a \sin mt + b \sin nt$ so as to give

$$e = ab \sin \left(\frac{m+n}{2}\right) t \cos \left(\frac{m-n}{2}\right) t \quad (3a)$$

The factor $\cos \left(\frac{m-n}{2}\right) t$ is periodic, varying in value from 1 to —1 and goes through a complete period in the time $\frac{4\pi}{m-n}$.

Since $(m-n)$ is very small in comparison to $(m+n)$, we may therefore consider $2a \cos \left(\frac{m-n}{2}\right) t$ to be the slowly varying amplitude of a wave having a period $\frac{4\pi}{m+n}$.

This is often represented graphically as a wave of frequency $(m-n)$ riding on the wave of frequency $(m+n)$.

The wave arriving at the receiving station is represented largely by

$$e_1 = ab \sin mt \sin nt + a \sin mt \quad (6)$$

and the wave impressed on the grid of the first detector tube may be represented by

$$e_g = k \sin mt \sin nt + k' \sin mt \quad (7)$$

where k and k' are constants depending upon a and b.

Equation (7) represents a complex wave expressible in the form of equation (3a).

The wave in the plate circuit will be,

$$e_p = (e_g + e_g^2)\,\mu \quad (8)$$

When the value of e_g from (7) is substituted in (8) the square term yields a term $kk' \sin^2 mt \sin nt$.

Since $\sin^2 mt = \frac{1}{2}(1 - \cos 2mt)$ we have, $kk' \sin nt - \frac{1}{2}kk' \cos 2mt$ (9) The term $\cos 2mt$ is high frequency and is suppressed by the audio transformer or phones. The term $\frac{1}{2}kk' \sin nt$ is the original voice wave modified in amplitude only.

In the superheterodyne receiver, the incoming wave is represented by equation (6) which is combined with a locally generated wave of the form of equation (1). The resulting wave applied to the grid of the first detector is of a form represented by equation (3a) and is of high frequency, and may be analyzed according to the above method. The intermediate transformers offer a low impedance to the frequency corresponding to the difference between the two frequencies and present a high impedance to the other frequencies of the complex wave.

In the infradyne the incoming wave after passing through the radio frequency amplifier contains terms represented by equation (6) which are impressed upon the grid circuit of the first detector tube where it is combined with the oscillator output to form a wave represented by the form of equation (3a). The infradyne amplifier offers a low impedance to the sum frequency in a manner shown by the excellent article of Raymond B. Thorpe in January, 1927 RADIO.

In picture transmission, the current from the photo-electric cell is of a form represented by equation (2) which is combined with a carrier of the form expressed in equation (1) producing the complex wave of equation (3a), which is then changed by the modulating tubes to a wave represented by equation (8).

In long distance telephony a voice current of the form represented by equation (2) is combined with a carrier of equation (1) also producing a wave shown by equation (3a) which is in turn changed by the modulating tubes to a wave of equation (8).

These are illustrations of the phenomena of interference when properly controlled. When not properly controlled, the results are distressing indeed. Two broadcasting stations very near the same wave length emit carriers which may combine to produce an audible frequency wave. This evil led to the allocation to broadcast stations of positions in the broadcast band expressed in terms of kilocycles rather than meters, on the supposition that two carriers more than ten kilocycles apart cannot combine to produce an audible beat frequency. This sad state of affairs is very evident in these days of "piracy".

The poorly designed regenerative receiver and the poorly controlled radio frequency receiver in which the tubes are oscillating at radio frequency, emit a wave which may be of a frequency very near that of a broadcast carrier wave or very near to a wave radiated from a similar receiver, in either case producing an audible squeal or whistle which is very disturbing to the music lover.

In the transatlantic radio telephony equipment, the phenomena of interference is utilized in several different steps.

The carrier of the form shown by equation (1) is produced by an oscillator at a frequency of 33,700 cycles and is doubly modulated by a wave of voice frequency of equation (2) from the microphone forming a complex wave of equation (3) which is then applied to the grids of the modulator tubes. The output of the plate circuit is passed through a filter which cuts off the carrier and one side band permitting the lower side band to pass through. This side band is contained in the first term of equation (6), is of a frequency of the order of 33,000 cycles and is in turn combined with a new carrier, equation (1) of a frequency of 89,200 cycles forming a complex wave of equation (3a) which is then applied to the grids of a second set of modulator tubes. The output of these modulators is then passed through a second filter which passes the lower side band but suppresses the new carrier and upper side band, produced by the second modulation.

The resulting wave formed by the lower side band which is of the order of 55,000 cycles is then impressed upon the grid of an amplifier tube, the output of which is impressed on the antenna circuit.

This method of transmitting only one side band is believed to be the most practical method of increasing the number of frequencies available for broadcasting without causing interference between carrier waves. The transmission of a single side band without carrier has progressed very far in connection with carrier telephony on wires, where the carrier currents of adjacent channels are separated by only 3000 cycles. If both side bands were transmitted, the number of channels would be halved. In addition to this is the objection that the components of one side band would beat with the components of the other side band thus introducing undesirable distortion.

Since the output of the modulator tubes is expressed by an equation such as $e_p = (e_g + e_g^2)\,\mu$, a term ($a \sin mt$) is present, which represents the unmodulated carrier and which does not carry any of the signal variations, but only demodulates the received signal wave. Hence, it is not necessary that this term be included in the transmitted wave in order that intelligent signals be received at the receiver. It is well known that the energy resident in the carrier is very large compared to that in the modulated carrier and it is readily seen that the suppression of the carrier from the transmitting wave introduces the possibility of transmitting with reduced power.

If however, the carrier is suppressed at the transmitter, a local carrier must be supplied at the receiver in order that the signal wave may be demodulated. This is done by applying both the signal wave and the local carrier to the grid circuit of the detector tube which forms a complex wave as follows:

If the received wave is represented by $e_g = k \sin mt \sin nt$ and the local carrier represented by $e_c = k' \sin mt$ then the wave applied to the detector tube is given by equation (7) and the discussion following equation (7) applies.

Filament Center-Tap Location

ON SETS employing a.c. for the filament the usual practice is to have a filament center-tap. This is sometimes improperly located. Occasionally the filament winding on a transformer may not be a single layer and sometimes it is not possible to finish the winding on the same leg of the transformer. Under these conditions, the center will not be at exactly one-half the number of turns. To properly locate the center, use the filament voltmeter and test each half. Solder a small, sharp brad to one voltmeter terminal to locate the proper position before scraping the wire. Don't think that since the voltage from one end is half the voltage of the total winding you now have the center. This is not the case. Test each half until they read the same. The sum of the voltages of the halves, for instance, might be 8 volts; the total winding 10 volts, under some conditions. In other words, the voltage is not proportional to the number of turns, if this number is very small. Run the leads out straight from the winding otherwise they will act as an additional half turn or so and throw the center off.

A new high-mu tube, CX-340, UX-240, has been developed for improving resistance or impedance coupled amplifiers. Its filament consumption is ¼ amp. at 5 volts. Operated at 135 volts plate it requires 1.0 to 1.5 volt grid bias, at 180 volts, 3 volt bias. It has a theoretical voltage amplification factor of 30 which gives an effective factor of 20 in practice. It may also be used as a detector at the same plate voltage with grid bias of from 2 to 5 volts. A recommended circuit to give volume without distortion employs this tube as a detector and as a first stage amplifier and a UX-171, CX-371 tube is the second stage.

THE BALSA WOOD LOUD SPEAKER

(*Continued from Page* 17)

driving unit can be placed in position on the bottom of the speaker unit. The number of wooden cross pieces for holding the driving unit depends on the design of the unit, but two are preferable. In the picture, but one cross piece is in place, so as to show the details of the unit more clearly.

The position of the driving unit on the cross piece must be adjusted by hand, until the driving pin fits into the coupling bushing on the diaphragm, and is exactly centered in it. A favorite method of holding the unit in place is to use two 18 in. cross pieces placed on each side of the center of the frame, and about 5 in. apart, with another piece placed like the horizontal part of the letter "H," on which the driving unit is mounted. When the unit is in position, tighten the set screw of the bushing on the diaphragm, and the speaker is ready for operation.

Some sort of decorative covering to conceal the diaphragm will improve the appearance of the outfit. Do not paint or varnish the Balsa wood under any circumstances, for to do so will impair its fine tone quality. The frame on which the Balsa wood is mounted can be stained or painted in any convenient manner, and it is also permissible to paint or stain that part of the edge of the speaker which is glued to the frame, or to cover this edge with an ornamental molding. Over this molding a piece of thin silk or decorated cloth can be stretched, to hide the diaphragm, and the finished speaker hung on the wall from the picture molding. If the covering over the front of the instrument is made of too heavy a material, the speaker will sound muffled and unnatural. Do not allow the covering to touch the diaphragm at any point, or a rattling sound will occur. Be sure to cement the diaphragm thoroughly along the edges, where it joins the frame or the speaker will buzz.

A list of the parts needed to build the outfit is given, the driving unit being any suitable cone unit. The cost of the wood together with the coupling bushing should not exceed $10.00, and good loud speaker units can be had at prices ranging from $7.50 to $10.00.

A word of warning in conclusion will not be amiss. Handle the Balsa wood with extreme care, for it will be damaged by the slightest blow from sharp instruments such as a screwdriver or pliers, and even fingernail marks show up plainly if the wood is pinched between the fingers.

A Short-wave Super Regenerat

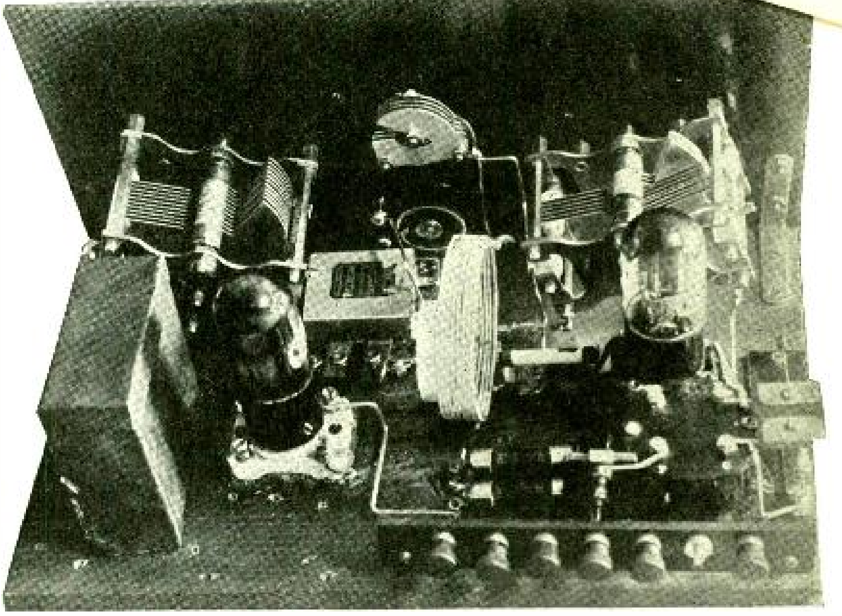
Well Suited for Continuous Wave Code Recep

By Francis Churchill

SUPER-REGENERATION, which obtained a lot of publicity a year or so ago, has several undesirable characteristics for broadcast work and so died a more or less natural death. However, for short-wave work it has several good points, and as the sensitivity increases with a decrease in wavelength, it is obvious that a well constructed set will be extremely sensitive.

The circuit shown in Fig. 1 was developed while experimenting with a four element vacuum tube. The secondary side *G* of the transformer *T*, was accidentally disconnected from the second grid of the 4 element tube and by a slight readjustment of R_1, the circuit still oscillated at about 17000 cycles.

The action of this short-wave receiver is as follows: the circuit using transformer *T* oscillates at 17000 cycles per second and this causes a changing bias on the grid of the detector at the rate of 17000 times per second. This in turn throws the short-wave detector circuit in and out of high frequency oscillation that many times per second, which means an enormous amount of regeneration, or super-regeneration on the short-wave band. The short-wave circuit is kept on the verge of oscillation or oscillating by means of a variable resistance control R_2 and the tickler coil L_2. As soon as the other circuit in this tube is adjusted, for once and all, to oscillate at some high audio frequency, the super-regenerative action starts and at 40 meters the signals fairly jump at you and even better results are obtained on 20 meters, due to its being a shorter wavelength.



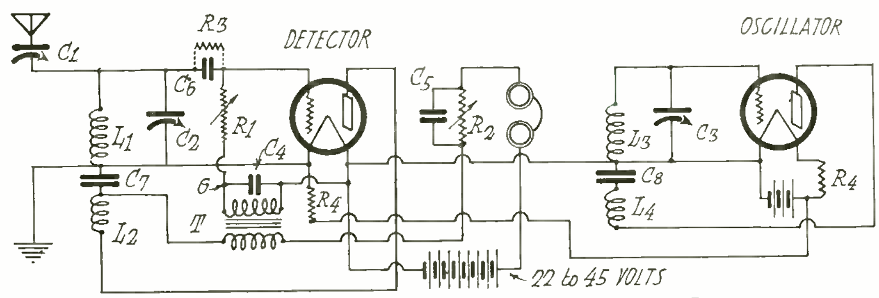
Rear View of Short-Wave Super-Regenerative Set.

Since the detector is thrown in and out of oscillation 17000 times per second, the usual beat note on cw is not obtained and only the modulated carriers are audible. In order to get the pure cw stations it is necessary to use a separate heterodyne and obtain the desired beat note by that means. The tube marked *osc.* in Fig. 1 is used for this purpose, one of its harmonics slightly below the broadcast band being used to heterodyne the received signals.

In the picture, this heterodyne is on the left hand side of the receiver, the oscillator coil being inside of a copper box for shielding purposes. The drop across the common impedance of the *B* battery is sufficient to cause the harmonics to heterodyne the incoming signals very nicely.

This means a second tuning control, but neither control is especially critical in the settings, so that tuning is easily accomplished. The setting of R_2 does not have to be changed frequently and nearly the whole 40 meter band can be covered without changing it. R_2 is shunted by a 1 mfd. condenser in order to reduce any tendency for noise to originate from this source. The use of a good variable resistance eliminates such difficulties anyway.

Another factor worth mentioning for any short-wave receiver is the noise due to microphonic vacuum tubes in which the elements are not rigidly supported. The use of a detector tube which has some type of bridge construction, such as the QRS tube, eliminates the awful ringing noises which occur in a short-wave receiver when the set is jarred ever so slightly. Another thing is the use of special detectors which are much more sensitive on weak signals than the ordinary "A" type tubes. It is necessary however, to use a detector which has practically no hiss, as this is very annoying when working with short wave cw signals. There are several such makes of special detectors on the market at present, such as the QRS, the CeCo and the Sylfan tubes.



Circuit Diagram for Short-Wave Super-Regenerative Set.

L_1=8 turns 2¾" diam., No. 16 ga. Space wound on celluloid strips.
L_2=10 turns 1½" diam. No. 24 ga., held together with collodion.
L_3=30 turns or thereabouts 3" diam. (any kind of winding) Broadcast R.F. transformer can be used.
L_4=10 turns on 3" diam. (any kind of winding) Broadcast R.F. transformer can be used.
T—Intermediate frequency transformer (Remler, Baldwin Pacific, etc.)
R_1=0-200,000 ohm variable resistance (Electrad, etc.).
R_2=0-50,000 ohm variable resistance (Electrad, etc.).
R_3=Grid leak 6 to 10 megohms.
R_4=Amperites.
C_1=Midget variable condenser 30 mmf. max. or thereabouts.
C_2=.000125 mf. max. variable condenser.
C_3=.0003 mf. max. variable condenser.
C_4=.00025 mf. fixed condenser, depends on type of "T" used.
C_5=1. mf. fixed condenser.
C_6=.0001 mf. fixed condenser.
C_7=.001 mf. fixed condenser.
C_8=.001 mf. fixed condenser.

...e shows a suggested lay-... type of receiver, though no ... fast rules are necessary in the ... of the apparatus behind the ... Any short-wave receiver can be ...y modified to make use of this prin-...ple by adding an external hetero-...dyne, a tuned transformer T, a variable resistance R_1, and the removal of the customary grid leak R_3.

The entire set can be mounted behind a 7x12 or 7x14 in. panel as shown. The transformer T is an iron cored intermediate frequency transformer, such as used in a super heterodyne receiver, and is tuned in this case to 17000 cycles when shunted by a .00025 mfd. fixed condenser. The value of this condenser has to be determined experimentally and is found by trying different values until a very high pitched whistle is heard in the telephone receivers when this part of the circuit is oscillating. The markings P and $+B$ on the primary of the transformer will be reversed for most makes of transformers.

R_1 should be adjusted to some value such as 100,000 ohms as a preliminary setting, or varied until the tube oscillates at the high audio frequency. Its value will also depend on the ratio of the primary to secondary turns in the transformer T and so it is preferable to use some transformer in which the ratio is rather low in value. R_1 may be a plunger type resistance or a slider type such as the Electrad 0-200,000 ohms resistance, the latter being preferable.

R_2 is an Electrad 0-50,000 ohms resistance and R_3, when used, is the usual 6 to 10 megohm grid leak. R_3 is only used when comparing a standard short-wave receiver circuit against the circuit shown, the change being made in about two seconds by inserting R_3 across the grid condenser clips and disconnecting R_1 from the grid.

The antenna is coupled to the receiver through the midget condenser C_1, this providing a very satisfactory means for short-wave receivers. The two tuning condensers C_2 and C_3 should have some good type of vernier dials for ease of tuning.

The heterodyne unit, marked *Osc.* in the diagram, is tuned to wavelengths between 120 and 300 meters, and the third, fourth, or fifth harmonics of this oscillator used for heterodyning signals in the vicinity of the 40 meter band, or higher harmonics for the 20 meter band. It is not necessary to shield this oscillator coil but it is desirable as it then has less effect on the short-wave coil fields.

In adjusting the receiver it is best to disconnect R_2 and insert R_3, making it a standard short wave receiver and tune to signals in the 40 meter band. If the polarity of the tickler coil L_2 is correct, the receiver should go in and out of oscillation as R_2 is varied. As soon as the set is functioning properly as a standard short-wave receiver, connect R_1 back to the grid and lift out the grid leak R_3. By varying R_1, a high pitched whistle should be heard in the phones if condenser C_4 is of the proper value and the windings of the transformer T are poled correctly. As soon as this high whistle is audible, R_2 should be varied until a rushing sound or hiss is heard, and if there are any signals or power buzz present, their audibility will be increased a great many times. In order to get the usual whistle from the incoming signals it is necessary to tune the heterodyne by means of C_3 so that one of its harmonics causes a beat note with the signal. C_3 and C_4 should be adjusted simultaneously.

For 20 meters the same layout can be used by changing L_1 to 4 turns and L_2 to 7 turns with the same respective diameters. The high frequency of 17000 cycles per second is even more efficient at 20 meters. This value of 17000 was used as it was so high as to be nearly inaudible, though a slightly lower frequency will give a little greater signal strength. This frequency was measured by zero beat with a calibrated audio frequency oscillator.

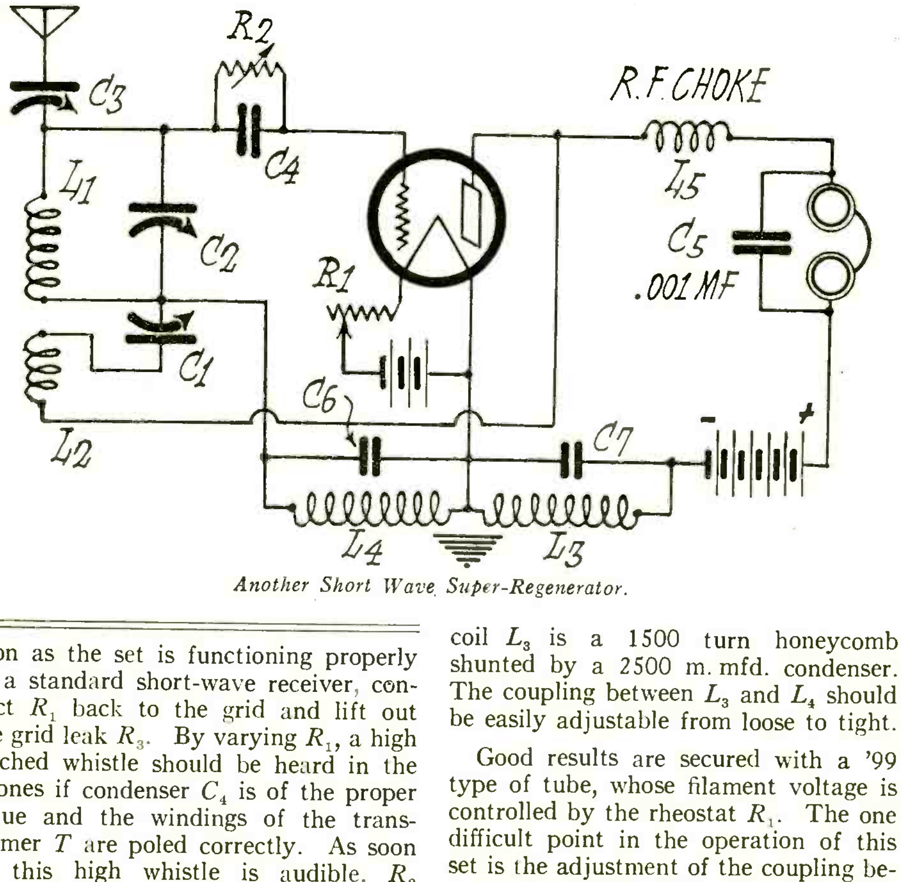
Another Short Wave Super Regenerator

By G. B. Hart, 8 DK

So remarkable have been the results with a super-regenerative circuit for short-wave reception at 8DK, that the circuit details are here passed on to other amateurs who might like to duplicate it. The parts are standard and the assembly is simple. The reader is assumed to be familiar with the principles of Armstrong's invention.

The r.f. coils are three Aero plug-ins, covering the band from 15 to 110 meters. These are tuned with a 140 m. mfd. variable condenser C_2. The regeneration control C_1 is a 250 m. mfd. variable condenser. The antenna tuning condenser C_3 is a 50 m. mfd. variable. The 150 m. mfd. grid condenser is fixed and the grid leak is variable.

The grid coil L_4 is a 1250 turn honeycomb shunted by a 1,000 m. mfd. condenser, preferably a variable, as its value is somewhat critical. The plate coil L_3 is a 1500 turn honeycomb shunted by a 2500 m. mfd. condenser. The coupling between L_3 and L_4 should be easily adjustable from loose to tight.



Another Short Wave Super-Regenerator.

Good results are secured with a '99 type of tube, whose filament voltage is controlled by the rheostat R_1. The one difficult point in the operation of this set is the adjustment of the coupling between L_4 and L_3 until the oscillations are just at the point of stopping. This may require several trials, but once it is accomplished the coupling may be left in its proper position and the set operated without changing it.

When nothing is heard except a faint, high-pitched hum, adjust the variable grid leak R_2 until the set will go into and out of regeneration with only a slight plop. Then tune for the signals with the usual tuning controls and re-adjust the grid-leaks until the best results are secured.

The set has good selectivity, though the tuning is broad enough to hang on to swinging signals. It nearly doubles the loudness of signals as ordinarily heard with single tube. The howls, squeals and rustling noises that characterized super-regenerative receivers on broadcast wavelengths are almost completely eliminated.

Static Facts

By Kirk B. Morcross

ARE you troubled with scratchy sounds in your phones? Have you disconnected the antenna to make sure they don't come from the receiving set? Have you removed the phones to make sure they don't come from your head?

Yes! Yes!

Then you may be getting static somewhere from the great void. And again you may not. Just because you hear some funny noises which come without an introduction you resolve they are static. But do you *know* they are static?

If you were walking down the streets on a Sunday morning, your head filled with thoughts pure and good, and something hit you from behind, would you, when you regained consciousness, claim that an automobile hit you? Of course not. It might have been an airplane or a motor boat. As a matter of fact you might forget to claim anything for the first few moments after regaining consciousness because you would be relieving your mind of thoughts which were the exact opposite of pure and good.

So it is with static in your radio set. When a mysterious noise hits your ear you think: "Static." And then you say some things which I shall not record here and all the while it may not be static at all but something more tangible and more easily run down to its lair. It may even be something in your own receiving set. Your motto should be: "Investigate before you explode."

According to scientists the elimination of static is not an accomplished fact but its effects can be tamed; according to some advertisements of devices for reducing interference and improving signals these devices completely eliminate static as well (merely as a side line you understand); according to BCL's, static is the chief cause of failure to get that DX station and on nights bereft of static the distant stations are not heard because conditions are unusually poor (et cetera); according to the writer, static is not as black as painted for the simple reason that that which is called static is often something else. Of course my own ideas of static are best and therefore their elucidation will occupy the most space in this article.

As a tangible non - abstract definite object or piece of apparatus, there is no such thing as a static eliminator. This is a pretty flat statement so let me add hastily that every radio set is so constructed that static can be totally eliminated; the set will become adamant. This is done quite readily by disconnecting the phones or loud speaker, turning off the *A* battery, grounding the antenna or some other expedient, depending upon the phase of the moon. If you have a crystal set the suggestion of turning off the *A* battery must be thrown out. As a substitute try lifting the cat whisker from the crystal. This is usually very effective. The chief objections to such methods is that they eliminate the signals as well which is of course a disadvantage. Hence such methods of static elimination are useful only from the viewpoint, *per se*.

Up to the date of publication of this article no one has satisfactorily covered the subject of static. To be sure, numerous attempts have been made, but invariably the writer gets off on a tangent or else his explanations are so conglomerate and indefinite that the reader is in a quandary as to what sort of "static" the writer is talking about and is more befuddled than enlightened.

Years before radio, the term "static electricity" was found in abridged dictionaries. Then at the dawn of radio, interference from static electricity came to be known as "static." Static is therefore an abbreviation of static electricity; hence all static must come from static electricity or it is not static. Is that clear? Other expressions for static are "atmospherics" or "strays" but whichever term is used it refers to a *natural* form of interference. "Strays" might well include static and *all other* forms of non-radio interference (disturbances not originating in transmitting stations or radiating receiving sets) but "strays" and "static" are generally assumed to be synonymous.

The "static" in the phones or loud speaker comes from many sources,—yes sir! Some of it may come from the receiving set, some may ah, er,—come from your head, but let us not mention that again, while other disturbances of non-static ancestry may come from outside the receiving circuit. Special observations have shown that bona fide static is responsible for about one-sixth the interference encountered at night in the broadcast band of frequencies. So after all, the "demon" static is not as black as he is painted. Where does the other five-sixths come from?

From radio stations and radiating sets; from the receiving set in question; from power line induction; leaky power lines; motors; annunciators; door bells; X-ray and violet ray apparatus; gasoline engines; elevators; rural telephone ringers; thermostats; leaky transformers.

To assist in locating the portions of this interference coming from outside the house, disconnect the antenna and ground wires from the set. If the "static" decreases markedly in intensity or disappears entirely its source is probably outside the immediate premises. If it becomes only rather slightly weaker the trouble probably originates in or about your home, while if it remains the same then you should look to the receiving set itself.

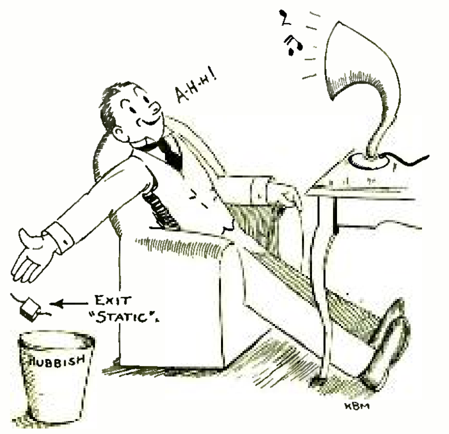
Some forms of inductive interference from power lines may be reduced or eliminated by erecting the antenna at right angles to the power wires. Apropos to the subject of general interference attention is called to an interesting treatise on the elimination of electrical interference in a publication of the National Electric Light Association Number 25-63 which may be obtained for 60 cents from the Association at 33 West 39th Street, New York.

If the "static" is coming from within your own home it should not be difficult to locate. While listening on the set and provided it does not derive its power supply from the lighting circuit, have some one open the supply switch from the mains. You may notice a cessation of some of the noise background following which it should be comparatively easy to determine the source of interference whether it be a contact in an electric heating pad or an electric fan. This method of opening the power supply is particularly effective at night while the family is engaged in reading or writing. The nicest thing about it is that the person opening the switch gets all the credit.

The receiving set itself is not infrequently a source of "static." I once had a set which took a fancy to picking up a lot of sizzling frying interference. I tried to tune it out but it persisted. I listened attentively for several minutes and became firmly convinced that the source was a leaky power line. In my mind's eye I pictured the power line, its supporting towers, the kind of wire and the color of the insulators. I saw the president of the company sitting in his office, his young and beautiful daughter,—she was about my age and unmarried,—and she,—

"P-s-s-t-s-c-s-c-s-s-t" went the power line and I turned off the set in disgust. I tried it again in half an hour. The noise was still there. I returned in forty minutes; still no change. Returned again in forty-six and one-half minutes; still ditto. I waited until the next day and tried again; same result, morning, noon and night. It seemed that that power line maintained a remarkably uniform flow of power or a remarkably uniform leak. The third day was the same and then an idea came and I removed the antenna and ground wires from the set. Still the same leaky power line. Remarkably sensitive set.

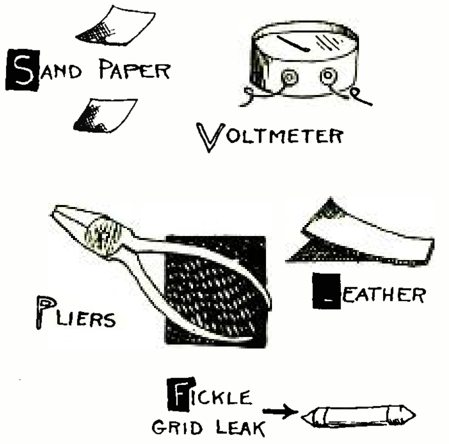
Light began to dawn. Grabbing a screw driver I began to look for a loose connection but found none. I followed up other lines but no results. Finally I thought of the fixed condenser shunting the *B* battery and primary of the first audio transformer. Using a nice pair of embroidery shears I cut the wire leading to it. Immediately the noise ceased. "Confound you," I said (or words to that effect) addressing the fixed condenser, "you've spilled your last microfarad." I deposited it in the rubbish can, purchased a brand new nifty condenser, installed it, and the leaky power line was but a memory.



"LEAKY POWER LINE BECAME A MEMORY"

The experience just noted is a salient example of how "static" may get into the receiving circuit. Another way it presents itself is through poor contacts in tube sockets, particularly the old type of socket. For that kind of static there is a very simple and cheap eliminator. It consists of a piece of fine sandpaper $\frac{1}{2}$ by $\frac{13}{16}$ in. in size. Remove the tubes and rub the contact surfaces of the prongs until they are bright and shiny. Then look to the contact springs and if they show signs of corrosion use up the rest of the sandpaper on them. This is a very economical static eliminator. A larger piece of sandpaper may be used but it is more expensive. After all contacts are polished up it may be found worth while to bend the contact springs in the tube sockets to secure firmer contact. The finer the sandpaper used for this work the better and as we go down the scale of "finer and finer" we emerge from the spectrum of sandpaper into the realm of,—leather. A piece of that substance, smooth on one side and rough on the other is excellent for massaging besmudged contact surfaces. It removes the dirt but not the metal.

The accompanying sketch suggests some "static" eliminators. A direct current voltmeter is often very effective. Test each *B* battery in turn and see if the voltage registers less than 17 or 18. If it does, then the *B* battery is a potential possibility as a static producer. Discard it and substitute a good one and you will probably notice a pleasing improvement. The slogan, "The best is always the cheapest," is usually bunk but in the case of a voltmeter used as a static detective it holds water. (It is assumed that the calibration of the instrument is reliable.) A cheap voltmeter has a low resistance and shows the *B* battery voltage while the battery is exercising itself. An expensive voltmeter has a high resistance, the *B* battery can't push any current through it, and the voltage indicated is essentially nothing more than the open circuit voltage. If you are unfortunate enough to have an expensive voltmeter try shorting its terminals momentarily while it is connected to the battery. If the battery is a mere pretender the voltage immediately after the short is removed will be found wanting.



SIMPLE STATIC ELIMINATORS

One might say that a resistor or grid leak (shown in the sketch) could never be a static eliminator. The objection is excusable but entirely erroneous, because when this simple little device develops variations in its resistance it makes plenty of static and when it is removed from the circuit away goes the static with it. By not being there the resistor eliminates static. So why isn't it a static eliminator? I couldn't draw a picture of something which wasn't there and so it was necessary to adopt this method.

The pliers need almost no explanation. As everyone knows they are frequently used for shorting *A* and *B* batteries by attempting to tighten up nuts on the receiving set. However, use them with discretion for this purpose and not infrequently a goodly portion of your static worries will be dissipated.

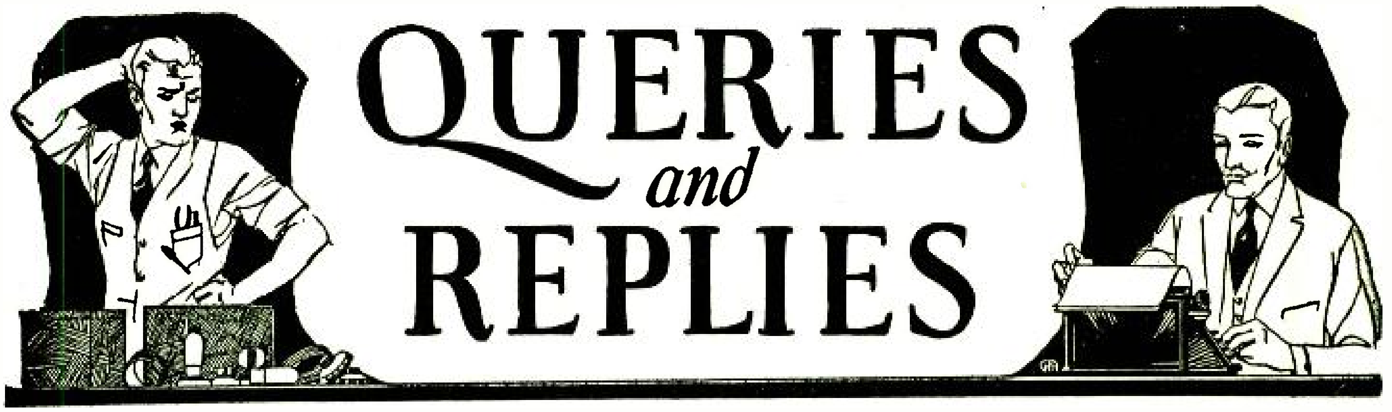
The other devices as pictured may be taken as suggestions just sufficient to scratch the surface of the subject of simple static eliminators; nevertheless they should be entirely adequate to start the set owner on the right mental perambulations incidental to the assemblage of a large repertory of static eliminators. In truth, the particular types adopted will be governed to a large extent by the type of receiving apparatus.

Some day when I am rich and independent I shall purchase a nice plot of ground (I have my eye on one now) away from the dust and turmoil of the city and place a neat comfortable radio shack in its geometrical center. The shack will be equipped with all manner of radio sets and jimcracks but there will not be a single antenna wire floating in the breeze outside nor will there be any loop antennas to intercept the radio waves. But buried in the ground underneath my shack and all around like the spokes of a great wheel I shall have wires laid in carefully insulated conduit and shall bring them into the shack all numbered and tagged. More than this, there will be other underground antennas laid at different depths, some extending straight down into the ground.

On one of those summer nights when static makes distant reception "impossible" I shall ensconce myself comfortably within the radio shack and selecting one or more of my underground antennas, experimentally connect them to the various pieces of apparatus until the proper combination is found and presto!—in will come those distant stations minus the static. I may even go further. By careful experimentation and the use of a completely shielded radio set I shall listen to broadcasting stations while a life-sized thunderstorm is in progress outside.

This isn't entirely a dream. Tests have been made with underground receiving antennas which indicate their vast possibilities as static eliminators. Apropos, the following references are given: Journal of The American Institute of Electrical Engineers, Volume 42, pages 258, 372, 636 and 728, 1923; "QST," Vol. 6, page 7, November, 1922; Proceedings of The Institute of Radio Engineers, Vol. 7, page 363, 1919 and Vol. 9, page 41, 1921. Current articles dealing with static elimination are given under the number, R431 in the radio reference list in the Radio Service Bulletin.

The present day radio fan is so absorbed in wiring up a superneutroflex an idoautophase or a quasipliodyne and so engrossed with the shape of the panel, the proportions of the cabinet and the use of unit control that he forgets there is such a thing as an antenna. So intent is he upon making a totally shielded set (which in truth is a good thing) that he never stops to consider the power of Old Mother Earth to shield his antenna from shock excitation due to static while retarding the radio waves in less proportion.



Questions of general interest are published in this department. Questions should be brief. typewritten, or in ink, written on one side of the paper, and should state whether the answer is to be published or personally acknowledged. Where personal answer is desired, a fee of 25c per question, including diagrams, should be sent. If questions require special work, or diagrams, particularly those of factory-built receivers, an extra charge will be made, and correspondents will be notified of the amount of this charge before answer is made.

Kindly advise how a variable condenser can be used to control regeneration in the plate circuit of a vacuum tube detector.—O. E. E., Altadena, Calif.

A typical capacity regeneration scheme is shown in Fig. 1, the circuit being a simple regenerative detector connected to the antenna tuned circuit, and without amplifiers. Energy from the plate of

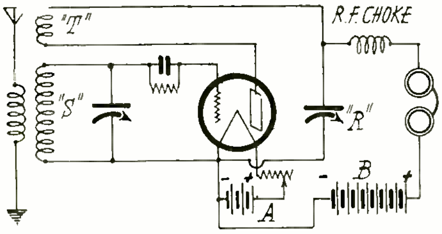


Fig. 1. Detector Circuit With Capacitive Regeneration Control.

the tube is fed through the tickler coil "T" into the secondary coil "S", and causes the tube to oscillate when the feedback from the tickler to the secondary is of sufficient magnitude. Naturally, with a fixed tickler coil, the amount of energy transferred between the tickler and the secondary will vary with the setting of the secondary tuning condenser, and regeneration which precedes the point where the tube oscillates would be had only over a small section of the band of waves to which the set will tune. Hence, if we introduce a control in the plate of the tube, whereby the energy fed into the tickler coil can be varied, this regeneration point can be selected for any setting of the secondary tuning control. By placing an r.f. choke in the output circuit between the tickler coil and the headphones, all high frequency current passing through the tickler coil must go through the regeneration control condenser "R" in order to return to the filament circuit.

Since the alternating current resistance, or reactance, of a condenser increases as the capacity is decreased with the frequency remaining the same, we can imagine the condenser as a variable resistance. As a matter of fact, a very popular method of controlling regeneration with a fixed tickler coil is to shunt the coil with a variable non-inductive resistance of the order of 25,000 ohms, which accomplishes the same effect as the condenser, and takes up less space. The condenser method, however, is preferable on the short waves.

Would it be possible to use the Infradyne amplifier unit in the 1927 model Best Superheterodyne?—M. H. W., Spokane, Wash.

It would not be advisable, due to the fact that the mechanical layout of parts in the 1927 superheterodyne is not easily adapted to the Infradyne parts, and there is insufficient room for the amplifier unit At least two stages of tuned r.f. amplification is advisable with the Infradyne, to get the most out of the circuit, while the 1927 Super has but one stage.

Am planning to construct an electrolytic "B" eliminator to deliver 45 and 90 volts, with maximum capacity of 65 milliamperes. What are the specifications for a power transformer, and the size of the necessary choke coils for use in the filter circuit?—E. F. R., Berkeley, Calif.

A suitable size for the core would be 1 in. wide by 1½ in. high for the cross sectional dimensions, with a square window formed by the assembled core having dimensions at least 2x3 in. The primary, for 110 volt service, should have 550 turns of No. 20 D.C. C. wire wound on one leg of the core. The secondary should have a total of 400 volts so that 2200 turns of No. 22 D.C. C. or enameled wire wound on the other leg of the core, with a tap taken out at the 1100th turn, will give 200 volts on each side of the center tap. Even though 90 volts maximum is wanted, it will be necessary to wind the transformer to a much higher secondary voltage, to take care of the loss in the filter circuit, as well as inaccuracy in the design of the core, and the selection of the core material. Silicon steel core pieces should be used, where it is possible to obtain them.

The filter chokes should have at least 20 henrys inductance, making a total of 40 henrys where 2 chokes are used. As there are many excellent chokes on the market at a low price, and designed to carry as high as 85 milliamperes, it would hardly be worth while to build your own chokes unless you are particularly anxious to build all the apparatus yourself. However, using the same sized core as for the power transformer, and providing an air gap of $\frac{1}{32}$ in. in the core, 8700 turns of No. 36 enameled or cotton covered wire wound in two sections, on opposite sides of the core, will give sufficient inductance for use in the filter circuit. See Fig. 3 for a suitable circuit.

Please tell me the reasons for a tuned r.f. set having a high and low dial setting for the same station, acting on the same principle as the oscillator dial in a superheterodyne.—A. S., Dayton, O.

The phenomenon is not a frequent one with tuned r.f. circuits, and is probably caused by the coupling between the primary and secondary circuits of one of the r.f. stages being too broad. Among the other probabilities are that one of the r.f. tuning condensers is out of line with the rest, in the case of a gang condenser, or when the r.f. amplifier breaks into oscillation and causes powerful local stations to be brought in at almost any point on the tuning controls.

Would like to operate my eight tube loop type superheterodyne from an outdoor antenna, and need the necessary instructions for the coils and condensers which will be required.—E. J. S., Belleville, Ill.

While this circuit has been published several times in past issues of RADIO, it is being reprinted as an aid to those

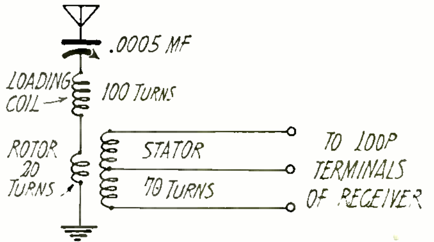


Fig. 2. Antenna Tuner for Superheterodyne Receiver.

who do not have the back numbers on hand. The necessary equipment consists of a variable condenser of .0005 mfd. with suitable tuning dial, a loading coil made up by winding 100 turns of No. 24 cotton covered wire on a 2½ in. tube, or by purchasing a 100 turn honeycomb coil and a coupler. The circuit is shown in Fig. 2, the secondary of the coupling unit being used in place of the loop antenna. The rotor of the coupler may be wound on a 1¾ in. tube and should have not more than 20 turns of No. 24 or 26 cotton covered wire. The secondary may be wound on a 2½ in. tube, with 70 turns of No. 24 or 26 cotton covered wire, a tap being taken out at the 35th turn. Factory made coils, such as the Silver Marshall No. 110-A, will do equally as well, where the coils are not to be home-made. In connecting this device, it is important to remember that the coupling between the rotor and stator of the coupling unit must be extremely loose, or the tuning will be broad, the sensitivity of the set low and, worst of all, the set will radiate into neighboring antenna systems. Should it be necessary to operate the tuner with close coupling, it would be much better to install a stage of tuned r.f. amplification as is done in the 1927 Best superheterodyne, and thereby avoid trouble with the neighbors due to radiation of energy from your receiver. Once the proper adjustment of the rotor coil is made, the tuning is accomplished entirely with the antenna series condenser, which will have a low capacity setting for the shorter waves, and will be set at practically full capacity at the higher waves. For local stations, it may be set at maximum and the tuning done with the dials already installed in the receiver.

What do you think of the idea of tuning three long wave intermediate frequency transformers with variable condensers, in order to adjust them all to the same frequency, after which the condensers are to be left alone?—T. J. O., Salt Lake City, Utah.

Several transformers designed for use in superheterodynes have been manufactured with the variable tuning condenser built in as an integral part of the transformer. The ear is a poor judge of the peak frequency of the intermediate amplifier, however, and it is best to have some idea of the frequency best suited to the transformers by matching them with an oscillator and vacuum tube voltmeter.

I expect to build a "B" eliminator, using a four jar electrolytic rectifier, and wish to know the following: What size elements should be used in the rectifier cells? Where can they be purchased? Will the secondary of a good bell ringing transformer serve as an effective choke for the filter? What values of resistance should be used to provide the variable voltage taps? Should the cases of all chokes, condensers and transformers be grounded? Can you suggest a satisfactory circuit for this combination?—C. A. G., Baltimore, Md.

is unsuited for use as a choke. The primary winding, however, has an inductance of several henrys when passing 30 or 40 milliamperes d.c., but you would require four or five of these transformers in series to obtain a sufficient amount of inductance to make an effective filter. Good filter chokes may now be purchased at a cost of not more than $6.00, so that it would be poor economy to use a number of bell ringing transformers. The resistance values for the variable voltage taps will depend upon the exact current requirements of the receiving set. Hence, Clarostats, or other suitable heavy duty variable resistances should be used at this point. The metal cases of all apparatus used in the eliminator should be connected to the negative "B" circuit, and to ground.

Is it possible for us to still obtain the circuit diagram of the Best superheterodyne described in May, 1924, RADIO? We want to build an all-dry cell receiver, with 220 power tube and do not have the diagram.—W. F. A., Falmouth, Mass.

Fig. 4 shows the original circuit, with such changes and additions as are needed to bring the circuit up to date, and with the oscillator coil marked for the terminal designations of the Silver Marshall No. 110-A coil, since the Remler coupler is no longer made. It is important to use a variable condenser having an insulated shaft in the oscillator and loop circuits to avoid body capacity. The fixed condenser across the primary of the filter is for use with the filter transformer described in detail in past issues

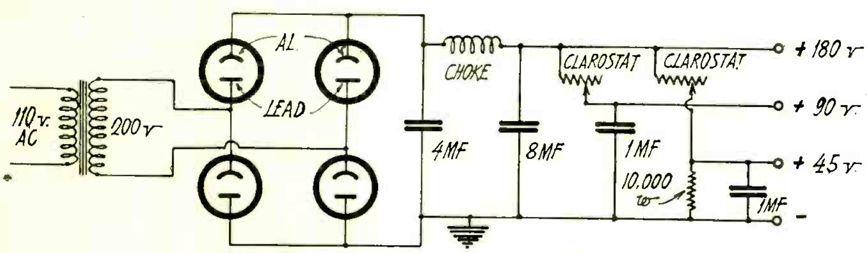


Fig. 3. Circuit for Electrolytic "B" Eliminator.

The recommended circuit is shown in Fig. 3. Quart fruit jars make handy rectifier cells, and the elements, which are lead and aluminum, may be 1x6x$\frac{1}{32}$ in. each. It is important that the aluminum elements be chemically pure, and as the Willard Colloid rectifier uses these elements, they may be purchased from any Willard battery stations. Willard Colloid filler packages contain a combination of salts which makes excellent electrolyte, and while common borax may also be used, the Colloid filler is more satisfactory, since it is chemically pure. The inductance of the secondary of a bell ringing transformer is very low, and

of RADIO, and if a factory built filter is used the condenser specified by the manufacturer should be used and the position of the condenser in the circuit diagram disregarded. It is assumed that the set is to be operated from a 4½ volt dry cell "A" battery, and that type 99 tubes are to be used in all sockets, except the power tube, which is a type CX-220. As an actual matter of fact, the circuit is almost identical with the portable superheterodyne described in this issue.

Am using a 1924 model Best Superheterodyne, and wish to know if there are improvements to this circuit which can be incorporated in my present set.—C. E. F., Washington, D. C., and G. H., Portland, Ore.

See the February 1927 issue of RADIO for the latest information on this circuit, or write for a reprint of the article. Fig. 4 shows the original circuit.

Have trouble due to a howl at certain settings of the dials on low wavelengths in my L-2 Ultradyne. It sounds like tube noise, but cannot cure it by cushioning the detector tube.—W. L. W., Olympia, Wash.

It is quite probable that the mixer tube, or some other tube ahead of the detector, is oscillating, and thereby becomes susceptible to mechanical vibration. Cushioning the tubes will not cure the trouble, which is due to coupling between stages in the intermediate amplifier, or regeneration somewhere in the circuit.

What set would you recommend for me to take to South America, for use in receiving U. S. stations?—L. I. McM., Trenton, Mo.

Either an Infradyne or a good superheterodyne should enable you to hear the U. S. stations under favorable conditions at night.

Have a Best superheterodyne built after instructions in May, 1924, RADIO. Is there any way of making the two dials read the same? The loop dial is five points below the oscillator dial over practically the entire range of the set. Have you a copy of the May, 1924, issue available?—S. M., Cicero, Ill.

It is practically impossible to make the loop and oscillator dials of a superheterodyne receiver tune exactly alike over the entire wavelength scale. This can easily be proved by the fact that the characteristic tuning curves of the two dials, when plotted on cross section paper, do not have the same angle with the horizontal. However, if in your case the loop dial settings are below those of the oscillator, for any given station, a small variable mica condenser such as the XL Model N can be shunted across the loop terminals, inside the set, and the capacity varied until the loop settings are identical with those of the oscillator. We have no more 1924 copies.

Have a Daven Bass Note receiver, and would like to know if an Infradyne amplifier can be added without many changes in the wiring of the set.—H. E. H., Philadelphia, Pa.

You can convert the set into an Infradyne by constructing an adaptor such as was described in February, 1927 RADIO, so that no changes need be made in your present receiver other than to disconnect the output of the present detector tube, into the audio amplifier, inserting the connections to the adaptor unit. If a copy of February RADIO is not at hand, the Infradyne Manual has similar information, and can be obtained for 25 cents.

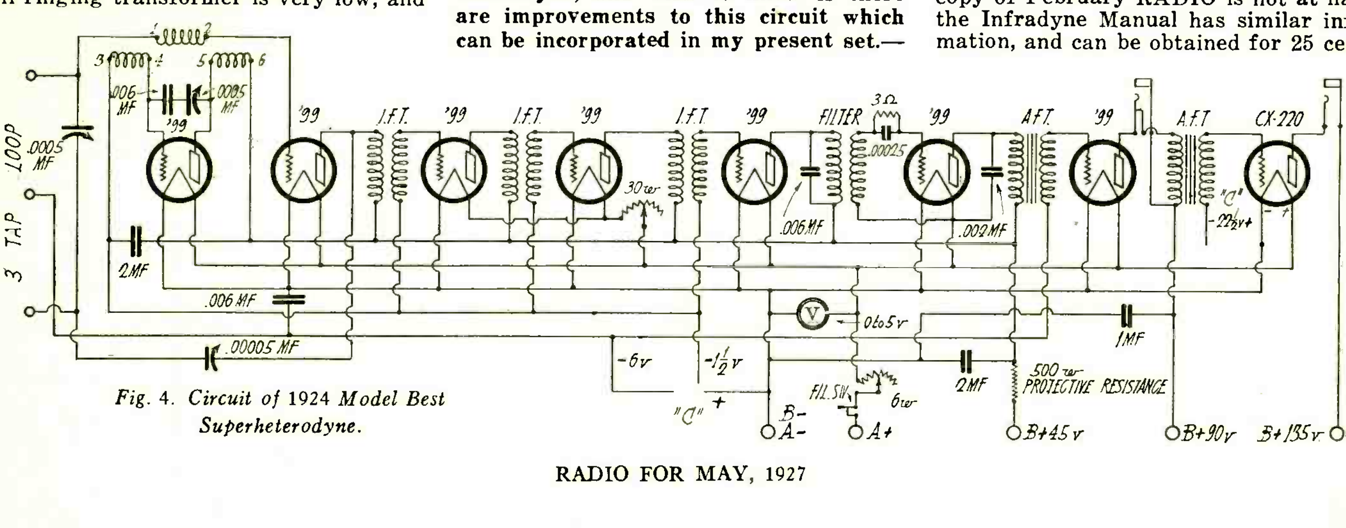
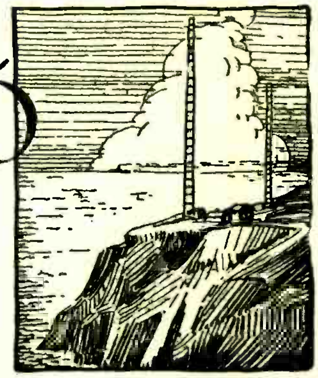


Fig. 4. Circuit of 1924 Model Best Superheterodyne.

The Commercial Brasspounder

A Department for the Operator at Sea and Ashore



R. O. Koch, *Great Lakes Correspondent* — *Edited by* P. S. Lucas — C. W. Rados, *Boston Correspondent*

WE'RE GOING TO HELP

No doubt you're tired of reading about the Radio Commission; nevertheless, mention of it should be made in reference to its effect upon marine radio and the operator. At present, and for several months to come, the commission will be completely absorbed in its broadcast troubles, leaving the comparatively well-fixed marine station to continue on its course until its turn comes for the radio commission's attention. But as soon as the troubles of the B. C. L. are ironed out and the future of the "ham" determined, the commission will turn to the branch of the science which, although foremost in importance, is not so clamorous in its insistence for relief.

It would take a Philadelphia lawyer to make much out of the radio communication laws as they are today, with all the various "classes" and "grades" of ship and operators' licenses. One system of these "classes" and "grades" is used to fill the well-known fifteen cent pamphlet, while actual use relies on a different system entirely, leaving the license holder in quite a quandary as to just where he stands, and putting a great deal of responsibility upon the individual inspector's interpretation. This is the first problem that will confront the commission when it investigates this angle of radio communication.

Moreover, the laws themselves are in need of revision and modernization. Ships should be reclassified, requirements upon them standardized, and a new grading system for operators should be established. All this has been taken up at length in our department in an article by Rawson B. Dixson, (RADIO for March). If you haven't read it, read it now. And if there are suggestions or changes you'd like to see made write us at once and we'll combine your idea with ours. In that way we may be able to be of some assistance to the Radio Commission in stabilizing radio at sea; yet we must *know* we are right before we offer any suggestions. So consider Mr. Dixson's article carefully, men (remembering, of course, that it was written before the organization of the commission) and help us out with your ideas on the subject.

We operators may well feel that with Colonel J. F. Dillon on the commission, our needs will be represented as if by one of us. In truth Col. Dillon should be considered one of us, having spent many years looking after the marine radio situation in the Ninth and Sixth districts. He certainly understands the matter in hand if anyone does, and we, as well as the broadcasters, are to benefit from the President's good choice.

There are now licensed some 6600 commercial operators. 5300 of these have first class tickets. The hams number about 16,500. The 23,000 oprs. licensed represent only 40% of the men who took exams in the last two years!

SHORT WAVE RECEPTION

By Jack Bront

Supplementing Mr. Doran's timely suggestions for the reception of short wave signals, the following may be of interest to commercial operators who employ the SE-143 Navy receiver and SE-1071 detector installations.

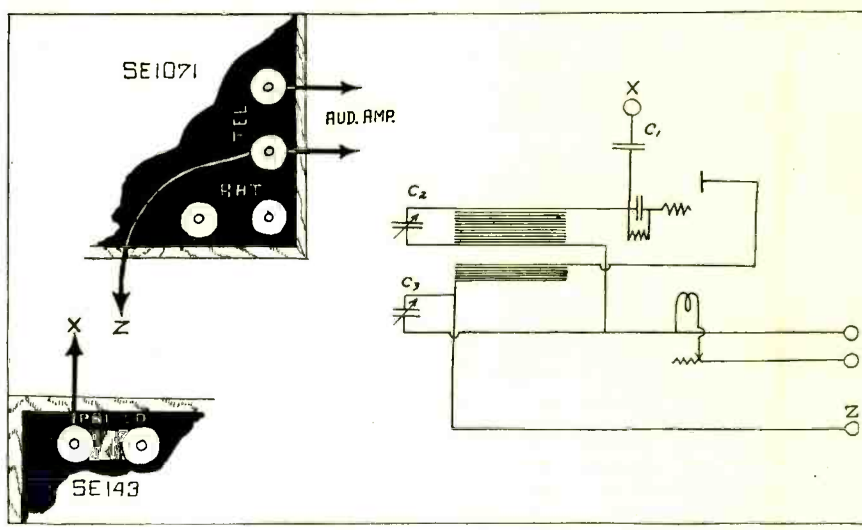
Doran's apparatus necessitated the removal of the detector tube from the cabinet and the insertion of a plug, formed from a tube base, into the detector socket. This may or may not be desirable. In the set described here the whole short wave unit may be permanently attached to the regular apparatus, and left there—this with no difficulty from the fickleness of the short wave stuff.

Primarily the Schnell circuit, as shown by Doran, is not used, but instead, an old reliable is employed and with excellent results. Referring to the illustrations, the antenna lead of the short wave set is attached to the primary load posts of the SE-143 (X). The antenna condenser C_1 should be of small capacity, and of such value as to not induce oscillations in the big antenna when the short wave set is oscillating. Two plates about 2 by 1½ in. and 3 millimeters apart were found satisfactory. The lower condenser lead goes to the secondary coil, which is ordinary in every way.

The tickler coil is mounted about 2 centimeters from the secondary, and with one lead running to plate in the one direction, as ordinarily. But the other lead ("Z") goes to the lower telephone post of the SE-1071 detector panel. This throws the plate of the short wave set in parallel with that of the detector of the SE-1071, the two plate circuits branching at a point above the primary of the audio amplifier, if such is used. In case no audio amplifier is used, and phones are attached directly to the *tel* posts of the 1071, the effect is the same except that the two plate circuits branch above the phones. This is obvious. The "Z" connection supplies the plate current for the shortwave set, taking the potential from that applied to the detector *storage battery* posts of the SE-1071 panel.

The variable condenser "C_3" controls the r.f feedback, and is connected between filament and the lower side of the tickler coil. This condenser does not tune the tickler coil, but simply shunts *B* battery and the primary of the first audio stage if an amplifier is used, —or the phones attached to the SE-1071 if no audio amplifier is employed. The capacity of this condenser may be about .0005 microfarads.

In operation, the detector tube of the SE-1071 should be left at the *detector* setting, and the bridging condenser switch placed on the dead tap (if one is provided), or if no dead tap is there, a piece of paper may be slipped under the switch arm.



Short-Wave Adaptor

Using the hook-up here described, the operator may listen to spark signals on the 600 meter wave without regeneration in the SE-143,—while at the same time CW signals on short waves may be copied at will.

The attachment of extra apparatus to ship installations is frowned on and in general discouraged, but the information here given is tendered for what it may be worth.

Used with the SE-143 set ashore, coast to coast short wave signals have been copied,—while at the same time 600 meter watch has been maintained with usual efficiency.

This happened:

"CQ de ? ? ? qra ship on my port side?"

"Who er u es were yat?"

"Rite over here yr on my port side sees me?"

"Pull one of yr tail feathers out es let fly in the wind es I wl watch fer it."

And thus silence of a sort was restored.

SS STANLEY DOLLAR "WLM"

By O. SANIN

The following is a list of Px, time, Wx and Tfc skeds, which I use on S. F. Oriental run. All skeds given are for Greenwich Mean Time. (Taking in consideration: — Triple, 3 tube H. C. C. receiver.)

KPH — Px to QST and WWAA — carries 3500 miles west at 0815 to 0900 GMT, on 2200 CW.

NPL—Px to QST—starts 1000 GMT, on 9800 meters, and carries about 3500 miles west of S. F.

KPH — Broadcasts Pacific Coast Wx—at 0805 and 1605 GMT, on 2400 CW. Latter can be copied 2500 miles west of S. F.

NPL—Sends time signals at 0800 GMT, on 9801 CW, and NPG sends time signals at 1800 GMT, on 3338 CW.

VAE—Estevan, B. C., can be copied over 2000 miles west of S. F. Sends Wx to QST on 600 meters at 1800 GMT and when necessary.

Approaching the Hawaiian Islands, NPM—Pearl Harbor—sends time signals at 1200 GMT, on 11,490 CW. This station does not send either Px or Wx.

KHK—Wahiawa, Hawaii, does not carry far, and one must be very close to hear this station.

JJC—Funabashi Rdo—Sends time signals at 0000 GMT and 1400 GMT, on 4000 meters, daily except Sundays.

JAA—Iwaki Rdo—Sends Tokio Px in English at 0230—1300—2100 GMT, on 1200 CW. Very good sending and carries over 2500 miles east and about 800 west.

NPO—Cavite (Manila)—Sends Px to QST at 1400 GMT, on 5260 CW, following by time signals at 1455 to 1500 GMT, and Wx to QST 1505 GMT, then QTC msgs on hand. NPO also sends time signals following by Wx to QST at 0155 GMT, on 2700 spark. This is a powerful station and I have copied it at 3500 miles from east, but from north and northwest, owing to some peculiarity, lucky to pick it up at 500 miles on high wave, and on 600 meters neither NPO nor KZRC (Manila) can be heard over 150 miles daylight. I never heard anybody complaining of dead spots in that locality, but it is a real fact that at distance of 700 miles I worked KZCR fine (coming from S. F.) and the following two days I absolutely could not hear this station till about 150 miles from it.

KPM—Iloilo, and KPI—Cebu, Philippines, carry about 80 miles daylight and work ships only the first 15 minutes of each hour. Lots of fellows don't know it and call them without results. Both stations send Wx on 600 meters only when necessary.

NPN—Guam ,is very hard to get from east, but carries pretty fair from NW. This station sends neither time signals, Wx nor Px, but will handle Tfc on 600 meters at any time.

HZA — Saigon, French Indo-China, sends time signals at 0930 GMT on 20,800 CW.

HVB—near Haiphong, French Indo-China, sends time signals to CQ de HVD at 1415 to 1419 GMT, on 1200 spark and Wx. Code: New International Metereological, at 1500 and 0130 GMT, also on 1200 spark.

VPS — XPI — BXY — Hong Kong, China, stations—VPS—is very good station and carries 1500 miles east on 600 meters, daylight. West does not carry so very well. VPS—sends Wx at 1700—2100—2300 and 2400 GMT, 600 spark.

XPI—carries about 200 miles daylight and will handle Tfc at any time.

BXY — carries about 400 miles daylight. Sends time signals to CQ de BXY at 0100 and 1400 GMT on 600 spark.

JFK—Formosa. Small station, carries about 100 miles from north and very hard to get from south. Stands watch on 600 meters 15 minutes of each hour. Sends typhoon warnings at 1000—1600—2200 GMT during typhoon, every hour.

FFZ — Shanghai — carries about 300 miles, daylight. Sends time signals at 1455 and 2055 GMT, on 600 meters, following by Wx to QST de FFZ in French and English.

JCS—Choshi, Ko Rdo—very good station. Carries about 1200 miles daylight. Sends Wx in English at 1500—2100 and 0900 GMT on 600 spark.

JOC—Otchishi Rdo—I found to be very peculiar station; from east it can be heard for 1500 miles; from SW impossible to get it farther than 100 miles daylight.

QRN on China Sea is very bad, especially during the summer months. There are periods of time when it is absolutely impossible to distinguish any radio signals. Sometimes static comes in big lumps, and sometimes continuous roar, lasting for days, drowning all the radio signals.

NORTH PACIFIC AND ORIENTAL SCHEDULES

Correct to January, 1927

By MICKEY DORAN

Time G.M.T.	Call	Wave	Location	Remarks
0000	GBR	18740	Rugby, England	British press. CW
0000	JMAA	800	Keijo, Korea	*Weather bulletin. Spk.
0010	JFRA	4000	Tokyo, Japan	†Weather. Rpts on 600 CW
0030	JTJ	750	Kobe, Japan	*Weather. Spk. Rpts on 2650 Arc.
0030	XRT	2800	Tsingtao, China	*Weather to XPI. Spk.
0155	BXY	2200	Hong Kong, China	Time sigs. CW
0200	NPO	5260	Cavite, P. I.	Press to Navy. Arc.
0200	JJC	7700	Funabashi, Japan	*Time sigs., Weather. CW
0255	FFZ	750	Zikawei (Shanghai), China	Time sigs. Spk.
0255	NPO	5260	Cavite, P. I.	Time sigs. Arc. Also on 2677 CW
0030	HVI-HVM	600	Tourane and Mytho, Indo China	Weather. Spk.
0330	NPG	7000	San Francisco, Calif.	†Evening weather bulletin. Arc.
0400	VPS	600	Hong Kong, China	†Weather bulletin. CW
0430	WNU	3331	New Orleans, La.	Weather Tfc. and press to KUS. CW
0500	VPS	2800	Hong Kong, China	†Weather bulletin. CW
0555	NPG	4836	San Francisco, Calif.	Time sigs. Arc.
0600	JFRA	4000	Tokyo, Japan	†Weather bulletin. CW Rpts on 600 CW
0810	KPH	2200	San Francisco, Calif.	Press. CW
0800	JFK	600	Kurun, Formosa	Formosa weather. CW
0800	NPM	37	Pearl Harbor, T. H.	Tfc and press to NPO-NPN. CW
0853	FFZ	750	Zikawei, China	Time sigs and weather. Spk.
0900	VAE	450	Estevan, B. C.	Press. CW
0900	JAA	15100	Iwaki, Japan	Japanese press. CW (English)
1000	NPL	9798	San Diego, Calif.	Press to Navy. CW
1100	JMAA	800	Keijo, Korea	*Weather bulletin. Spk.
1110	JFRA	4000	Tokyo, Japan	†Weather. CW Rpt on 600 CW
1159	JJC	7700	Funabashi, Japan	*Time sigs and weather wngs. CW
1200	GBR	18740	Rugby, England	Press. CW
1200	VPS	600	Hong Kong, China	†Weather bulletin. CW
1300	VPS	2800	Hong Kong, China	†Weather bulletin. CW
1230	JTJ	750	Kobe, Japan	*Weather bulletin. Spk.
1255	BXY	2200	Hong Kong, China	Time sigs. CW
1330	HVI-HVM	600	Tourane and Mytho, Indo China	Weather. Spk.
1355	NPO	5260	Cavite, P. I.	Time sigs and wea. Arc. Also on 2677 CW
1400	FFZ	750	Zikawei, China	Weather. Spk.
1700	NPG	7000	San Francisco, Calif.	†Morning weather bulletin. Arc.
1955	NPG	4836	San Francisco, Calif.	Time sigs. Arc.
2000	GBR	18740	Rugby, England	Press. CW
2000	NPM	11490	Pearl Harbor, T. H.	Tfc and press to NPO-NPN. Arc.
2230	NPM	5552	Pearl Harbor, T. H.	Weather bulletin. CW
2355	NPM	11490	Pearl Harbor, T. H.	Time sigs. Arc.

NOTES: Only the more important schedules of interest to off-shore vessels are given. Coastwise reports such as from Lightships and Naval stations are not included.

*Indicates that the weather is sent in code.

†Code weather reports followed by plain language reports.

The various weather codes have all been published in RADIO, also in Hydrographic Publication H. O. No. 205.

Some eastern stations such as WNU and GBR have been included, as they can be copied over most of the Pacific Ocean.

JAPANESE WEATHER CODES

Supplement No. 2 to Hydrographic Office Publication H. O. 205 is now in print and gives corrections to the Japanese synoptic weather code which is used in the broadcasts of JTJ, JFRA and JMAA.

These reports give weather at many points in Japan, Korea, Manchuria and China, including the islands along the Chinese coast.

The following notes should be added to the Japanese Code: JFRA 4000 mtr. schedules can be copied at a much better distance than those of JTJ. JFRA does not use the numerals for the code indicating wind direction at the various stations, but uses the following LETTER code instead:

O or C—Calm	Q—SE.	W—W.
F—NNE.	R—SSE.	X—WNW.
G—NE.	S—S.	Y—NW.
H—ENE.	T—SSW.	Z—NNW.
E—E.	U—SW.	N—N.
P—ESE.	V—WSW.	

J. H. Brown, formerly chief operator of the *Ecuador*, on the Frisco to New York run, is now standing the 4 p. m. to midnight trick on 2400 meters arc at KFS, the new marine station of the Federal Telegraph Company at Daly City.

Karl Zint, KNT, Zane Grey's yacht, *Fisherman*, is cruising around the Antipodes in search of swordfish and such. (Such means any *sig* on or around 40 meters.) KNT gets out fine on short waves in certain directions, depending upon the direction of the ship's bow, as the rigging seems to have a beacon effect.

KFFG, the tug *Elmore* of Everett, Wash., may install a low power short wave CW transmitter.

The Bumblebee

A 15-Watt Short Wave Transmitter

By G. M. Best

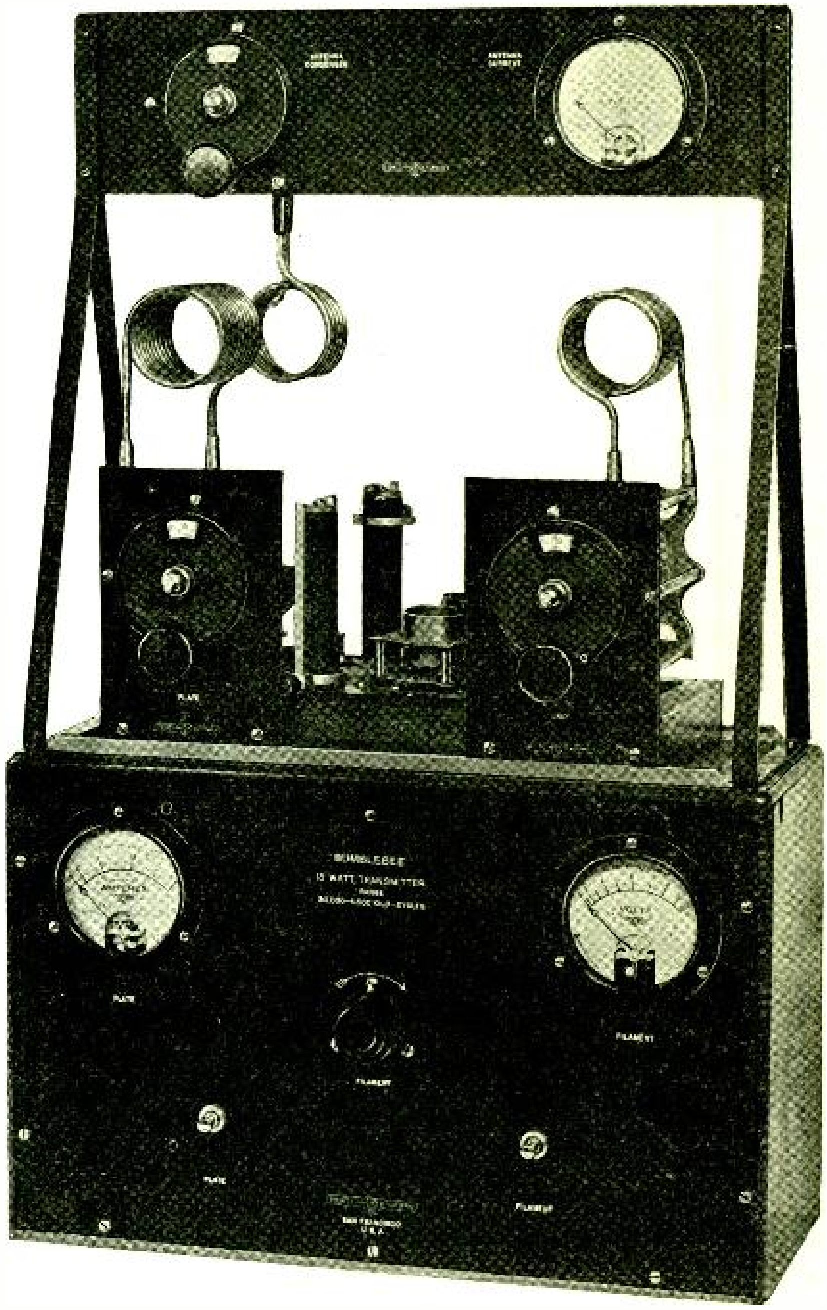


Fig. 1. The Bumblebee Transmitter.

A tuned-grid, tuned-plate transmitter using two 7½ watt tubes has been developed by Ralph M. Heintz, 6XBB and 6GK. The power panel cabinet supports the antenna tuned circuit and the oscillator, which is mounted on a movable chassis. The pictures herewith show the arrangement of the parts. Fig. 4 shows the circuit diagram.

The grid coupling coil L_2 is tuned by condenser C_2, which is a .001 mfd. variable with double spaced plates so as to make a condenser of .00025 mfd. actual capacity. Common coupling to the grids of the two tubes is had through identical sized grid condensers C_6 and C_7 in series, C_6 being a midget variable air condenser of 35 mmf., and C_7 a fixed mica condenser of .001 mfd. Each grid condenser combination is shunted with a 12,000 ohm fixed resistance, two of these being shown in Fig. 2, under the left hand tuning condenser.

The plate coupling coil is L_1, tuned by condenser C_1, which is the same capacity as the grid tuning condenser. The high frequency plate feed is obtained through two condenser combinations like those used in the grid circuit. Plate voltage supply is obtained from a small motor-generator having a 110 volt 60 cycle motor and a 100 volt, 900 cycle a.c. generator, which feeds a transformer having a 100 volt primary and a 1500 volt center tapped secondary. Thus each 7½ watt tube has 750 r.m.s. volts applied to the plate, which is permissible with the generator shown in Fig. 5. But where 60 cycle supply is to be used, the voltage per tube should be reduced to 550, making a total of 1100 volts secondary.

Each of the two r.f. chokes in the plate supply leads is tuned by a brass or copper ring, which can be adjusted up and down on a a rod, as is shown in Fig. 3. In this way, the choke can be adjusted for most efficient operation on any wavelength above 10 meters, without using a set of plug-in r.f. chokes. A thermocouple ammeter having a 2 ampere scale is placed in the plate transformer primary, and is used to indicate input amperes at 900 cycles. If 60 cycles is to be used a low frequency meter should be used instead of the thermoammeter.

The filaments are in parallel and are supplied from a transformer having a 110 volt 60 cycle primary, and an 8 volt center tapped secondary. A 10 volt a.c. voltmeter is shunted across the 8 volt line, and a 50 to 70 ohm rheostat is connected in the transformer primary, to regulate the voltage supply. By-pass condensers of .001 mfd. each are connected across the two sides of the filament supply line, on the transmitter chassis.

The antenna circuit consists of the antenna coupling coil L_3, a .0005 mfd. series variable air condenser C_3, and a thermocouple radiation ammeter having a 1.5 ampere scale. The plate and antenna coils are placed in the same plane, so that the coupling can be varied by moving the transmitter chassis along the tracks on top of the power panel box.

The parts list specifies two variable .001 mfd. condensers, which are cut down to .00025 mfd. by double spacing the plates. The rotor assembly is removed, and every other plate cut down until only the hub remains. This hub provides a washer of the right size, so that when the rotor is assembled again, the plates are correctly double spaced. In the diagram of Fig. 4, .001 is specified for C_1 and C_2, but as explained above, the actual capacity after the condensers are rebuilt is .00025 mfd.

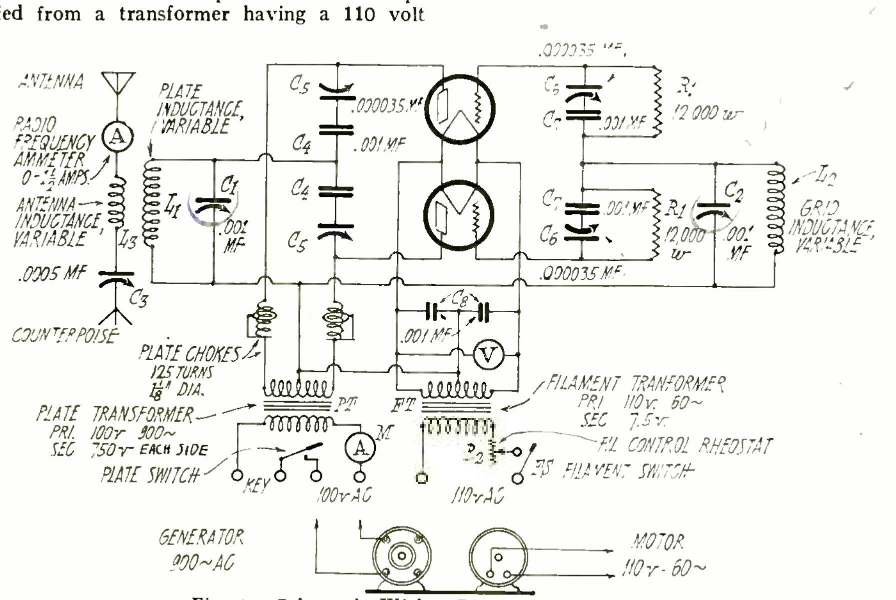


Fig. 4. Schematic Wiring Diagram of Bumblebee.

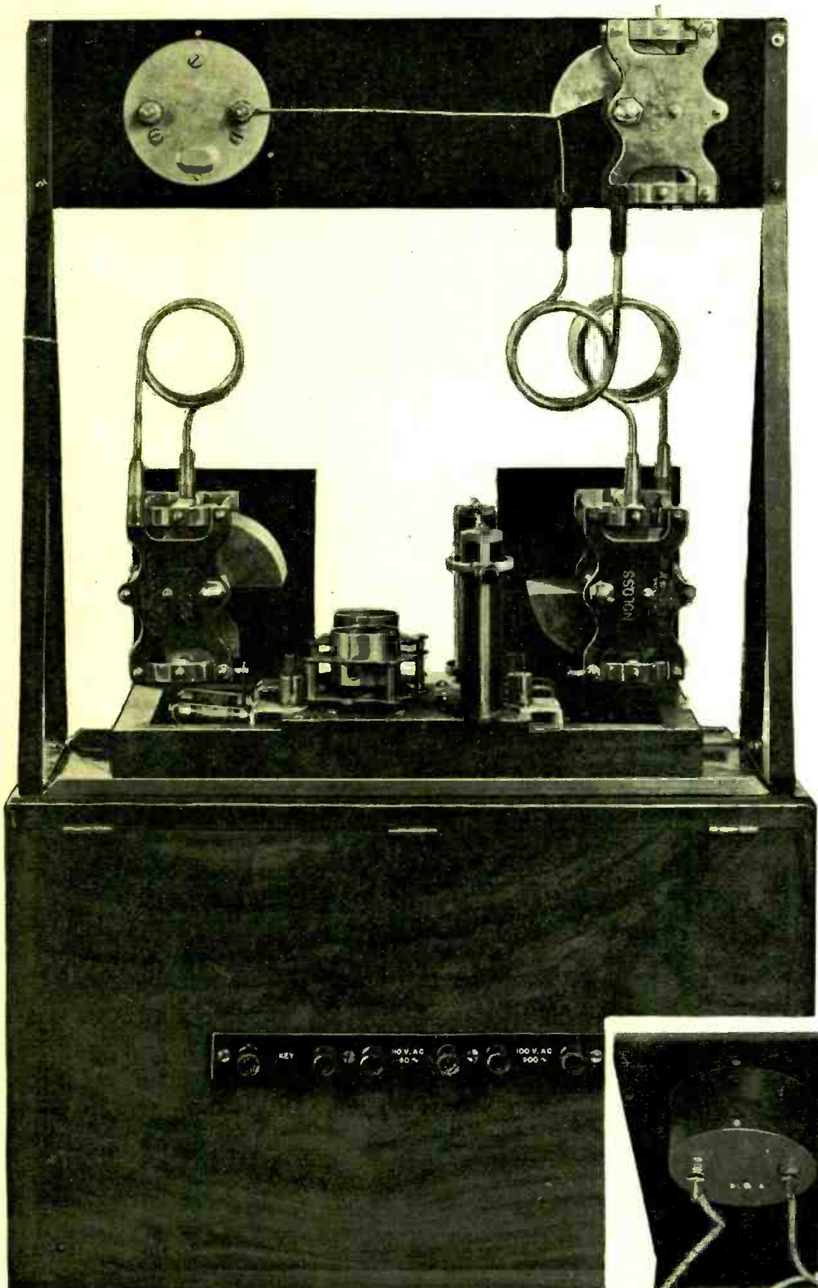


Fig. 2. Rear View of Bumblebee.

The construction of the power panel is so simple that no panel drilling dimensions are needed, the pictures giving a good idea of the spacing of the meters; which are mounted at each end of the panel, near the top, with the filament rheostat in the exact center, and the two main switches placed in any convenient position below the rheostat. The panel is 10 x 15 x 3/16 in., and fits into a cabinet whose outside dimensions are 10 5/8 x 16 1/2 x 6 5/8 in., with a 1/4 in. overlap around the edge of the panel. The cabinet is provided with a hinged lid, so that the wiring of the power apparatus is accessible.

The plate transformer is mounted at the left, as shown in Fig. 3, and the filament transformer at the right. All wiring is done in No. 14 stranded, plain rubber covered ignition wire, except those wires which are not affected by the opening of the box either at the lid or the front panel. All of these wires carry low frequency a.c., and hence the fact that they are longer than actually is necessary need not worry the experimenter, for the losses are negligible.

On the back of the cabinet is placed a small bakelite strip 1x8x1/4 in., on which are mounted the terminals for the telegraph key, and the 60 and 900 cycle a.c. input leads.

The chassis of the transmitter is made of 3/4x1 in. hardwood, in the form of a rectangle, 6x12 in. outside dimensions. This chassis fits into a track made by bending two strips of 1/16 in. brass into a U-shaped piece. The bottom angle is used to hold the pieces to the top of the cabinet, and the top angle is a flange which fits into a groove sawed into the edge of the chassis on each side, and 1/4 in. from the cabinet lid, parallel to it. This brass can be obtained formed to shape and is called 1/4"x 3/8"x 1/4" channel brass. This permits the chassis to slide back and forth over a distance of 2 1/4 in., but prevents the chassis from falling off the lid of the cabinet when the lid is tilted back.

The variable condensers, with their associated inductance coils, are mounted on bakelite panels 4 x 6 x 3/16 in. each, and are fastened to the side of the chassis with two flat head wood screws. The coils are arranged to plug into small brass fittings fastened to the top of each condenser. These fittings may be obtained ready made, or they can be made up by turning down a piece of 3/8 in. brass tubing so that at least half the piece is tapered in thickness, and slotted so that the coil ends will fit in the tapered ends without the use of much force.

The tube sockets, r.f. chokes, and the grid and plate coupling condensers are mounted on a piece of 3/16 in. bakelite, 5x6 in., placed in the center of the chassis. The four variable coupling condensers are ordinary trimmer condensers used in broadcast receiving sets, with the shafts sawed off and the ends slotted so that a screwdriver can be used for the adjustments. These condensers are mounted to the edge of the panel, as shown in Fig. 2. The r.f. chokes each consist of 125 turns of No. 32 silk wire, wound on a 1 1/8 in. wooden form, 3 3/4 in. long. The rod for holding the tuning ring is made of a piece of 3/8 in. square brass rod, 3 3/4 in. long, with a ring 1 1/4 in. in diameter, of 1/16 x 3/8 in. brass

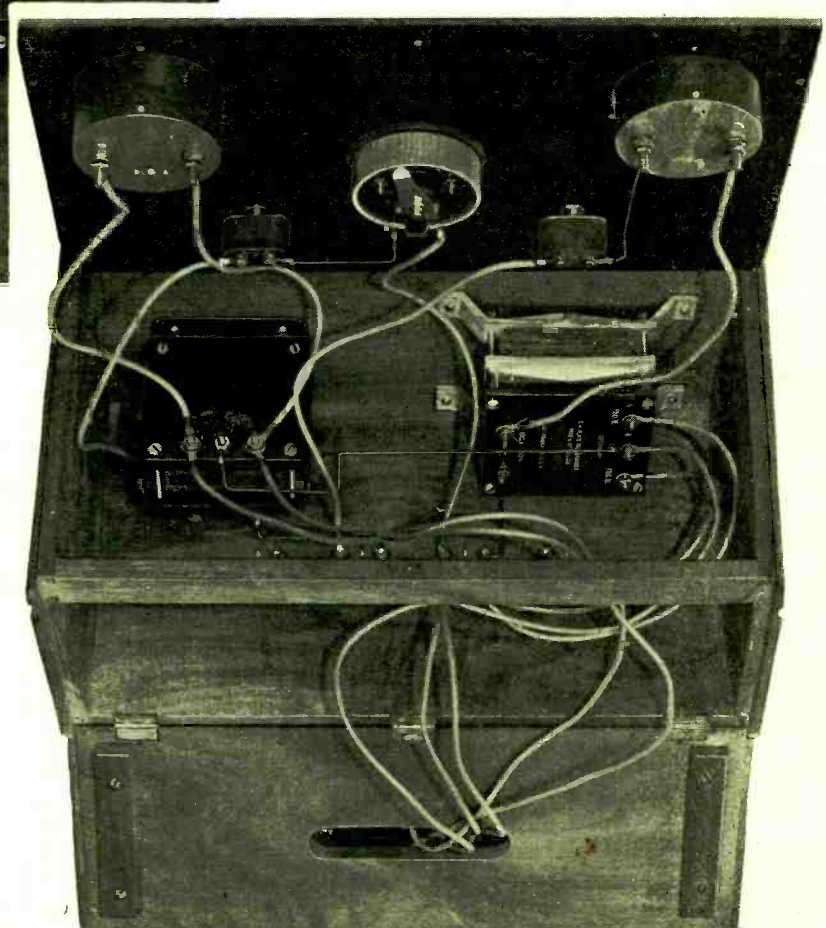


Fig. 3. Power Plant Assembly.

strip. The rod is grounded to the bottom terminal of the r.f. choke, as is shown in the wiring diagram. The grid leaks are fastened to the grid condensers underneath the grid tuning condenser, and can be seen in Fig. 2.

The antenna panel is made of a piece of 3/16 in. bakelite, 4 x 15 1/2 in., supported by brass brackets which are made by bending two pieces of 1/8 in. brass 38 in. long and 1/2 in. wide into the general shape shown in Fig. 1. These brackets are screwed to the top of the cabinet, and the panel is held in place at the top of the bracket by passing two machine screws through the brackets and panel, at each end of the panel, and securing them in place with lock nuts.

The tuning inductances are all made of 3/16 in. O.D. copper hard drawn tubing, heavily silver plated, although the plating is not absolutely necessary. Each coil is equipped with a solid tip made by sweating on a small piece of solid brass which has been turned down in a lathe to fit the holes in the tubing. To completely cover the 20, 40 and 80 meter amateur bands, the following coils will be needed: One 12 turn, one 11 turn, one 10 turn, one 9 turn, one 8 turn, one 7 turn, one 5 turn, one 4 turn, one 3 turn, one 2 turn, and one 1 turn.

All three variable condensers are tuned with vernier dials, having at least a 10 to 1 ratio. With the rotors of the grid and plate condensers connected to ground, these dials can be adjusted while the set is in operation without the slightest trouble from body capacity, so that an extremely fine adjustment in tuning can be had.

The motor generator for the 900 cycle supply was originally designed for the Signal Corps air service. A multiple-groove pulley with five sewing machine belts gives a quiet and economical drive with a light belt and a minimum of replacement trouble. Should one of the belts break, the remaining four will operate until the transmitter is ready to be shut down. The 900 cycle supply produces an easily-read 1800 cycle modulation of the transmitted carrier.

Tuning of the transmitter is best accomplished by selecting a set of inductance coils of the right size for the particular wave band desired, and installing them in their mountings. For 40 meters, the grid and plate coils should have about 8 and 9 turns, while the antenna for ordinary operation, will probably require a 7 turn coil. Adjust the grid tuning condenser to about mid scale, start up the power plant, and close the key. Adjust the plate condenser slowly back and forth until the grid and plate circuits are in resonance; if the plate supply ammeter is watched, the resonance point can easily be detected by a sudden rise in the primary current. If the antenna series condenser is moved through its entire range, the resonant point of the antenna circuit, with that of the transmitter frequency, will probably be found, and the antenna ammeter will indicate the radiation current.

This first test should be made with fairly close coupling between the plate and antenna coils, and once an indication of radiation is obtained, the coupling should be loosened by sliding the chassis along its tracks, until the coils are about in the position shown in the pictures. Now vary the settings of the grid and plate tuning condensers until the wavelength best suited to the antenna system is located, and the final adjustment to the antenna series condenser can then be made. The adjustment to the r.f. chokes should be made after a temporary setup for transmission is completed, as above described.

When making the first adjustments, the tuning ring on each choke should be left at the bottom of the slider, and after all other adjustments to the set are completed, these rings should be raised, a little at a time, until the portion of the choke between the ring and the top is the right size for the particular

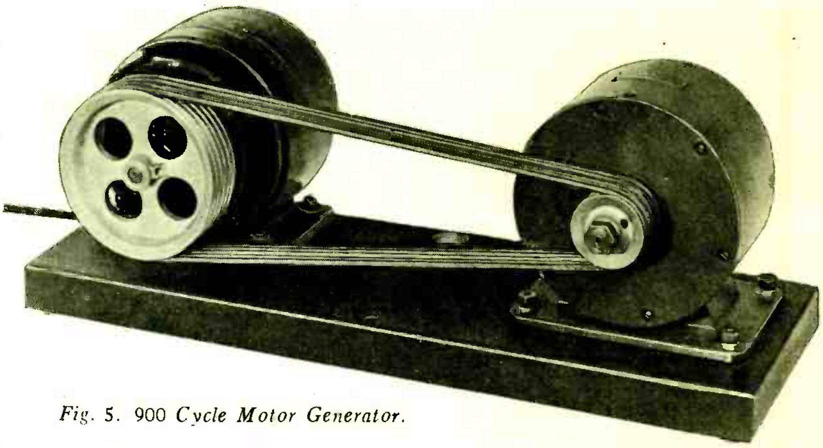


Fig. 5. 900 Cycle Motor Generator.

wavelength at which the transmitter is operating, as will be indicated by a rise in the radiation current in the antenna circuit or dip in primary current.

A word should be said about the keying. In spite of opinions to the contrary, keying in the transformer primary, when a well made transformer is used, does not produce a chirping note, and does not harm the transformer, while it has the decided advantages of reducing the key clicks to a minimum, and placing the key at a point in the circuit where the danger of electric shock is negligible.

LIST OF PARTS

- 2—General Instrument .001 mfd. condensers—see text C-1, C-2.
- 1—General Instrument .0005 mfd. condenser. C-3.
- 6—Sangamo .001 mfd. fixed mica condensers. C-5, C-7, C-8.
- 4—Hammarlund .000035 mfd. variable condensers C-4, C-6.
- 2—UX base vacuum tube sockets, suitable for high voltages. H-K.
- 2—Ward Leonard 12,000 ohm fixed resistors.
- 2—R. F. chokes—see text. H-K.
- 1—Jewell Pattern 64 A.C. voltmeter 0-10 volts.
- 1—Jewell Pattern 64 Thermocouple ammeter 0-1.5 amperes.
- 1—Jewell Pattern 64 Thermocouple ammeter 0-2 amperes. See text.
- 1—General Radio 50 or 70 ohm rheostat.
- 2—Cutler Hammer filament switches.
- 6—Eby plain binding posts.
- 1—Thordarson filament transformer 110-8 volts, 60 cycles.
- 1—Heintz & Kaufmann plate transformer 100-1500 volts, 900 cycles.
- 1—Set tuning inductances—see text.
- 1—Power panel—10x16x3/16 in. bakelite.
- 2—Condenser panels 4x6x3/16 in. bakelite.
- 1—Antenna panel 4x15 1/2x3/16 in. bakelite.
- 1—Binding post strip 1x8x1/4 in. bakelite.
- 1—Tube socket shelf 5x6x3/16 in. bakelite.
- 2—Pieces 1/16x7/8 in. brass, 4 3/4 in. long, for channel tracks.
- 2—Pieces 1/16x1/2 in. brass, 38 in. long, for brackets.
- 1—Chassis, 3/4x1 in. stock, 6x12 in. outside.
- 1—Cabinet, 10 5/8x16 1/2x6 5/8 in., outside.

By 6BMM - 6BYW, William A. Lang, 133 East Ave. 44, Los Angeles

1adm, 1ajx, 1apd, 1axx, 1bcn, 1bez, 1cd, 1cki, 1cmx, 1fm, 1kx, 1ro, 1uk, 1yb, 2afw, 2ahj, 2ahv, 2amf, 2ane, 2apq, 2avr, 1ayp, 2cdr, 2cvs, 2cyh, 2dy, 2ev, 1pv, 2uo, 2xg, 8afu, 3au, 3bhu, 3bms, 3fh, 8lt, 8py, 4av, 4cf, 4fe, 4hd, 4hs, 4it, 4iz, 4lk, 4nu, 4pz, 4rm, 4rn, 4ti, 4tu, 4uk, 5aaq, 5acl, 5acv, 5adw, 5agu, 5ain, 5aio, 5aj, 5ak, 5amn, 5apo, 5aqy, 5atf, 5auz, 5bh, 5fh, 5gc, 5hz, 5ip, 5kk, 5oa, 5ob, 5pr, 5ql, 6atu, 6ayj, 6cdu, 6cnx, 7abb, 7abk, 7acf, 7adw, 7gd, 7gp, 7ll, 7mn, 7pu, 7vg, 7wu, 8adg, 8akv, 8aly, 8amc, 8axs, 8bau, 8bct, 8bja, 8bps, 8bsc, 8bth, 8ccs, 8cjb, 8cnt, 8csr, 8ctn, 8cwt, 8czn, 8dcm, 8dcp, 8dcq, 8ded, 8dei, 8dfo, 8dke, 8dm, 8dme, 8dmn, 8dqz, 8drq, 8pl, 8px, 8sh, 8wk, 8xe, 8yo, 9acu, 9adi, 9aek, 9afx, 9ain, 9ajp, 9aju, 9akt, 9amy, 9ara, 9arn, 9auy, 9avi, 9awv, 9baf, 9bay, 9bbc, 9bcl, 9bfx, 9bhb, 9bht, 9bhz, 9blu, 9bnd, 9bon, 9bqe, 9bqy, 9brr, 9bud, 9bvw, 9bwi, 9bwo, 9cbl, 9cbt, 9cn, 9cgh, 9cif, 9cnt, 9cor, 9cpm, 9ctg, 9ctz, 9cvn, 9cwa, 9cwn, 9cwq, 9cws, 9dba, 9dgg, 9dch, 9dfr, 9dga, 9dju, 9dng, 9dps, 9dr, 9dvl, 9dvr, 9dwp, 9dws, 9efe, 9efk, 9efo, 9ehm, 9ehn, 9ehp, 9hp, 9uu, 9xi, 9xl, 9zk. Foreign: ef8jf, 8yor, eg2lz, foa3b, a4k, a4z, a5n, nc3fc, 3hp, 3wa, 4ac, 4du, nj2pz, nq8kp, nmln, lo, 5c, 9a, nuabl, ak6, dx8, d8q, oh6clw, sabal, sblab, 1am, 1ib, 2as, snni, selfg, sulam, sc2as, 2bl, oz4am. Commercial: kio, lpl, naj, nao, naw, nkf, rxy, voq, wik, wiz, wrb, wvy, xam, xba, kdka, wbbm, wgy. Heard on 20 meters, February 6 and 20, 1927: eg2kf. United States: 1bux, 1cmx, 1cpb, 2nm, 2nr, 5ql, 5wz, 6adp, 6ako, 6bac, 6bux, 6bzm, 6ct, 6ea, 7aiz, 8aly, 8cpf, 8dan, 8df, 8ex, 9acl, 9aex, 9bed, 9byl, 9caw, 9cpq, 9cxn, 9dbw, 9kv, naa, nkf, wik.

At 9FO, Art Bates (8RY), 508 S. Dearborn St., Chicago

ef8fk, eg5dh, ndHIK, nj2pz, oh6cxy, oa2sh, oa(?)2rm. QRA wanted of sa-en8, sblbr, 2ig, oa3mm, 4cg. QTC??

By 2ALW, C. L. London, 3291 Hull Avenue, Bronx, N. Y. C.

United States: 6clp, 6bq, 6zat, 6cls, 6clp, 6ea, 6ccl, 9bjp, 9bld, 9dck, 9chs, 9nk, 9drw, 5aop, 5aur, 4bl, 4qb, 4iz, 4mw,, 1adm. Uruguay: 1br. Brazil: 2ab. Miscellaneous: ARDI. All codes QSL'd.

By KNT, Schooner-Yacht Fisherman, Karl E. Zint, Opr. Address care F. L. Dewey, 730 So. Spring St., Los Angeles, Calif.

En route, Los Angeles to Auckland, N. Z.: NU, 1xv, 1aao, 2cxl, 2sz, 2uo, 3ww, 4am, 4bl, 4fl, 5adz, 5avi, 5jd, 6aat, 6cain, 6ahp, 6akx, 6am, 6ano, 6bhz, 6bpg, 6bux, 6bye, 6cbp, 6cfq, 6chn, 6cii, 6cik, 6cis, 6cng, 6czz, 6dbe, 6ddo, 6eb, 6le, 6mu, 6nw, 6ob, 6rc, 6vr, 6zbf, 6zbj, 6zr, 7aif, 7av, 7bm, 7ek, 7fh, 7gj, 7jc, 7ou, 7ul, 7vp, 8bly, 8aly, 9bq, 9cjp, 9eam, 9eek, 9ek, 9ez, 9mo, 9xi, OH, 6acg, 6adh, 6akp, 6axw, 6bdl, 6buc, 6cfq, 6clj, 6dcf, fxl, gdl, npm, OA, 1gw, 2by, 2cy, 2mh, 2tm, 2sh, 2yi, 8dc, 3hl, 3kn, 4cg, 4nj, 4rb, 5bw, 5hg, 7cu, 7cw, 7dx, OZ, ifb, ifq, 2ae, 2ak, 2br, 2bx, 2bz, 2ga, 2ms, 2wa, 2xa, 3ai, 3ar, 4aa, 4ai, 4aj, 4ak, EF, 8em, 8qrt, fw, EI, 1gw, AJ, 1sk, 8yz, jhbb, AF, 8xx, Y, 1cg, OP, 1bd, 1hr, 3ac, 8aa, wuaj, SC, 2ar. Miscellaneous: arcx, aqe, bam, fbio, gas, glq, glky, kdgl, wwdo.

Unknown: PCP, BCD.

By su1-AM, A. Mantegani, Casilla No. 37 Montevideo, Uruguay

U. S.: 1blf, 2fj, 2uo, 2vxl, 2aim, 2xaf, 5rg, 5wi, 5aab, 5ada, 6no, 6am, 6awa, 6fq, 6csw, 6ael, 6bmw, 6sb, 6cua, 6btm, 6bjx, 6bgt, 8dqz, 8avd, 8ben, 8bpl, 8bf, 9eji, 9bj, 9avy, 9xi. New Zealand: 2ac, 2ae, 3aj, 3ar.

By 6RO, J. E. Randolph, 305 30th St., San Francisco, Calif.

U. S.: 1hv, 1awe, 1cue, 1gw, 1xv, 2ev, 2ga, 2om, 2sz, 2uo, 2xg, 3aks, 3bgs, 3wf, 3wm, 3ql, 3zo, 4bek, 4cv, 4jn, 4pk, 4wj, 4do, 5aao, 5acl, 5adz, 5api, 5aql, 5eb, 5ev, 5re, 5jd, 5tt, 5xav, 8cau, 8ci, 8avd, 8brd, 8mc, 8zf, 9aak, 9aek, 9akf, 9ara, 9bbf, 9bbn, 9bqm, 9bqo, 9brq, 9bwm, 9cet, 9dvi, 9dvl, 9dvl, 9kg, 9oo, HU 6aff, 6axw, 6buc, FXI, DM2, BZ, 2af, 2ag, CH, 2ar, 2as, 2ur, F, FW, M, 9a, JH, XC5I, AA7, RXY, AQE, M5G, LOI, LPJ, WAX, AND, NOVQ, NAW, NTT, NPC, NAR, NOT. Will QSL to any of the above stns QRK es KSB?

By P. M. Hayes, Nu6ALH, 2604 Prosser Street, (Palms Sta.) Los Angeles, Calif.

1aao, 1aap, 1aay, 1aae, 1aer, 1air, 1aci, 1amd, 1amz, 1aof, 1asu, 1akr, 1aem, 1asr, 1atv, 1asf, 1awy, 1au, 1awb, 1axx, 1ag, 1aga, 1ahu, 1aj, 1ak, 1aza, 1bum, 1bcz, 1bhm, 1blb, 1bms, 1bgt, 1big, 1bgg, 1bhs, 1bz, 1cjh, 1ch, 1cmp, 1ckp, 1cek, 1caw, 1cmf, 1di, 1fs, 1ga, 1ic, 1ii, 1mp, 1rb, 1rf, 1sw, 1sf, 1tu, 1ux, 1vx, 1xme, 1xv, 1xm, 1zj, 1zez, 2agq, 2agm, 2ahm, 2ahp, 2aib, 2ami, 2amj, 2av, 2avr, 2bs, 2buy, 2cdu, 2bu, 2cvj, 2cxl, 2cyx, 2dh, 2ff, 2gk, 2hp, 2lh, 2li, 2mk, 2ol, 2tp, 2tuz, 2uo, 2uz, 2kx, 2sq, 2sz, 3afp, 3ahl, 3ain, 3ajc, 3auv, 3bgs, 3bsc, 3ckj, 3cl, 3dh, 3ef, 3gp, 3ji, 3mk, 3kp, 3nn, 3pf, 3qw, 3rt, 3ue, 3bqz, 3bwt, 3cds, 3hg, 3jo, 3ld, 3rt, 3zw, 4aab, 4bl, 4he, 4ll, 4dd, 4gu, 4hl, 4kt, 4lk, 4lq, 4rm, 4sl, 4tk, 4tv, 4xe, 5acl, 5agn, 5akn, 5akz, 5als, 5md, 5ms, 5nd, 5ax, 5he, 5mi, 5og, 5ox, 5pk, 5xbh, 5zai, 5zu, 7acg, 7aab, 7df, 7al, 7ga, 7ri, 8abn, 8adg, 8afq, 8aly, 8ago, 8ada, 8bag, 8ceq, 8dsy, 8kf, 8rd, 8rs, 9aem, 9agq, 9ahq, 9aln, 9anz, 9atb, 9atq, 9baz, 9bcl, 9bdg, 9bc, 9bff, 9bgo, 9bhp, 9bwo, 9caj, 9ccq, 9caw, 9ccn, 9ccq, 9ceg, 9cgh, 9cia, 9cn, 9cwa, 9cye, 9dac, 9dax, 9dga, 9dhb, 9dij, 9dla, 9dlg, 9dnw, 9doe, 9dpw, 9drh, 9drr, 9duz, 9dwd, 9dxg, 9eai, 9ef, 9eff, 9egc, 9ego, 9eir, 9ek, 9eti, 9fk, 9hb, 9hp, 9kd, 9kp, 9ln, 9mn, 9ux, 9uz, 9xx, 9xl, 9za, oa-3ba, oa-3tm, oa-4an, sb-1ak, sb-1am, sb-1ar, sb-1aw, sb-1ib, sb-2af, sb-2ag, sb-2ib, sc-2as, sc-2ag, sc-2ld, sc-2lg, sc-2agt, sc-2ar, np-4sa, oh-6bdl, oh-6aff, oh-6axw, oh-6buc, oh-6dcf, oh-6ko, sa-bal, sa-cb8, sa-de3, sa-dh5, sa-fc6, oz-ife, oz-2ac, oz-2ae, oz-2gc, oz-2ak, oz-2br, oz-2xa, oz-3ar, oz-4aa, oz-4av, oz-4ag, oz-4ak, nc-4dq, nc-4dy, nc-4dw, nc-4eb, nc-5ct, ef-8gi, eg-2nm, eg-2qb, eg-2vq, eg-5by, eg-5dh, eg-5mq, eg-6pu, nm-jh, nm-5b, nm-9a, nm-1h, nm-1v, nm-4r, nm-5n, nm-7a, op-1aj, nq-5ry, nq-8az, nq-8kp, nq-7cx, ac-2ff, np-4al, su-2ae, ei-1ay, ei-1co, ei-1gj, ei-1ts, aa7.

TO THE RADIO INDUSTRY

An announcement of interest

THE Ward Leonard Electric Company has built nothing but resistance apparatus for more than 35 years.

Today it offers the Vitrohm Resistor as the solution to your radio resistor problem.

Ward Leonard wants the business of manufacturers who are giving to the public good apparatus that will work and keep on working.

The Vitrohm Resistor is a wire-wound, vitreous enamelled unit that will not alter in value during service nor disintegrate under constant use and heavy loads.

Ward Leonard has made this type of Vitrohm Unit for more than 35 years, and as is usually the case, skill and methods have improved with practice.

Ward Leonard maintains a staff of trained engineers and technicians with all of the resources of well equipped laboratories to aid them in their work. For more than 35 years they have endeavored to find something "good enough" to replace the vitreous enamelled wire-wound Vitrohm Unit. And after 35 years they are still trying, but no equivalent for Vitrohm has been found.

The Radio Industry has become a large, though youthful, factor in the Electrical Industry. It is finding that this is an industry which ever demands the best. In the Electrical Industry "best" in resistors means Vitrohm.

To the radio manufacturer who wants the best, to the man who insists that everything he buys be dependable in quality and sure in production, we say, "Come to our plant. See us work. See our facilities and learn why only Ward Leonard can give you the Vitrohm Resistor".

The prices of Vitrohm Resistors for radio are not high. While they cannot enter into price competition with molded "mud" or makeshift units, they are cheaper on a dollar basis than any other unit which even approximates their performance. And they are Vitrohm *dependable* Resistors.

"RESISTOR-SPECIALISTS FOR MORE THAN 35 YEARS"

Ward Leonard Electric Company

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7235-2

PORTABLE SUPER
(*Continued from Page* 12)

Testing the receiver after the wiring is completed should be simple, as the danger of blowing out tubes due to short circuits is eliminated with the *C* biasing resistances present in the *B* battery circuit. Should a *B* battery short circuit develop, the resistances will limit the total current to a value much below that required to burn out the tube filaments, so that after the *A* circuit has been checked and found O. K., the tubes can be placed in their sockets, and the *B* connections made. The loop antenna is mounted on the lid of the receiving set box, with the brass sleeve on the bottom of the loop connected to the center tap, and the bushing in which the loop is fitted is connected to the binding post strip inside the box. The two outside terminals of the loop pass through holes drilled in the end of the loop, and are connected to the terminals in the box. When the loop is to be removed, it is only necessary to disconnect the two loop wires from the binding posts.

LIST OF PARTS

- 2 Remler .0005 mfd. straight line frequency condensers.
- 1 Silver Marshall No. 110-A coil.
- 1 Silver Marshall No. 515 coil mtg.
- 3 Shielded intermediate frequency transformers. See text.
- 1 Filter transformer.—Army Sales.
- 2 AmerTran DeLuxe audio transformers.
- 1 Silver Marshall No. 540 midget condenser .00005 mfd.
- 1 Carter 30 ohm Midget rheostat.
- 1 Carter 6 ohm Midget rheostat.
- 8 Remler No. 50 sockets.
- 7 Tobe 1 mfd. bypass condensers.
- 1 Carter single contact jack.
- 1 Electrad .006 mfd. mica condenser.
- 1 Electrad .002 mfd. mica condenser.
- 1 Electrad .00025 mfd. mica condenser.
- 1 Weston 0-5 volts Model 506 voltmeter.
- 6 General Radio No. 274 jacks.
- 6 General Radio No. 274-P contact terminals.
- 3 Eby Ensign binding posts.
- 1 Bodine No. B-12-X three tap loop.
- 1 Bakelite panel 7x13½x3/16 in.
- 4 Pieces 1/16 in. sheet brass:
  - 1 7x12½ 1 7x13½
  - 1 3x12½ 1 3⅜x3⅜
- 2 3 terminal connector blocks.
- 1 Carter Type H-100 Resistance 100 ohms.
- 1 Carter Type H-200 Resistance 200 ohms.
- 1 Carter Type H1000 Resistance 1000 ohms.

Volume control is obtained from the 30 ohm rheostat in the filament circuit of the first two intermediate frequency tubes. Regeneration in the loop circuit is had from the midget feedback condenser at the left end of the panel. The filament voltage is controlled from the rheostat at the right of the panel, with the voltage indicated on the voltmeter in the center.

The 1st detector is mounted at the right, next to the panel. The oscillator tube is in the same position at the left end of the panel. In the back line of tubes, starting from the right, are the three intermediate amplifiers, second detector and the two audio amplifiers. Between the first detector and the oscillator are two by-pass condensers, and the three fixed resistances required for providing *C* voltage in the various grid circuits. All apparatus mounted on the sheet-brass top shelf is fastened to it by means of 4-36 machine screws, drilling the brass with a No. 42 drill and tapping with a 4-36 tap. The by-pass condensers in the center of the shelf are shunted across the 1½ and 4½ volt *C* biasing resistances.

The condenser across the 16½ volt biasing resistance is shown in the picture of the under part of the shelf, being associated with three other by-pass condensers used in the *B* battery circuits. The loop tuning and oscillator condensers also appear in this picture, with the oscillator coil and by-pass condenser in the compartment with the tuning condenser. At the rear are the three intermediate frequency transformers, filter, and audio frequency transformers, each coil being directly under its associated tube.

SHORT WAVE CONVERTER

(*Continued from Page* 16)

band in which you want to receive and plug it into the coil jacks, connect the plug to the receiving set as previously described, and transfer the aerial and ground leads. You may listen either with head phones on the intermediate jack if your present set is so arranged, or use the loud speaker as ordinarily connected. Turn the Clarostat until the receiver oscillates. Tune in a station and clear up the signal by a further adjustment of the Clarostat or rheostat as required.

THE PARTS REQUIRED

1 National Equicycle Condenser .00025 mfd. with
1 National type "C" dial.
1 Na-ald Socket.
1 Clarostat 0-500,000 ohms.
1 Yaxley 20 ohm Rheostat.
1 Set Aero Short Wave Coils.
1 S-M Choke Coil.
2 X-L Push Binding Posts.
1 Tiny Tobe .00025 Condenser.
1 Tiny Tobe .001 Condenser.
1 Tobe Tipon Lead 3 meg.
1 5 ft. Birnbach Cable.
1 7x12x3/16 in. Panel.
1 7x11x½ in. Baseboard.
Screws, wire and solder.

More and more experimenting is being conducted on short wave lengths. Most of the signals that you hear will be in code, but several phone stations can be heard. For example, one evening the writer heard thirty-four code stations, representing every district in the United States, as well as KDKA and WGY broadcasting their regular program on short waves. Another interesting event was two amateurs, one in Illinois and the other in Ohio, talking to each other by radio phone. This perhaps seems more remarkable when it is taken into consideration that the author lives in Massachusetts. Also the British beam station in Canada can be heard with the short wave converter.

IT HAPPENED OFF NICARAGUA

(*Continued from Page 22*)

"Don't know m'self," said the operator. "The old man was in just now. Says he: 'You're fifteen fathoms down right now and goin' deeper. You been dead two days and I'm sick with grief, but dead you stay for all that!' Now figger it yourself."

The second officer's face was a study in expressions.

"Dead—jumpin' catfish!"

"Uh-huh—dead's it—a plain, mortified corpse. Got carried off kinda sudden too—fever, or glanders, or pip—somethin' des' prate! Anyhow it's all right with me."

"Well for John's sake!" The second officer expressed his amazement. Then his face lighted. "I wonder now could it have somethin' to do with—you know—?" He jerked a finger downward toward the cases of Boston beans in the hold.

"The old man told us not to discuss nothin' about no cargo among ourselves—no suspicions," said Soda Magee tartly.

"Well, I aint discussin' no suspicions," said the second officer. "I done pried up a cover and looked. I seen what I saw!"

"Folks that sees too much wakes up and is surprised to see their hides dryin' on a fence," suggested the operator.

The second officer snorted .

"I been livin' a long time," he said, "and I still got my bark. Anyhow, I never argues with no corpse. If you're dead like you say, you kin stay dead for all of me."

He returned to the little knot at the stern of the *Cassie Hogan* and acquainted them with the new development. There was a flurry of interest.

"I'll bet that there Sparks gets some change, some loose jack out of bein' dead," suggested Sammy. "I aint never seen nobody could equal him for thinkin' up ways of gettin' jack. Them dice of his now is just like him. I remember once when I was in the North Sea . . ."

"I know—you seen a shark playin' a flute," said the second officer.

"Aw go to hell," growled Sammy, in violation of certain sea rules, made and provided.

Conversation was terminated abruptly now as the smoke smudge revealed itself as a speeding gunboat which came racing down in their wake with the speed of a destroyer, which she had once been. As she ranged within sight, they could make out her name, *El Frigador*, the last vessel they wanted to see. Hardly had they made the identification when a number of code flags blossomed out in her upper-structure.

Captain McTavish studied the combination. Then he turned to Jasmine Hawkins.

(*Continued on Page 42*)

"My set is all right, but . . . . .

my "B" Batteries are just about gone."

How often have *you* had to embarass yourself by explaining that run-down "B" Batteries and *not* your radio set were the cause of all those reception "noises"—or worse, *no* reception at all?

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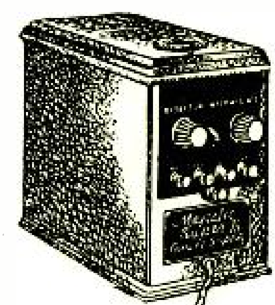

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West of Rocky Mts., $29.00 Raytheon Tube $6.00 extra	West of Rocky Mts. $31.50 Raytheon Tube $6.00 extra	West of Rocky Mts. $34.00 Raytheon Tube $6.00 extra

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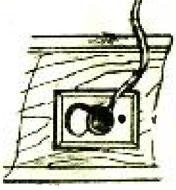

Majestic "B" is best

[redacted]

[redacted]

(*Continued from Page* 40)

"Get out a string," he commanded, "and be sure they don't spell anything. Sling the yellow ball on top!"

Hawkins stared open-mouthed.

"The yellow ball—yes sir!" He was gone for the lockers. Almost immediately the *Cassie Hogan* began to blossom with flags as bit after bit of bunting went racing into the air on taut lines.

Above them all floated the grim "yellow ball," known to shipping men the world over as the pestilence flag—the symbol of the dreaded smallpox. On board the gunboat glasses were leveled and figures ran about.

Presently from *El Frigador* came another string of code symbols — They were almost side by side now, the gunboat and the freighter, and the crew of the *Cassie Hogan* could plainly see the uniforms aboard the war-craft. Captain McTavish ordered out more flags, and signaled the engine-room to bring the freighter to a stop.

"How come we stop for her, and we flying the stars and stripes?" demanded Jasmine Hawkins familiarly.

" 'Tis but international courtesy," replied the skipper. "We're flyin' the yellow tommy. Gi'e them another string, Mr. Hawkins . . ."

Down below the crew watched the exchange of signals with restless eyes.

"Why don't the old man start somepin'" demanded Sammy. "This here wavin' hankies don't get nowhere. Me—I'd like to go over and kick hell out of that spiggoty tom-cat."

"Aw shut up," growled the second officer. "The old man's insultin' 'em. You got to do a lot of flag hokum to get these bimbos sore enough to fight. You watch now . . ."

The second and third barrage of code signals seemed to cause even more excitement and consternation on *El Frigador*. Figures ran about and clusters of officers gathered and pointed toward the freighter. One officer in considerable gold braid seemed to be looking for something in a book, an act which brought a grin from the first officer, up on the *Cassie Hogan's* bridge.

Captain McTavish had a glint in his eye as he turned to his second in command.

"They dinna' seem to understand us, Mr. Hawkins," he said. "Would ye be so kind as to give 'em the works?"

"Mr. Hawkins" did himself proud on the next attempt for within a few minutes the *Cassie Hogan*, dingy and disreputable freighter bloomed forth as the gayest ship ever seen on Pacific waters. From every point of vantage floated code flags of every color and hue. And from at least three points fluttered the dread "yellow tommy," the terror of the sea.

The gunboat's reaction was immedi-

(*Continued on Page* 44)

Snap a switch

No more batteries.

No battery charger to watch.

No batteries to water.

No failure of the power plant just as you sit down to a fine program.

No upsetting the house to have the radio serviced.

No apologies to make to callers that the batteries have just run down.

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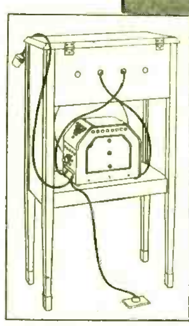
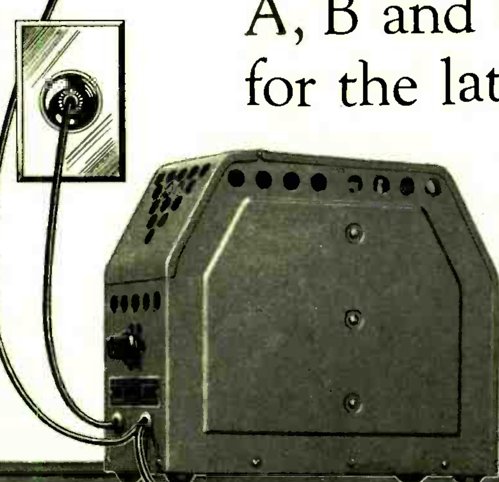


The 6 tube Console pictured above stands 40 inches high—contains skillfully engineered shielded circuit—single drum dial control. Musicone built in. Price, without tubes and power unit, $95.00.

A, B and C Power from the light socket for the latest model Crosley AC Radios



This power unit weighs 13 lbs., stands 9 inches high and is 4 inches wide and requires no more attention than a vacuum cleaner or an electric iron. It transforms mechanically ordinary 110 volt 60 cycle house current into smooth quiet radio energy. No interfering hum!

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Prices slightly higher west of the Rocky Mountains

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CROSLEY

BETTER ··· COSTS LESS

RADIO

(Continued from Page 42)

ate and emphatic. It began to back, leaving the *Cassie Hogan* wallowing in the long ground swells. Thereupon it went into a maneuver that brought it back again within hailing distance. A figure in an ornate uniform climbed out on a rail and sprayed a stream of Spanish through a megaphone.

Captain McTavish grabbed his own loud speaker and bellowed back.

"Si—calentura negra!" he shouted, pointing to the yellow flags. "Calentura negra—black smallpox—savvey usted?"

There was considerable conferring aboard the warship. Then the ornate officer tried again. Out of his jargon the skipper made out a word or two. For instance "maquinista de radio."

Captain McTavish shook his head and pointed over the rail downward.

"Radio operator muerto — mucho muerto—dead—tres dias—three days . . . no tengo nada . . . I have nobody . . ."

"That's me," said Soda Magee comfortably, lounging against the rail of the *Cassie Hogan*. "Think of havin' a whole gunboat het up like that because you're dead. Ain't it grand?"

"You been dead three days, fellah," said Sammy, "and I ain't for you."

On board *El Frigador* there was another shifting of officers and finally a new code flag blossomed out. This one Captain McTavish translated without the code book.

"They're coming aboard with doctors," he announced. "They think we're bluffin' . . ."

Jasmine Hawkins hitched up his belt and spat.

"Say Cap—I know a stunt . . ." he began.

"Yes?"

"Well, there's a case of stove polish aboard that was shipped by mistake. Now if we could jus' kinda fix the boys up . . . Well, calentura negra is black smallpox ain't it?" He paused in some embarassment. The captain cleared his throat.

"Mr. Hawkins," he said. "That's a vera guid idea. I'll thank ye to attend to it at once."

"Yes, sir," said Jasmine Hawkins and ran down the ladder. He called the men together in the shadow of the deck house and talked to them. There was laughter and much slapping of backs. Presently they all vanished down the companionways, Hawkins in the lead.

A gig put off from the gunboat with an officer and a number of men aboard and came teetering across the swells to the *Cassie Hogan*. Captain McTavish was at the freighter's ladder when the officer, a dapper but frightened young Latin-American, came cautiously aboard. The officer spoke English with great difficulty and did his talking from the top of the ladder. A terrible sight met his eyes.

Directly at his feet lay Soda Magee, sprawled as in death, his face and hands blackened in spots with stove polish, his teeth showing in a hideous grin. He had apparently shuffled off his none too secure mortal coil in great agony. Alongside was Sammy, moaning and twisting, to all intents and purposes, dead on one side. Against the wheel house were men in grotesque positions, lying motionless, all with the dread black-splotched faces. The very air was fetid with the rank odor of pestilence, the result of the cook's genius in concocting a combination of ship's disinfectant, lysol, and vinegar, and sprinkling in on the deck.

"Santo Christo!" gasped the young officer. "You have mooch seekness, eh?"

"Mucho muerto—much death," intoned Captain McTavish solemnly. He counted on his fingers. "Veinte cinco, seis . . ." He held up both hands. The young officer shuddered.

"Tombo . . . T o m b o ! " shrieked Sammy, putting a touch of realism into his act by frothing at the mouth with the aid of a little soap.

Afterwards Sammy confessed that he hadn't the slightest idea in the world what the word meant, but that he had "swiped it offen the ship's cat." But it jarred the young officer exceedingly for it was Spanish for "tomb," and the word screamed by a dying man unnerved him. He backed away and crossed himself. The ladder was conveniently near . . .

"We hav 'doctair . . . asseestance . . ." he hesitated, hoping the offer would not be accepted.

Captain McTavish shook his head.

"Muchas gracias," he said, "but nobody can do anything . . ." He explained in broken Spanish that one could do little with a situation of such a nature until it wore itself out.

The young officer backed hastily, hurriedly, down the ladder and into his gig, with a chorus of lusty moans and groans ringing in his ears. The skipper of the *Cassie Hogan* watched the gig hurry back to *El Frigador*, and the commotion aboard the gunboat caused by the young officer's report. Somewhere across the water a bell tinkled in an engine-room. Screws began to churn, and presently the gunboat was gone down the rim of the horizon in a flurry of foam and a curtain of smoke.

Thus it was that up and down the coast that night, went the story of the *Cassie Hogan's* taint—of the hell ship with the dead operator and decks rotten with unburied men, and the stench of a pestilence around her like a swarm of flies—winged by radio in Spanish, to leak from Managua through official channels into shipping centers, and to be relayed northward in the chattering staccato of the Continental code to the owners in San Francisco.

Soda Magee, with the "cans" on his head, listened to it all and chuckled, while down below the crew rolled cigarettes, slapped their thighs, and yarned far into the night of the manner in which a canny Scotch skipper had hoodwinked a nosey foreign gunboat without a shot fired on either side.

Wallowing on her way, the Cassie Hogan picked up a pair of red lights in a rocking foretop. She hove to and a lighter came alongside. By lantern light cases came up from the hold and went over the side, the squeak of winches, and the hoarse bellow of natives aboard the lighter mingling in the otherwise silent night. The cases were marked "Beans" but they weighed more than beans have weighed before or since, and they rattled when they struck against the rail.

It was an all night job and the men sweated as they worked. But by dawn the lighter pulled away, lying low in the water. Captain McTavish called all hands forward.

"There's double pay and a ration or two of rum, for the night's work," he said softly.

The men cheered. The radio operator, wearing a jumper and overalls, lounged against the rail. The captain motioned to him.

"We'll be into Vera Cruz shortly. You'll lay low and I'll sign you on under another name for a return trip."

The operator looked at his nails.

"Such as what?" he inquired softly.

The captain stared.

"Any name ye like," he said after a bit.

"I've a kind of hankerin' for my own—Soda Magee," he said without looking up.

"Soda Magee is dead!" said the captain tartly. " 'Tis so writ in the log."

The mortal remains of Soda Magee polished its nails on an erstwhile phantom sleeve.

"There's some as might think so," he said. "And then again there might be those as didn't."

"Ah," said the skipper, short and sharp.

"I'm thinkin' the widow of Soda Magee might not like me usin' her dead husband's name," said Soda Magee. "If there was a consideration now, I have no doubt she'd have no objection."

Captain McTavish took a turn up and down the deck. Finally he halted before the solemn figure of the "dead" operator.

"Wad five hundred dollars fix the widow, do ye think?" he asked harshly.

Magee nodded slowly.

"From what I know of the lady, I have no doubt it would," he said pleasantly.

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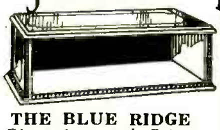

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Sargent's New Infradyne Manual
"RADIO," San Francisco

Trouble-Shooting The Infradyne

Detailed Tests and Diagrams for Testing Possible Faults in Each Part of the Circuit

By E. M. Sargent

ALTHOUGH thousands of sets employing the Infradyne circuit have already been assembled and are giving eminent satisfaction, an occasional difficulty is encountered which may be understood and remedied by studying and applying various tests herein explained. Furthermore much of this information should be of interest and value to any person who operates this selective and sensitive set.

These various tests, with their special accompanying diagrams, may be identified by reference to the complete pictorial wiring diagram shown in Fig. 1. When several tests are indicated by one diagram they have been designated by the diagram number, followed by *a*, *b*, *c*, etc., it being assumed that the tests will be made in the alphabetic sequence suggested. Most of the tests may be made with a pair of phones by the click method, although in some cases a voltmeter is preferable.

It will be noticed that the circuit differs slightly from that originally shown. No change has been made in parts specified and the modifications shown can be very easily incorporated. Those modifications indicated have been made with a view to making the set more stable in operation and more easily handled. They are, it is felt, well worth while.

As originally designed, the first two radio frequency tubes, the mixer, the Infradyne Amplifier tubes, the oscillator and the first audio tube were operated at 90 volts plate. It has been found that the Infradyne Amplifier is more stable and more easily handled when operated at a plate voltage of 67½. Critical adjustment of the mixer tube filament temperature is necessary when that tube is operated at 90 volts. If a plate voltage of 22½ is applied to the mixer tube and a grid leak of 4 or 5 megohms is used, critical adjustment of the mixer tube filament temperature will be found no longer necessary. In order that a plate voltage, different from that applied to the Infradyne Amplifier, may be applied to the mixer tube it is necessary that a blocking condenser of .001 mfd. capacity be used as shown. Passage of the 3500 kc. intermediate frequency through the *B* battery is prevented by a Remler No. 35 Choke Coil. The mixer tube plate voltage is supplied from the 67½ volt battery terminal, the necessary voltage drop being obtained through the use of a fixed resistor of .05 megohms.

In order to obviate the necessity of adding an extra binding post, the detector is operated at a plate voltage of 67½ instead of 45 volts as in the original model; operation of the detector at this voltage will be found entirely satisfactory. In order to effect this change, it is necessary to disconnect from the Frost No. 954 Gem Jac (phone jack) the wire originally connected between that jack and terminal No. 6 of the tapped inductance and to connect this wire between terminal No. 6 of the tapped inductance and terminal No. 1 of the first Silver-Marshall Audio Transformer. The 67½ volt terminal of the *B* battery will then be connected to the binding post marked plus 45.

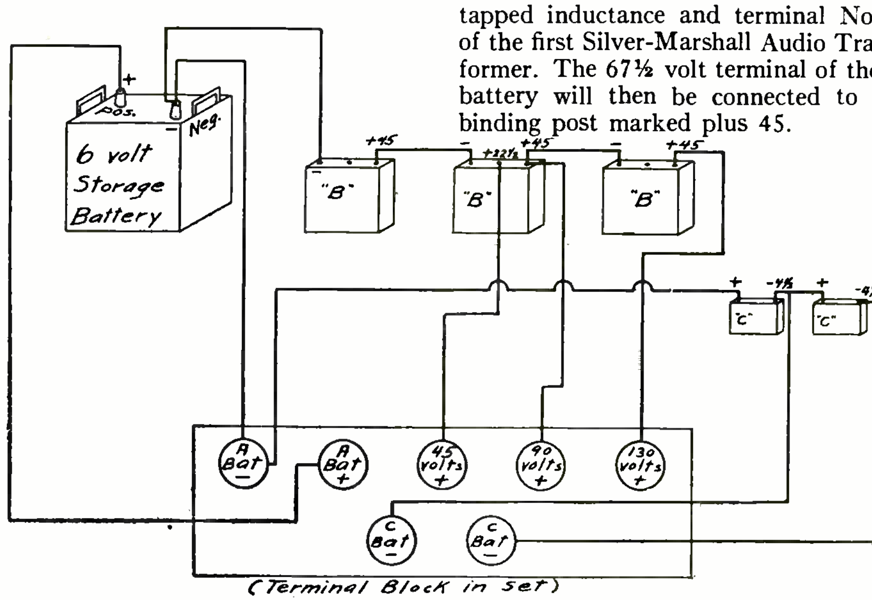


Fig. 2. Battery Connections.

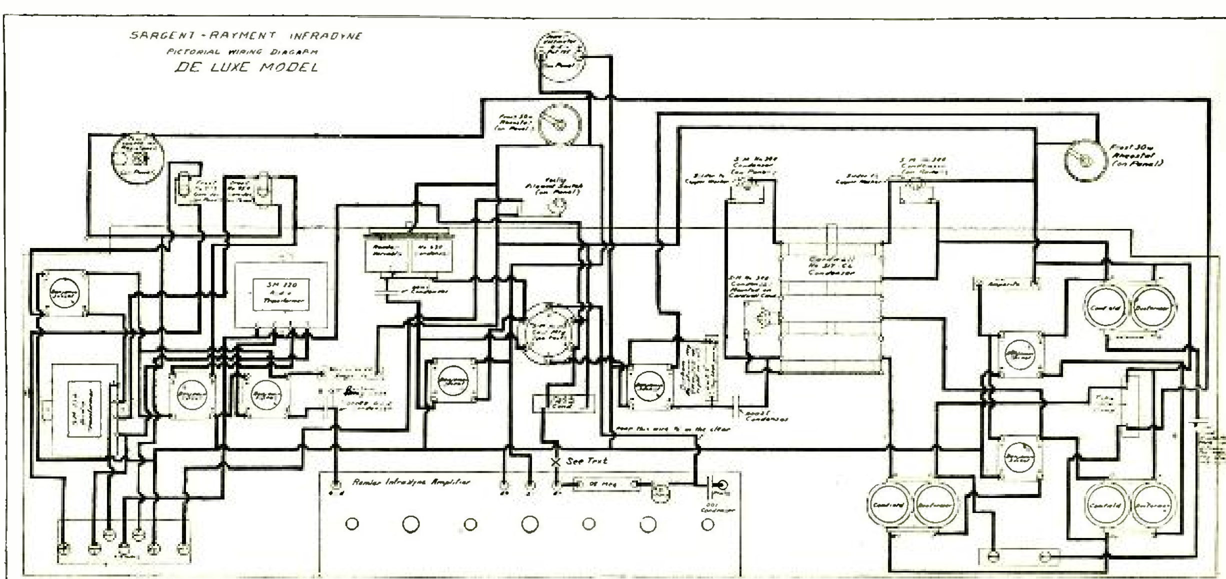
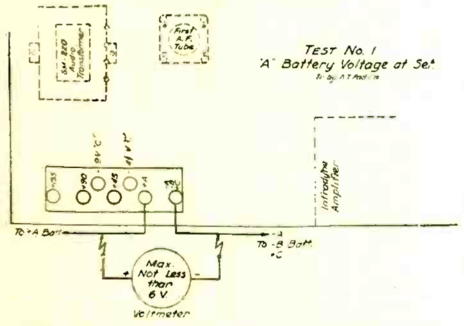


Fig. 1. Pictorial Wiring Diagram of the Infradyne.

TEST NO. 1—*A* BATTERY VOLTAGE

All tubes should be in their sockets and drawing normal current.

The filament switch should be in the *ON* position; the mixer tube and center panel rheostats should be turned on and the voltmeter should read 3 volts.



The test voltmeter should read 6 volts. If the voltmeter does not read 6 volts (1) The battery charge may be low or (2) The leads from the *A* battery to the set may be of too high resistance so that the voltage drop through them is excessive.

TESTS NOS. 2 A-B-C—*B* BATTERY VOLTAGE

The tubes can be left in their sockets or removed as desired.

The *B* batteries must be connected as in Fig. 2.

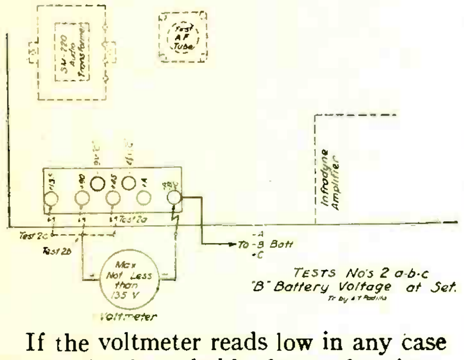
The filament switch should be in the *OFF* position.

Tests a, b and c should be made in natural sequence .

Test 2a.—The voltmeter should read 67½ volts.

Test 2b.—The voltmeter should read 90 volts.

Test 2c.—The voltmeter should read 135 volts.



If the voltmeter reads low in any case the trouble is probably due to deterioration or discharge of one or more of the *B* batteries.

If the voltmeter pointer is unsteady and all external connections are good there may be a poor connection inside of one of the *B* batteries. Such a poor connection would result in noisy operation of the set.

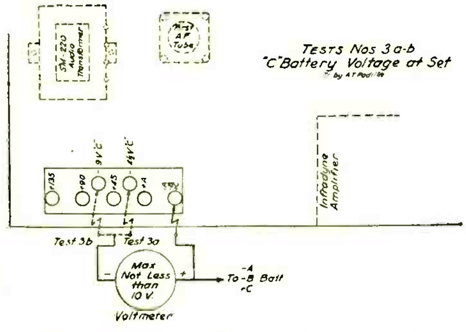
TESTS NOS. 3 A-B—*C* BATTERY VOLTAGE

The tubes can be left in their sockets or removed as desired.

The batteries should be connected as in Fig. 2.

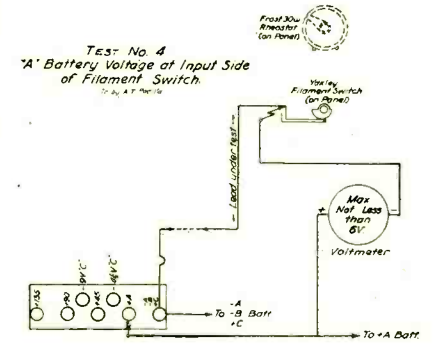
The filament switch should be in the *OFF* position.

Test 3a.—The voltmeter should read 4½ volts. It is assumed that a plate voltage of 90 is to be used on the first audio tube; if a different plate voltage is to be used on this tube, employ the



corresponding bias recommended by the manufacturer.

Test 3b.—The voltmeter should read 9 volts if a CX-112 or UX-112 is to be used at a plate voltage of 135. If a CX-371 or UX-171 is to be used in the last audio stage employ the grid bias recommended by the tube manufacturer.



TEST NO. 4—*A* BATTERY VOLTAGE

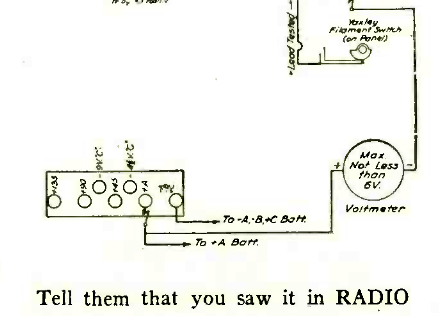
All tubes should be left out of their sockets as a protective measure.

The *A* battery must be connected as in Fig. 2.

The filament switch should be in the *OFF* position.

The voltmeter should read 6 volts.

If the voltmeter does not read 6 volts the lead from the —*A*—*B*+*C* binding post to the input side of the filament switch is incomplete. This lead is indicated in the diagram. The dotted portion of the lead is that part which could not be drawn due to space limitations.



TEST NO. 5—FILAMENT VOLTAGE

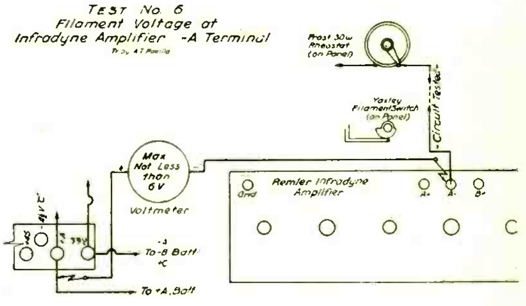
All tubes should be left out of their sockets as a precautionary measure.

The filament switch should be in the *ON* position.

The *A* battery should be connected as in Fig. 2.

The test voltmeter should read 6 volts.

If the voltmeter does not read 6 volts (1) The filament switch is defective or (2) The lead from the switch to the center panel rheostat is incomplete. This lead is indicated in the diagram.



TEST NO. 6—FILAMENT VOLTAGE

All tubes should be left out of their sockets as a protective measure.

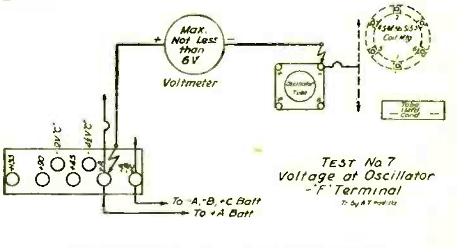
The *A* battery must be connected as in Fig. 2.

The filament switch should be in the *ON* position.

The center panel rheostat should be in the full *ON* position and the voltmeter should be temporarily disconnected.

The test voltmeter should read 6 volts.

If the test voltmeter does not read 6 volts (1) The center panel rheostat is defective or (2) The lead from the center panel rheostat to the Infradyne Amplifier minus *A* binding post is incomplete. This lead is indicated in the diagram.



TEST NO. 7—FILAMENT VOLTAGE

All tubes should be left out of their sockets as a protective measure.

The *A* battery must be connected as in Fig. 2.

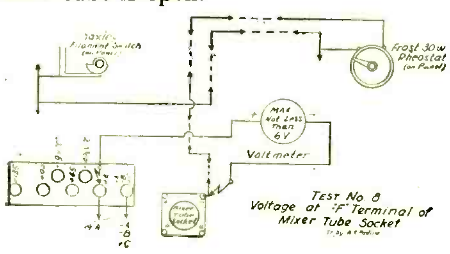
The filament switch should be in the *ON* position.

The center panel rheostat should be in the full *ON* position and the panel voltmeter should be temporarily disconnected.

The test voltmeter should read 6 volts.

If the voltmeter does not read 6 volts (1) The center panel rheostat is defective or (2) The lead from the center panel rheostat to the minus *F* terminal of the oscillator tube socket is incomplete.

Note — In the original Infradyne the filament temperature of the oscillator tube was controlled by means of a 6V-199 Amperite. If this arrangement has been used, the test should be made with the oscillator tube in its socket. The test voltmeter should then read 3 volts. If the voltmeter does not read 3 volts it would indicate that the wiring from the filament switch to the Amperite is incomplete or that the Amperite is defective or that the filament of the oscillator tube is open.



TEST NO. 8—FILAMENT VOLTAGE

All tubes should be left out of their sockets as a protective measure.

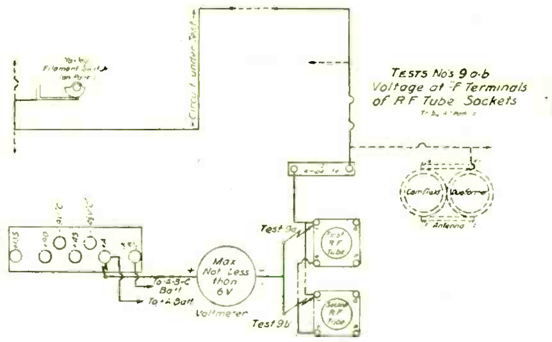
The *A* battery must be connected as in Fig. 2.

The filament switch must be in the *ON* position.

The mixer tube rheostat (at the left hand end of the panel) should be in the full *ON* position.

The test voltmeter should read 6 volts.

If the voltmeter does not read 6 volts (1) The lead from the filament switch to the mixer tube rheostat is incomplete or (2) The mixer tube rheostat is defective or (3) The lead from the mixer tube rheostat to the minus *F* terminal of the mixer tube socket is incomplete. Both of the leads mentioned are indicated in the diagram.



TESTS NOS. 9 A-B—FILAMENT VOLTAGE

The first two radio frequency tubes should be inserted in their sockets.

The *A* battery must be connected as in Fig. 2.

The filament switch must be in the *ON* position.

Tests a and b should be made in natural sequence.

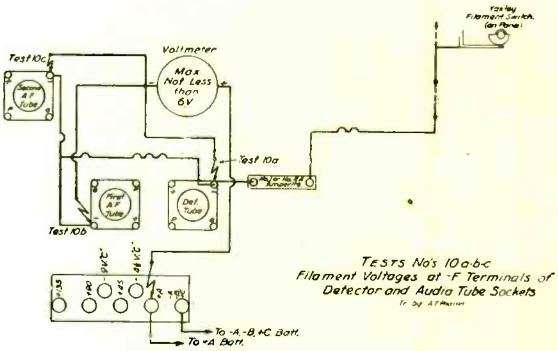
The voltmeter should read 5 volts in each test.

Test 9a.—If the voltmeter does not read 5 volts (1) The lead from the filament switch to the input side of the No. 112 Amperite is incomplete or (2) The No. 112 Amperite is defective or (3) The lead from the No. 112 Amperite to the minus *F* terminal of the first radio frequency tube socket is incomplete or (4) One or both of the radio frequency tube filaments is open.

Test 9b.—If the voltmeter does not read 5 volts (1) The lead from the No. 112 Amperite to the minus *F* terminal of the second radio frequency tube socket is incomplete or (2) One or both of the radio frequency tube filaments is open.

All leads mentioned are indicated in the diagrams.

Note—If rheostat control of the radio frequency tubes has been used, the tubes can be left out of their sockets during the test. The test will be made as above, the input side of the rheostat corresponding to the input side of the Amperite and the output side of the rheostat corresponding to the output side of the Amperite. The radio frequency tube rheostat should be turned all the way on during the test and the voltmeter should in each case read 6 volts.



TESTS NOS. 10 A-B-C—FILAMENT VOLTAGE

The detector and audio frequency tubes should be inserted in their sockets.

The *A* battery must be connected as in Fig. 2.

The filament switch must be in the *ON* position.

Tests a, b and c should be made in natural sequence.

The voltmeter should read 5 volts in each test.

Test 10a.—If the voltmeter does not read 5 volts (1) The lead from the filament switch to the input side of the No. 1 Amperite is incomplete or (2) The No. 1 Amperite is defective or (3) The lead from the No. 1 Amperite to the minus *F* terminal of the detector tube socket is incomplete or (4) The filament is open in one or more of the above listed tubes.

Test 10b.—If the voltmeter does not read 5 volts (1) The lead from the No. 1 Amperite to the minus *F* terminal of the first audio tube socket is incomplete or (2) The filament is open in one or more of the tubes listed above.

Test 10c.—If the voltmeter does not read 5 volts (1) The lead from the No. 1 Amperite to the minus *F* terminal of the second audio tube socket is incomplete or (2) The filament is open in one or more of the tubes listed above.

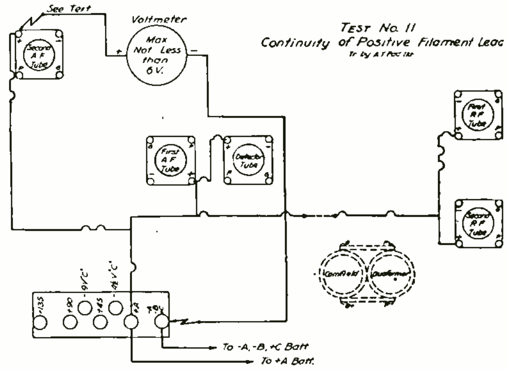
All leads mentioned have been indicated in the diagram.

TEST NO. 11—FILAMENT LEADS

All tubes may be left out of their sockets as a protective measure.

The *A* battery must be connected as in Fig. 2.

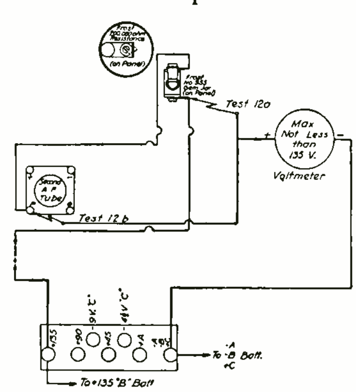
The filament switch should be in the *OFF* position.



Test No. 11
Continuity of Positive Filament Lead

Connect the positive terminal of the test voltmeter to the positive terminal of each socket in turn and to the plus *A* binding post of the Infradyne Amplifier. The voltmeter should read 6 volts in each case.

If the voltmeter does not read 6 volts in any of the above tests, the lead from the plus *A* binding post on the binding post strip to the point to which the positive terminal of the test voltmeter is connected is incomplete.



Tests No's 12 a-b
Plate Voltage on Second Audio Frequency Tube

TESTS NOS. 12 A-B—PLATE VOLTAGE

All tubes should be left out of their sockets.

The *B* batteries must be connected as in Fig. 2.

The filament switch should be in the *OFF* position.

Tests a and b should be made in natural sequence .

Test 12a.—The voltmeter should read 135 volts. If the voltmeter does not read 135 volts the lead from the plus 135 volt binding post to the "Speaker" jack (Frost No. 953) is incomplete.

Test 12b.—The "Speaker" jack must be short-circuited (a phone plug whose circuit has been closed with a piece of wire can be used for this purpose). The voltmeter should read 135 volts. If the voltmeter does not read 135 volts (1) The "Speaker" jack is defective or (2) The lead from the "Speaker" jack to the plate terminal of the second audio tube socket is incomplete or (3) The "Speaker" jack has not been properly short-circuited.

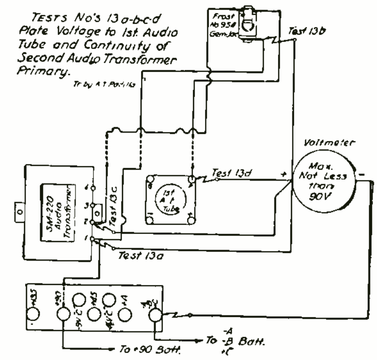
All leads mentioned have been indicated in the diagram.

TESTS NOS. 13 A-B-C-D—PLATE VOLTAGE

All tubes should be left out of their sockets as a protective measure.

The *B* batteries must be connected as in Fig. 2.

The filament switch may be in the *OFF* position.



Tests No's 13 a-b-c-d
Plate Voltage to 1st Audio Tube and Continuity of Second Audio Transformer Primary.

Tests a, b, c and d should be made in natural sequence.

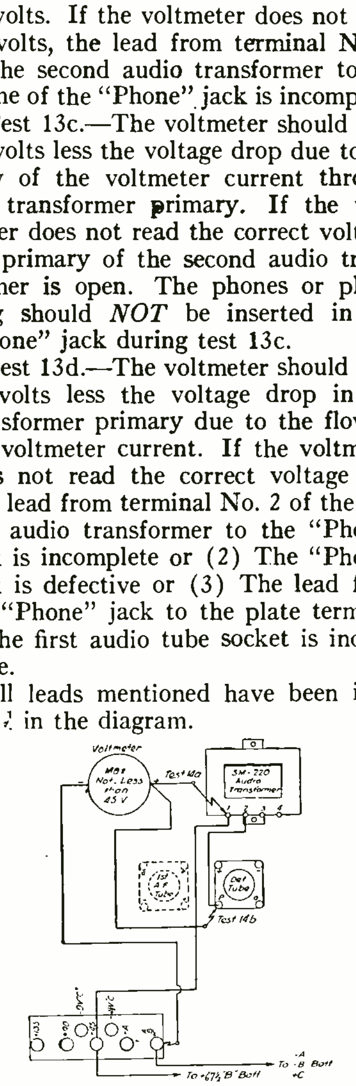
Test 13a.—The voltmeter should read 90 volts. If the voltmeter does not read 90 volts the lead from the plus 90 binding post to terminal No. 1 of the second audio transformer is incomplete.

Test 13b.—The voltmeter should read 90 volts. If the voltmeter does not read 90 volts, the lead from terminal No. 1 of the second audio transformer to the frame of the "Phone" jack is incomplete.

Test 13c.—The voltmeter should read 90 volts less the voltage drop due to the flow of the voltmeter current through the transformer primary. If the voltmeter does not read the correct voltage, the primary of the second audio transformer is open. The phones or phone plug should *NOT* be inserted in the "Phone" jack during test 13c.

Test 13d.—The voltmeter should read 90 volts less the voltage drop in the transformer primary due to the flow of the voltmeter current. If the voltmeter does not read the correct voltage (1) The lead from terminal No. 2 of the second audio transformer to the "Phone" jack is incomplete or (2) The "Phone" jack is defective or (3) The lead from the "Phone" jack to the plate terminal of the first audio tube socket is incomplete.

All leads mentioned have been indicated in the diagram.



Tests No's 14 a-b
Voltage of Detector Plate and Continuity of First Audio Transformer Primary

TESTS NOS. 14 A-B—PLATE VOLTAGE

All tubes should be left out of their sockets as a protective measure.

The *B* batteries must be connected as in Fig. 2.

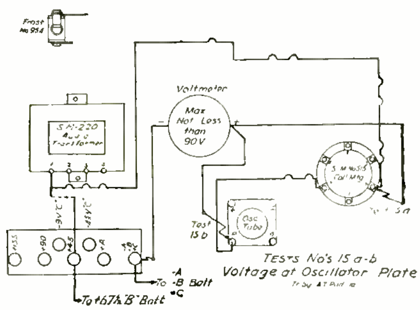
The filament switch may be in the *OFF* position.

Tests a and b should be made in natural sequence.

Test 14a.—The voltmeter should read 67½ volts. If the voltmeter does not read 67½ volts, the lead from the plus 45 binding post to terminal No. 1 of the first audio transformer is incomplete. (Remember that the plus 45 binding post is connected to the plus 67½ terminal of the *B* battery.)

Test 14b.—The voltmeter should read 67½ volts less the voltage drop due to the flow of the voltmeter current through the transformer primary. If the voltmeter does not read the correct voltage (1) The first audio transformer primary is open or (2) The lead from terminal No. 2 of the first audio transformer to the plate terminal of the detector tube socket is incomplete.

All leads mentioned have been indicated in the diagram.



TESTS NOS. 15 A-B—PLATE VOLTAGE

All tubes should be left out of their sockets as a protective measure.

The *B* batteries must be connected as in Fig. 2.

The filament switch may be in the *OFF* position.

Tests a and b should be made in natural sequence.

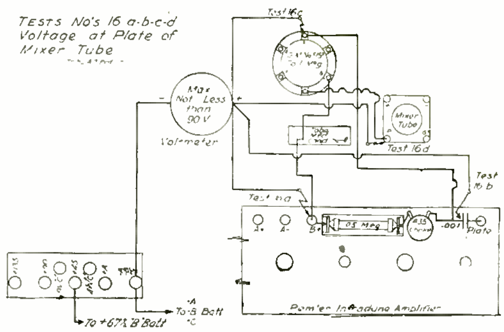
Test 15a.—The voltmeter should read 67½ volts. If the voltmeter does not read 67½ volts the lead from terminal No. 1 of the first audio transformer to terminal No. 6 of the tapped inductance is incomplete.

Test 15b.—The voltmeter should read 67½ volts. If the voltmeter does not read the correct voltage (1) Winding *5-6* of the tapped inductance is open or (2) The lead from terminal No. 5 of the tapped inductance to the plate terminal of the oscillator tube socket is incomplete.

All leads mentioned are indicated in the diagram.

TESTS NOS. 16 A-B-C-D—PLATE VOLTAGE

The mixer tube should be in its socket and the mixer tube rheostat should be



adjusted so that 5 volts is applied to the mixer tube filament.

The *B* batteries must be connected as in Fig. 2.

The filament switch must be in the *ON* position.

Tests a, b, c and d should be made in natural sequence.

Test 16a.—The voltmeter should read 67½ volts. If the voltmeter does not read 67½ volts, the lead from terminal No. 6 of the tapped inductance to the plus *B* binding post of the Infradyne Amplifier is incomplete.

Test 16b.—The voltmeter should read 22½ volts. The exact reading of the voltmeter will depend upon the accuracy of the fixed resistor used; it should be in the neighborhood of the value given. If the voltmeter does not read the correct voltage (1) The Remler Choke Coil is open or (2) The fixed resistor is defective or (3) The circuit to the mixer tube plate is open and the plate current necessary to cause a voltage drop through the fixed resistor is not flowing. If the plate circuit to the mixer tube is open but the circuit through the choke coil and resistor is complete, the voltmeter in test 16b should read 67½ volts, less the voltage drop due to the flow of the voltmeter current.

Test 16c.—The voltmeter should read 22½ volts (subject, as before, to the accuracy of the fixed resistor). If a voltmeter having a low internal resistance per volt is used, the voltage drop due to the flow of the voltmeter current through the fixed resistor must be taken into account in tests b, c and d. If the voltmeter does not read the correct voltage, the lead from one side of the resistor to terminal No. 2 of the tapped inductance is incomplete.

Test 16d.—The voltmeter should read 22½ volts (making allowance as before for the accuracy of the fixed resistor and for the effect of the voltmeter current). If the voltmeter does not read the correct voltage (1) Winding *1-2* of the tapped inductance is open or (2) The lead from terminal No. 1 of the tapped inductance to the plate terminal of the mixer tube socket is incomplete.

All leads mentioned are indicated in the diagram.

TESTS NOS. 17 A-B-C-D—PLATE VOLTAGE

The first two radio frequency tubes must be in their sockets.

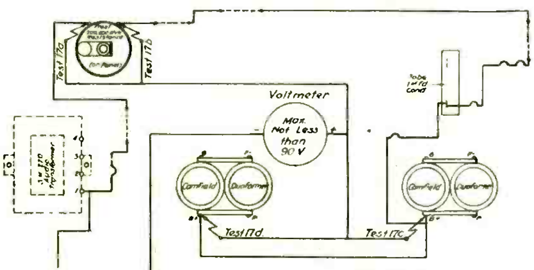
The *A* and *B* batteries must be connected as in Fig. 2.

The center panel rheostat should be in the *OFF* position.

The filament switch must be in the *ON* position.

Tests a, b, c and d should be made in natural sequence.

Test 17a.—The voltmeter should read 90 volts. If the voltmeter does not read 90 volts, the lead from the 90 volt binding post to the input side of the Frost 200,000 ohm resistance is incomplete.



Tests 17 a-b-c-d
Plate Voltage Regulation on R. F. Tubes and Voltage at Primaries of R. F. Transformers.

Test 17b.—The voltmeter reading should vary smoothly from approximately 90 volts to a minimum value as the 200,000 ohm resistance control knob is turned slowly over its whole range. If the voltage does not change smoothly and uniformly up to a maximum very close to 90 volts the resistance should be replaced with one having the desired characteristics.

Test 17c.—The 200,000 ohm resistance should be adjusted for the application of maximum plate voltage to the radio frequency tubes. The test voltmeter should read the maximum value obtained in test 17b. If the voltmeter does not read the correct value, the lead from the output side of the 200,000 ohm resistance to the plus *B* terminal of the second radio frequency transformer is incomplete.

Test 17d.—The 200,000 ohm resistance should be left as in test 17c and the voltmeter should again read the maximum value obtained in test 17b. If the voltmeter does not read the correct voltage, the lead from the plus *B* terminal of the second radio frequency transformer to the plus *B* terminal of the third radio frequency transformer is incomplete.

All leads mentioned are indicated in the diagram.

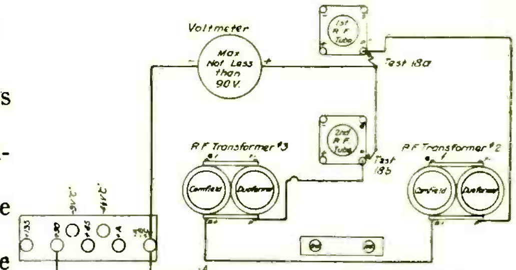
TESTS NOS. 18 A-B—PLATE VOLTAGE

All tubes should be left out of their sockets as a protective measure.

The *B* batteries must be connected as in Fig. 2.

The filament switch may be in the *OFF* position.

The 200,000 ohm resistance should be



Tests Nos 18 a-b.
Voltage at Plate Terminals of Radio Frequency Tubes

wire connected across its terminals.

Tests a and b should be made in natural sequence.

Test 18a.—The voltmeter should read 90 volts. If the voltmeter does not read temporarily shorted out by means of a 90 volts (1) The primary of the second radio frequency transformer is open or (2) The lead from terminal *P* of the second radio frequency transformer to terminal *P* of the first radio frequency tube socket is incomplete.

Test 18b.—The voltmeter should read 90 volts. If the voltmeter does not read 90 volts (1) The primary of the third radio frequency transformer is open or (2) The lead from terminal *P* of the third radio frequency transformer to terminal *P* of the second radio frequency tube socket is incomplete.

All leads mentioned are indicated in the diagram.

TESTS NOS. 19 A-B-C-D—INFRADYNE AMPLIFIER

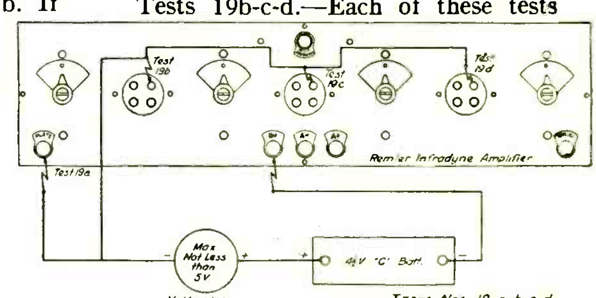
All batteries should be disconnected and the Infradyne Amplifier removed from the set.

The Infradyne Amplifier tubes should be left out of their sockets.

Tests a, b, c and d should be made in natural sequence.

Test 19a.—The voltmeter should read the *C* battery voltage. If the voltmeter does not read the *C* battery voltage, the Infradyne Amplifier input primary circuit is open.

Tests 19b-c-d.—Each of these tests

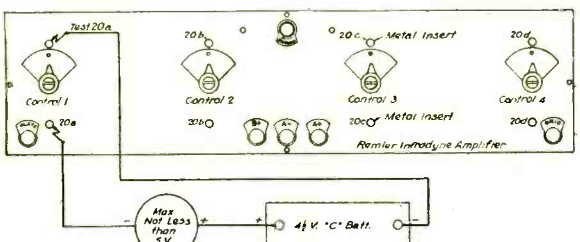


Tests Nos. 19 a-b-c-d
Continuity of Infradyne Amplifier Primary Circuits

checks the continuity of a primary circuit. The voltmeter should read the *C* battery voltage in each case; if it does not, the primary circuit under test is open.

During each of these tests the Amplifier should be jarred slightly so that any contact which may be made by one wire merely resting against the other will be broken. A loose contact of this kind will be indicated by fluctuation of the voltmeter pointer or by failure of the voltmeter to continue to register. Be sure that fluctuation of the voltmeter pointer is not due to poor contact outside of the Amplifier.

If in these tests the Amplifier proves to have an open circuit it should be returned to the manufacturer for adjustment through the channels through which purchase was made.



Tests No's 20 a-b-c-d. Continuity of Infradyne Amplifier Secondary Circuits.

TESTS NOS. 20 A-B-C-D—INFRADYNE AMPLIFIER

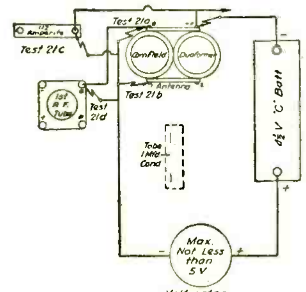
All batteries should be disconnected and the Infradyne Amplifier removed from the set.

The Infradyne Amplifier tubes should be left out of their sockets.

Tests a, b, c and d should be made in natural sequence, that is, the test terminals should be connected first across points 20a, then across points 20b, 20c and 20d in turn.

Each of these tests is a check on the continuity of a secondary circuit. The voltmeter should read the *C* battery voltage in each case. If in any of the four tests the voltmeter does not read the *C* battery voltage, it is an indication that the secondary circuit under test is open.

Should one of the secondaries prove to be open the Amplifier should be returned to the manufacturer for adjustment as described under Test 19.



Tests Nos. 21a-b-c-d Continuity of Antenna Coil Windings.

TESTS NOS. 21 A-B-C-D—ANTENNA COIL

All tubes may be left out of their sockets.

All battery leads should be disconnected.

The filament switch may be in the *OFF* position.

Tests a, b, c and d should be made in natural sequence.

Test 21a.—The voltmeter should read the *C* battery voltage. If the voltmeter does not read the *C* battery voltage the antenna coil is open (possibly at a point where it is connected to a terminal lug).

Test 21b.—The voltmeter should read the *C* battery voltage. If the voltmeter does not read the *C* battery voltage, that part of the antenna coil between the minus *F* terminal and terminal No. 1 is open.

Test 21c.—The voltmeter should read the *C* battery voltage. If the voltmeter does not read the *C* battery voltage, the lead between the minus *F* terminal of the antenna coil (radio frequency transformer No. 1) and the No. 112 Amperite is incomplete.

Test 21d.—The voltmeter should read the *C* battery voltage. If the voltmeter does not read the *C* battery voltage (1) The antenna coil is open or (2) The lead between terminal *G* of the antenna coil and terminal *G* of the first radio frequency tube socket is incomplete.

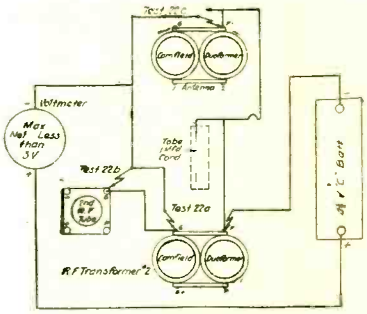
All leads mentioned are indicated in the diagram.

TESTS NOS. 22 A-B-C—R. F. TRANSFORMER

All tubes may be left out of their sockets.

All battery leads should be disconnected.

The filament switch may be in the *OFF* position.



Tests No's 22 a-b-c Continuity of Second Radio Frequency Transformer Secondary

Tests a, b and c should be made in natural sequence.

Test 22a.—The voltmeter should read the *C* battery voltage. If the voltmeter does not read the *C* battery voltage, the secondary of the second radio frequency transformer is open.

Test 22b.—The voltmeter should read the *C* battery voltage. If the voltmeter does not read the *C* battery voltage (1) The secondary of r. f. transformer No. 2 is open or (2) The lead from terminal *G* of r. f. transformer No. 2 to terminal *G* of the second radio frequency tube socket is incomplete.

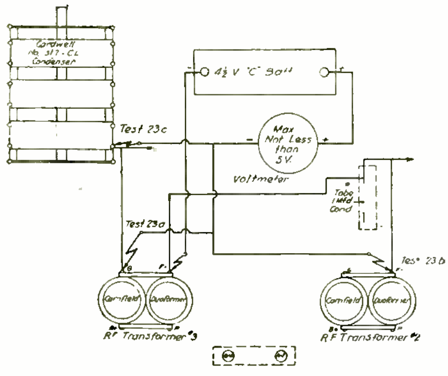
Test 22c.—The voltmeter should read the *C* battery voltage. If the voltmeter does not read the *C* battery voltage, the lead from the minus *F* terminal of r. f. transformer No. 2 to the minus *F* terminal of the antenna coil is incomplete.

All leads mentioned have been indicated in the diagram.

TESTS NOS. 23 A-B-C—R. F. TRANSFORMER

All tubes may be left out of their sockets.

All battery leads should be disconnected.



TESTS No's 23 a-b-c
Continuity of Third Radio Frequency Transformer Secondary

The filament switch may be left in the *OFF* position.

Tests a, b and c should be made in natural sequence.

Test 23a.—The voltmeter should read the *C* battery voltage. If the voltmeter does not read the *C* battery voltage, the secondary of r. f. transformer No. 3 is open (possibly at a point where contact should be made with a terminal lug).

Test 23b.—The voltmeter should read the *C* battery voltage. If the voltmeter does not read the *C* battery voltage, the lead from the minus *F* terminal of r. f. transformer No. 3 to the minus *F* terminal of r. f. transformer No. 2 is incomplete.

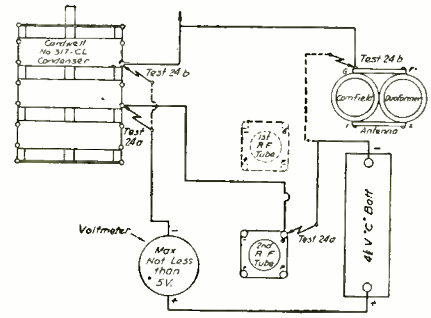
Test 23c.—The voltmeter should read the *C* battery voltage. If the voltmeter does not read the *C* battery voltage (1) The secondary of r. f. transformer No. 3 is open or (2) The lead from terminal *G* of r. f. transformer No. 3 to the rear stator section of the gang condenser is incomplete.

All leads mentioned are indicated in the diagram.

TESTS NOS. 24 A-B—GRID CIRCUIT

All tubes may be left out of their sockets.

All battery leads should be disconnected.



TESTS No's 24 a-b
Continuity Radio Frequency Grid Circuits.

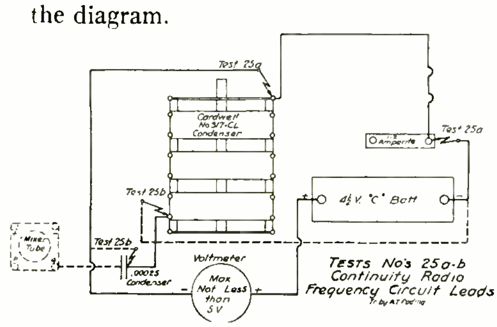
The filament switch may be in the *OFF* position.

Tests a and b should be made in natural sequence, that is, the test terminals should first be connected across points 24a and then across points 24b.

Test 24a.—The voltmeter should read the *C* battery voltage. If the voltmeter does not read the *C* battery voltage, the lead from terminal *G* of the second radio frequency tube socket to the center stator section of the gang condenser is incomplete.

Test 24b.—The voltmeter should read the *C* battery voltage. If the voltmeter does not read the *C* battery voltage, the lead from terminal *G* of the antenna coil to the front stator section of the gang condenser is incomplete.

All leads mentioned are indicated in the diagram.



TESTS No's 25a-b
Continuity Radio Frequency Circuit Leads

TESTS NOS. 25 A-B—R. F. LEADS

All tubes may be left out of their sockets.

All battery leads should be disconnected.

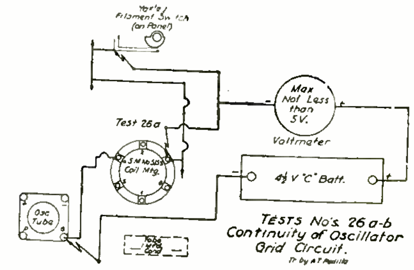
The filament switch may be in the *OFF* position.

Tests a and b should be made in natural sequence, that is, the test terminals should first be connected across points 25a and then across points 25b.

Test 25a.—The voltmeter should read the *C* battery voltage. If not, the lead from the No. 112 Amperite to the gang condenser rotor is incomplete.

Test 25b.—The voltmeter should read the *C* battery voltage. If the voltmeter does not read the *C* battery voltage, the lead from the rear stator section of the gang condenser to the mixer tube grid condenser is incomplete.

All leads mentioned are indicated in the diagram.



TESTS No's 26 a-b
Continuity of Oscillator Grid Circuit.

TESTS NOS. 26 A-B—GRID CIRCUIT

All tubes may be left out of their sockets.

All battery leads should be disconnected.

The filament switch may be in the *OFF* position.

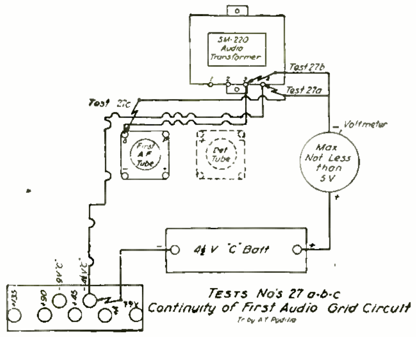
Tests a and b should be made in natural sequence.

Test 26a.—The voltmeter should read the *C* battery voltage. If not, (1) The lead from terminal *G* of the oscillator tube socket to terminal No. 4 of the tapped inductance is incomplete or (2)

Winding 3-4 of the tapped inductance is open.

Test 26b.—The voltmeter should read the *C* battery voltage. If the voltmeter does not read the *C* battery voltage, the lead from terminal No. 3 of the tapped inductance to the filament switch is incomplete.

All leads mentioned are indicated in the diagram.



TESTS NOS. 27 A-B-C—GRID CIRCUIT

All tubes may be left out of their sockets.

All battery leads should be disconnected.

The filament switch may be in the *OFF* position.

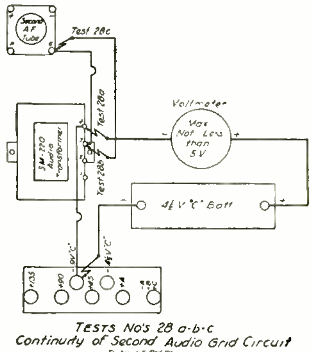
Tests a, b and c should be made in natural sequence.

Test 27a.—The voltmeter should read the *C* battery voltage. If the voltmeter does not read the *C* battery voltage, the lead from the minus 4½ volt *C* battery binding post to terminal No. 4 of the first audio transformer is incomplete.

Test 27b.—The voltmeter should read the *C* battery voltage less the voltage drop due to the flow of the voltmeter current through the first audio transformer secondary. If the voltmeter does not read the correct voltage, the secondary of the first audio transformer is open.

Test 27c.—The voltmeter should read the *C* battery voltage less the voltage drop due to the flow of the voltmeter current through the first audio transformer secondary. If the voltmeter does not read the correct voltage, the lead from terminal No. 3 of the first audio transformer to terminal *G* of the first audio tube socket is incomplete.

All leads mentioned are indicated in the diagram.



TESTS NOS. 28 A-B-C—GRID CIRCUIT

All tubes may be left out of their sockets.

All battery leads should be disconnected.

The filament switch should be in the *OFF* position.

Tests a, b and c should be made in natural sequence.

Test 28a—The voltmeter should read the *C* battery voltage. If the voltmeter does not read the *C* battery voltage, the lead from the minus 9 volt *C* battery binding post to terminal No. 4 of the second audio transformer is incomplete.

Test 28b.—The voltmeter should read the *C* battery voltage less the voltage drop due to the flow of the voltmeter current through the second audio transformer secondary. If the voltmeter does not read the correct voltage, the second audio transformer secondary is open.

Test 28c.—The voltmeter should read the *C* battery voltage less the voltage drop due to the flow of the voltmeter current through the second audio transformer secondary. If the voltmeter does not read the correct voltage, the lead from terminal No. 3 of the second audio transformer to terminal *G* of the second audio tube socket is incomplete.

The foregoing tests do not offer a check on the continuity of several short leads. These are listed below and can be checked without the aid of any supplementary apparatus.

(a) The lead from terminal No. 4 of the tapped inductance to one side of the oscillator tuning condenser.

(b) The lead from the plate terminal of the oscillator tube socket to one side of the .0005 mfd. fixed condenser in series with the oscillator tuning condenser.

(c) The lead from the output side of the filament switch to the grounding lug on the oscillator condenser.

(e) Trimmer condenser leads. Note: The rotors of the trimmer condensers should be connected to the rotor of the gang condenser.

(f) Voltmeter connections.

(g) The lead from terminal No. 3 of the tapped inductance to one side of the 1 mfd. by-pass condenser which is located in front of the Infradyne Amplifier.

(h) The lead from the mixer tube grid condenser to the grid terminal of the mixer tube socket.

(i) Leads from the mixer tube grid leak mounting to the plus *F* and *G* terminals of the mixer tube socket.

(j) The lead from the "Grid" binding post of the Infradyne Amplifier to the detector grid condenser.

All condensers should be examined to make sure that they are not short-circuited or leaky, or that they are not seriously off rated capacity when they are used in positions such that their accuracy is of importance. The fixed condensers used in the Infradyne include (1) Two grid condensers of .00025 mfd. capacity each (2) One .0005 mfd. condenser in series with the oscillator tuning condenser; the accuracy of this condenser is of importance (3) One .001 mfd. condenser connected between the Infradyne Amplifier "Plate" binding post and terminal No. 2 of the tapped inductance. (4) One .0001 mfd. condenser connected in series with the antenna. (5) Two 1 mfd. by-pass condensers.

If volume should be lacking in the receiver a check should also be made on the trimmer condensers to be sure that no leakage is occurring in them; such leakage would be particularly apt to occur if excessive amounts of soldering flux had been used.

Noisy operation is sometimes caused by defective grid leaks. If such trouble is experienced, therefore, this source should be investigated.

INFRADYNE OPERATION FROM SOCKET POWER

B eliminators can be most successfully used with the Infradyne. They are particularly desirable when a CX-371 or UX-171 tube is to be used in the last audio stage. As the Infradyne employs 10 tubes, the eliminator must be capable of supplying more current than one to be used with a smaller set of say 5 or 6 tubes. The average maximum plate current required by the Infradyne will be approximately 35 milliamperes; under certain unusual conditions this may momentarily rise to as much as 40 milliamperes. Under normal operating conditions the plate current drain will be approximately 25 milliamperes. Most eliminators will be capable of delivering this output easily but in order to insure freedom from hum or so-called "motor boating" it is necessary that the eliminator be capable of delivering several times the maximum required current. An eliminator capable of delivering from 60 to 80 milliamperes at the required voltages will be found most satisfactory.

We will assume that an eliminator having binding posts labeled 45, 90, 130 and "power" is to be used. Certain precautions must be taken in order to insure freedom from instability due to slight variations in terminal voltage. With such an eliminator the Infradyne Amplifier and oscillator tubes would be supplied from the 130 volt section, as well as the first two radio frequency tubes and the first audio frequency tube. As the stability of the radio frequency stages of the Infradyne is controlled by means of a 200,000 ohm resistance inserted in series with the common plus *B* lead to the first two tubes, and as variation of the 200,000 ohm resistance results in variation in the plate voltage applied to the first two radio frequency tubes, and consequently in the current they require, changes in the voltage applied to the Infradyne Amplifier and oscillator tubes will occur at such times as 200,000 ohm resistance is adjusted. This situation arises from the fact that any variation in the current drain from an eliminator results in variation in its terminal voltages. As the Infradyne Amplifier is adjusted for best results at a fixed plate voltage any such variation in the plate voltage applied to its terminals is undesirable. For this reason special precautions must be taken to maintain the voltage constant. A CX-374 tube connected across the eliminator section supplying the Infradyne Amplifier, oscillator and radio frequency tubes has been tried and found entirely satisfactory. The CX-374 tube will be found to draw in the neighborhood of 20 milliamperes. This additional current drain must be taken into account in considering the eliminator capacity.

The current drain on an eliminator 90 volt section may prove so large that the terminal voltage of this section is dropped to too low a value. Should this be the case it will probably be possible to use the eliminator section having the next highest voltage rating. As an example of this case may be mentioned the General Radio Eliminator which makes use of a Raytheon BH tube. This eliminator has binding posts labelled 45, 90, 130 and "power." The Infradyne 90 volt binding post was connected to the eliminator 130 volt binding post. A CX-374 tube was connected between the eliminator 130 volt binding post and the eliminator minus *B* binding post. In this particular instance, a 12,000 ohm fixed resistance was connected between the eliminator "power" binding post and the negative binding post in order to further drop the voltage. Any resistance used for this purpose should have a current carrying capacity of about 30 or 40 milliamperes.

With the General Radio *B* eliminator mentioned above, the first two radio frequency tubes, the Infradyne Amplifier and oscillator tubes, and the first audio tube were all supplied from the eliminator 130 volt section. The voltage to the Infradyne Amplifier and oscillator was dropped by means of a variable high resistance mounted inside of the receiver. A Bradleyohm can, for instance, be used for this purpose. It should have a resistance of approximately 5,000 ohms at the center of its operating range. To prevent undesirable coupling this resistance should be by-passed with a condenser of not less than 1 mfd. capacity. The mixer and detector tubes were supplied from the eliminator 45 volt section. This eliminator section is designed to supply 1 tube only. The additional drain placed on it drops the voltage to approximately 25 volts, which is very close to the voltage desired.

With those eliminators having separate binding posts labelled for all the various voltages desired in the Infradyne the procedure outlined above will of course be unnecessary. Should such an eliminator be used it is recommended that a separate *B* battery lead be taken out for the mixer and detector tubes as well as for the Infradyne Amplifier and oscillator tubes. The CX-374 glow tube mentioned previously can again be used to decided advantage.

In order to obtain maximum results from a *B* eliminator a voltmeter suitable for measuring *B* eliminator output voltages should be available. This voltmeter should have a high resistance per volt so that the current required by it will not cause a drop in the eliminator terminal voltage. A voltmeter particularly suited to this purpose is the Weston model 489 which has a resistance of 1000 ohms per volt and which requires a negligible current for its operation.

OPERATION AS A FIVE TUBE RECEIVER

The preliminary testing of the Infradyne can be greatly simplified by testing the tuned radio frequency stages and the audio frequency amplifier without the Infradyne and oscillator being in the circuit. After the five tube radio tuned frequency set thus obtained has been made to function properly and smoothly the Infradyne amplifier and oscillator can be returned to the circuit and the complete Infradyne put into operation.

The Infradyne can be considered as a five tube, single dial control, tuned radio frequency set to which the Infradyne amplifier and frequency changing circuit have been added. It is obvious that the five tube set must function properly before maximum results can be obtained from the complete Infradyne.

Remove from their sockets the four '99 tubes and the detector tube (the detector tube is the tube located between the first S-M audio transformer and the Infradyne Amplifier). Remove the .05 megohm resistor from its holder. Run a jumper wire from the mixer tube plate side of the Remler No. 35 Choke Coil to the plate terminal of the detector socket (the plate terminal is the one marked "P"). The jumper wire need not be soldered but may be temporarily connected. Any insulated wire will serve. Care must be exercised to see that an uninsulated part of it does not come into contact with the copper can in which the Infradyne Amplifier is enclosed, as damage would result.

The antenna and ground should now be connected and the loud speaker plugged in. If possible use an antenna 70 or 80 feet long for this test.

The set is now ready for operation as a five tube receiver. Turn off the rheostat under the voltmeter and turn the mixer tube rheostat (at left hand end of the panel) nearly all the way on, that is, nearly to the position at which the mixer tube filament becomes brightest. Set the Silver-Marshall trimmer inside of the set so that the plates are from 1/8 to 1/2 fully meshed. Turn the volume control (Frost 200,000 ohm resistance) about 3/4 of the way on. Now rotate the left hand gang condenser dial slowly to tune in a local station.

If a series of tweets, or "birdies," is heard as the gang condenser dial is rotated it is an indication that the radio frequency stages are oscillating. This oscillation can be stopped by turning the volume control back; that is, by reducing the plate voltage applied to the radio frequency tubes. For maximum selectivity and sensitiveness, the volume control should, for any setting of the gang condenser dial, be turned to the point just below that at which oscillation occurs.

When a local station has been tuned in, set the volume control to the point just below that at which oscillation occurs. Note the settings of the panel trimmer condensers. Now vary the settings of the panel trimmers slightly and then turn the gang condenser dial backward and forward past the point at which it was set. Is there a "birdie" as the station setting is passed? If there is, the radio frequency circuits have been tuned more nearly to resonance by adjustment of the trimmers and have gone into oscillation. If this has occurred, turn the volume control back to the point just below that at which oscillation takes place. Remember that oscillation will be evidenced by "birdies" as the gang condenser dial is rotated.

Now note the new settings of the panel trimmer condensers. Repeat the above procedure until settings of the panel trimmer condensers are found such that their further adjustment does not throw the radio frequency stages into oscillation. When these settings of the panel trimmer condensers have been found readjust the gang condenser dial for maximum volume from the local station. If the gang condenser sections are uniform the panel trimmer condensers should need but little adjustment in tuning from the low to the high broadcast wavelengths.

All three radio frequency stages are now assumed to be in resonance, that is, to respond to the same frequency or wavelength. *This is the condition for maximum* selectivity and sensitiveness. As the gang condenser dial is rotated past the setting for a station the station should tune in and out sharply (remember that the volume control must be set at the point just below that at which oscillation occurs; the farther it is from this point the broader the tuning will be). If the approach to the station is rather broad, the trimmer condensers and volume control should be more accurately adjusted in accordance with the procedure outlined above.

If the radio frequency stages have been properly constructed and adjusted it should be possible to bring them into oscillation at any wavelength in the broadcast band. If construction has been poor or if the circuits have not been properly tuned to resonance it will not be possible to bring them into oscillation at the longer broadcast wavelengths; the result will be lack of selectivity and volume at these wavelengths.

Log stations over the entire wavelength band if possible. The dial settings for these stations will be useful when the complete Infradyne is to be put into operation.

It is well worth while to operate the five tube tuned radio frequency part of the set for a few days before connecting up the complete Infradyne. Be sure that this part of the set is functioning perfectly and that a certain amount of familiarity with it has been gained before the change is made.

If trouble is experienced in getting the tuned radio frequency part of the Infradyne to operate as it should, make the tests previously outlined. If the tuned radio frequency receiver is functioning properly, return the Infradyne Amplifier and frequency changer to the circuit as follows:

Remove the temporary jumper connected between the Remler No. 35 Choke Coil and the plate terminal of the detector tube socket. Return the .05 megohm resistor to its holder. Put all of the tubes into their respective sockets. Turn the center panel rheostat on and adjust it until the voltmeter indicates 3 volts. The antenna, ground, and loud speaker are, of course, to be left connected as before.

Set the oscillator dial as follows: (Note: these directions apply only when a Remler .00035 mfd. Condenser and a National Type B, CCW Dial have been used with a Silver-Marshall No. 110-B Coil.)

Turn the oscillator condenser to the wide open position, that is, set it for minimum capacity. With the condenser in this position turn the dial to 150 and fasten it securely to the condenser shaft by means of the set screw.

Now turn the Cardwell gang condenser dial to about 30, being sure that the trimmers are correctly adjusted in accordance with the above instructions, and turn the volume control all the way on. This should throw the radio frequency stages into oscillation although nothing may be heard unless the Cardwell condenser happens to be adjusted for a local station which is transmitting. If this should be the case, shift the dial a little. Slowly turn the oscillator dial over the entire scale. At six or seven points on the oscillator dial squeals or "birdies" should be heard. These squeals are caused by heterodyning between the oscillator fundamentals and harmonics and the fundamental and harmonics of the oscillating radio frequency stages. If the squeals are not heard as described, two things are possible (1) the radio frequency stages are not oscillating or (2) the oscillator is not functioning. Momentarily make the change to the five tube hook-up to see if the radio frequency stages are oscillating. If they are, return the Infradyne Amplifier to the circuit again without changing the positions of the trimmers or volume control. If the difficulty is due to failure of the oscillator to function try another tube, or make sure that the one used is in good condition, and make circuit tests Nos. 7, 15, 16, and 26.

Having caused the oscillator to operate properly turn down the volume control until the radio frequency stages are no longer oscillating. We are now ready to adjust the Infradyne Amplifier tuning controls and "Increase" screw. Using the wooden wedge furnished with the Infradyne Amplifier, set the four Amplifier tuning controls to zero and turn the "Increase" screw about two-thirds of the way out. Set the oscillator condenser for minimum capacity and then slowly rotate the oscillator dial in the *decrease* direction (decreasing according to dial numbers but increasing according to capacity.) When the dial has been turned through about 50 degrees (so that it reads about 100) a point will be found at which a sound will come out of the speaker. It will sound as if the condenser might be short-circuiting or scraping or it may make the speaker howl. This sound will be spread over perhaps four or five degrees. This setting of the oscillator dial is that at which the oscillator frequency equals that of the Infradyne Amplifier. It may be used as a guide to the right oscillator settings for use in operating the receiver because the setting for 545 meters will fall about 20 or 25 degrees lower on the dial (say at 75 or 80).

The following is a typical log of the Infradyne oscillator condenser. In obtaining data for this table a Silver-Marshall No. 110-B Coil was used as an oscillator coupler. (The No. 110-B Coil wound with enameled wire must be used; the earlier model of this coil, which was wound with silk-covered wire, will not be satisfactory.) The fixed condenser in series with the .00035 mfd. Remler tuning condenser was of exactly .0005 mfd. capacity. The oscillator settings may vary 10 degrees or more, depending upon the accuracy of this fixed condenser.

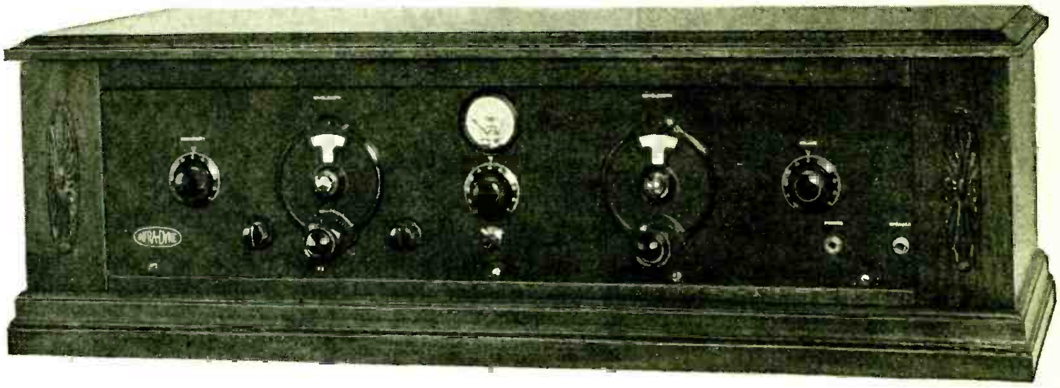
Dial Setting	*Wavelength*
30	225
38	250
53	300
69	400
80	500
105	"Interference Point."

Using this table and the settings previously obtained for the gang condenser dial tune in a local station. Don't forget to turn up the volume control, not so that oscillations occur, but a little before that point. If everything is in good condition it should be possible to tune some one in easily. Adjust the trimmers and then turn down the volume control until the station is just comfortably audible. The Infradyne Amplifier tuning controls can now be adjusted more accurately. With the Infradyne Amplifier so placed that the "Increase" screw is away from you consider the tuning knobs, reading from the left, as numbers one, two, three and four.

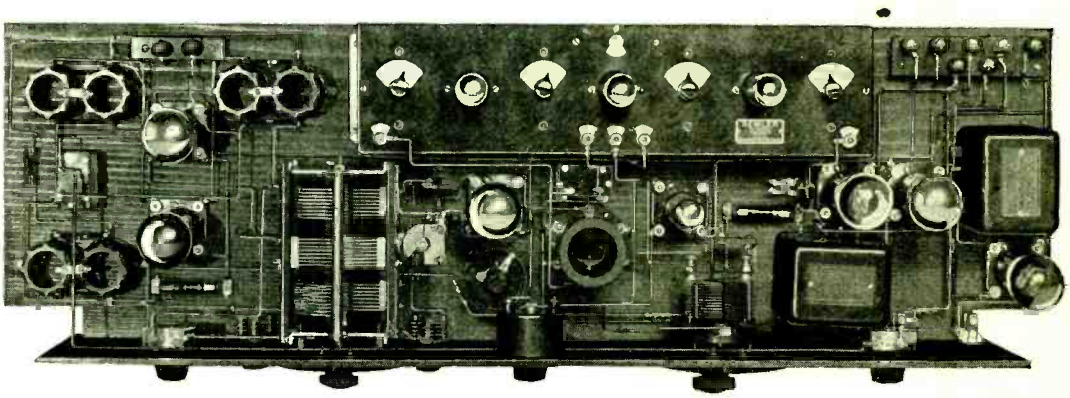
Leaving knob number two set at zero adjust knob number three for maximum signal strength while slowly rotating the oscillator dial backward and forward over a few degrees. Next set knob number one for maximum signal strength while rotating the oscillator dial backward and forward slowly as before. Having adjusted knobs one, two and three, it remains only to find the correct setting for knob number four. While adjusting knob number four the oscillator dial should be slowly turned backward and forward as in the preceding cases. Knob number four will be found to tune quite broadly.

Now tune in a station at least 500 miles distant and check the settings of all four knobs. The circuit controlled by knob number two will determine the intermediate frequency to be used and the Amplifier circuits should be adjusted with knob number two set at zero. Use the wooden wedge furnished with the Amplifier in making all adjustments.

If adjustment of the Infradyne Amplifier tuning controls throws the Amplifier into oscillation, this oscillation can be stopped by turning "Increase" screw outward. In order that the proper setting of the "Increase" screw may be found, the four Infradyne Amplifier tuning controls must first have been correctly set. It is assumed that final adjustment of the Amplifier tuning controls has been made on a station at least 500 miles distant. While this station is being received, with the right hand turn the oscillator dial several times back and forth across the station setting and note the volume. Continue to do this and with the left hand slowly turn down the "Increase" screw. The volume should become greater as the "Increase" screw is turned down and the character of the oscillator dial "crossing" should gradually change from a rather broad, weak cross to a louder, sharp "zip" as the amplification comes up to a peak. DO NOT USE PLIERS TO TURN THE "INCREASE" SCREW. USE THE FINGERS ONLY.



Front View of Infradyne in Decorative Cabinet.



Looking Down on the Completely Wired Receiver.

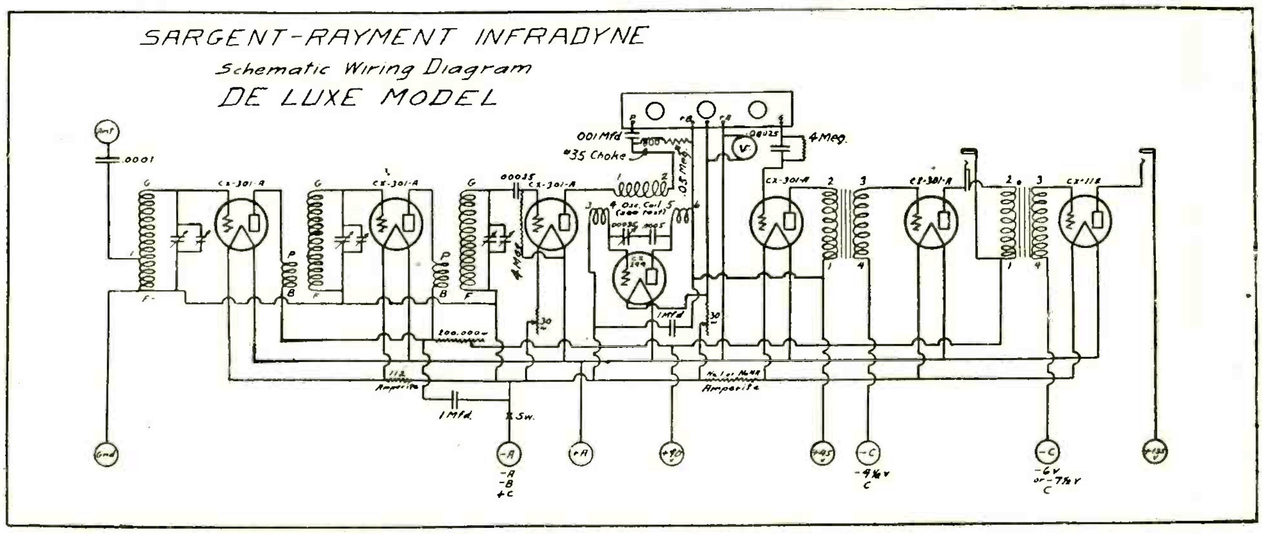
When the "Increase" screw has been turned down far enough the Amplifier should break into oscillation. When this happens, loosen the "Increase" screw until the oscillation ceases; it may then be left alone.

If turning the "Increase" screw down will not bring the Amplifier up to the point of oscillation, test your tubes. If they are not good the Amplifier will not oscillate. Also be sure that the right *B* battery voltage has been applied to the Amplifier. Everything else being in good shape, if the Amplifier will not come up to the point of oscillation the following procedure can be followed:

Disconnect from the Infradyne Amplifier plus *B* binding post the wire to terminal No. 6 of the tapped inductance. Connect a 10 ohm bakelite base rheostat in series with the wire that has been disconnected and the Amplifier plus *B* binding post. This rheostat must be mounted by means of a bracket directly on the Amplifier plus *B* binding post. The insertion of this rheostat is very desirable in many cases. With the filaments at three volts it will probably be found that the inclusion of only a few turns of the rheostat will bring the Amplifier up to the peak of amplification. The rheostat and "Increase" screw should be used in conjunction and adjusted for best results.

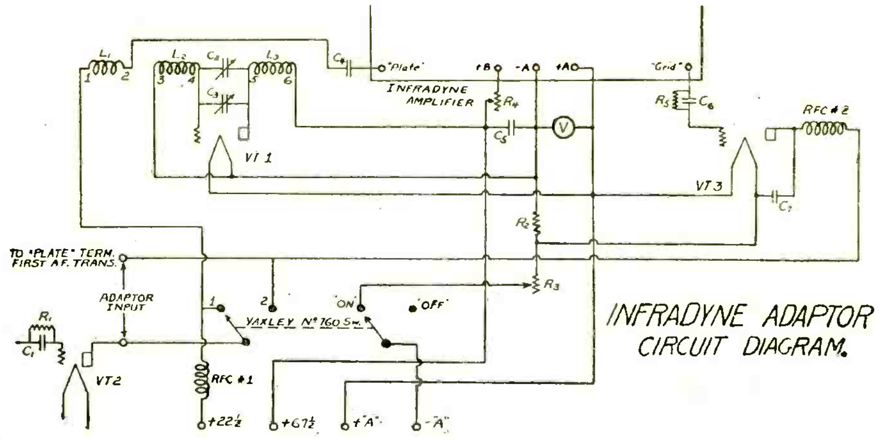
The more nearly the Infradyne Amplifier has been brought up to the peak of amplification through correct adjustment of the "Increase" screw (or of the "Increase" screw and the 10 ohm rheostat) the sharper the Amplifier circuits will tune.

The correct position for the 10 ohm rheostat in series with the Amplifier plus *B* lead is indicated by a small cross in the pictorial wiring diagram.



Schematic Wiring Diagram of the Improved Infradyne

INFRADYNE ADAPTOR CIRCUIT DIAGRAM



VT 1	Oscillator Tube—CX 299 (UX 199).
VT 2	Mixer Tube—CX 300A (UX 200A) or CX 301A (UX 201A).
VT 3	Detector Tube—CX 301A (UX 201A).
R_1	Grid Leak—4 or 5 megohms.
R_2	Fixed Resistance—8 ohms (Yaxley No. 808).
R_3	Rheostat—10 ohm, panel mounting.
R_4	Rheostat—10 ohm, bakelite base.
R_5	Grid Leak—4 megohm.
C_1	Fixed Condenser—.00025 mfd.
C_2	Remler Twin Rotor Condenser—Type 659 of .0001 mfd. capacity (set for low minimum).
C_3	X-L Vario Denser Model G-1 (see special directions below for adjustment).
C_4	Fixed Condenser—.001 mfd.
C_5	By-Pass Condenser—1 mfd.
C_6	Fixed Condenser—.00025 mfd. (with grid leak clips).
C_7	Fixed Condenser—.00025 mfd.
RFC #1	Radio Frequency Choke—Remler No. 35.
RFC #2	Radio Frequency Choke—Remler No. 35.
L_1, L_2, L_3	Windings of tapped inductance wound with #24 dsc. wire on 1½-inch diameter. Spacing between pick-up and grid coils is 3/16 inch and spacing between grid and plate coils is 1/16 inch. See page 14 of Infradyne Manual, October 1, 1926 Edition, for order of terminals.
L_1	Pick-up Coil of Tapped Inductance (8 turns).
L_2	Grid Coil of Tapped Inductance (14 turns).
L_3	Plate Coil of Tapped Inductance (14 turns).
V	Voltmeter (0-5 volt range).

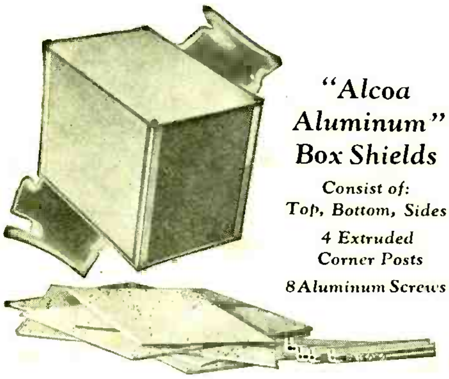
Directions for Adjusting the X-L Vario Denser.—The X-L Vario Denser should be adjusted so that the oscillator dial will read zero for the lowest wavelength station to be received (200 meters). The gang condenser should therefore be set for 200 meters, the oscillator condenser set at maximum capacity (plates fully meshed), and the oscillator dial set at zero. The X-L Vario Denser capacity should then be increased from minimum, by turning the adjusting screw downward, until the 200 meter signal is brought in best. It is assumed that the Infradyne Amplifier circuits have been adjusted as described in Infradyne Bulletin No. 1.

If there is no 200 meter station within receiving range, set the gang condenser dial for a station on a wavelength as near 200 meters as possible. Arbitrarily set the oscillator dial at about five degrees and by varying the capacity of the Vario Denser as above, tune the station in with maximum volume. Now set the gang condenser dial for the highest wavelength station to be received and adjust the oscillator dial. If it is found that the highest wavelength station cannot be tuned in on the oscillator dial it is an indication that the X-L Vario Denser has been set for too high capacity. In this case the Vario Denser adjusting screw should be turned out slightly.

Parts Required But Not Indicated in Diagram

1 Remler Infradyne Amplifier.
2 "CX" Sockets—Remler No. 50.
1 Drum Dial—Remler No. 110.
1 Panel.
1 Yaxley Filament Switch No. 160.
6 Binding Posts (2 "Input," + A, — A, + 22½, + 67½).
1 Baseboard.

Box Shields
of
"ALCOA ALUMINUM"



"Alcoa Aluminum" Box Shields

Consist of:
Top, Bottom, Sides
4 Extruded Corner Posts
8 Aluminum Screws

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Manufacturers can obtain these shields made to their exact specifications or they can secure the necessary corner-post moulding and sheet to manufacture under their own supervision.

Those who use Aluminum have ample proof of its advantages. Insist on "Alcoa Aluminum," ask your dealer or write us.

"ALCOA ALUMINUM"
is furnished to manufacturers in the following forms:

- Sheet: for shields, chassis, variable condensers, cabinets.
- Panels finished in walnut and mahogany.
- Die and Sand Castings.
- Screw Machine Products.
- Foil for fixed condensers.
- High Purity Rods for rectifiers.
- Stamping, rod, wire, rivets.

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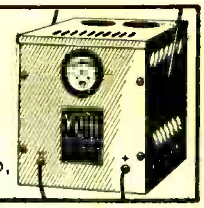
Valley Chargers



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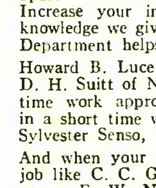

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