SEPTEMBER, 1925 25 CENTS

RADIO

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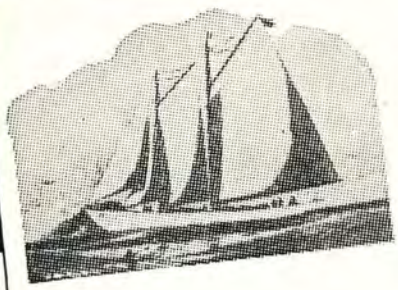

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Standard for all sets
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In that white and silent Northland with its glistening ice, driving blizzards and endless, relentless cold Cunningham Radio Tubes deliver the same efficient, well-rounded service that makes them valued so highly in the shelter of the American home.

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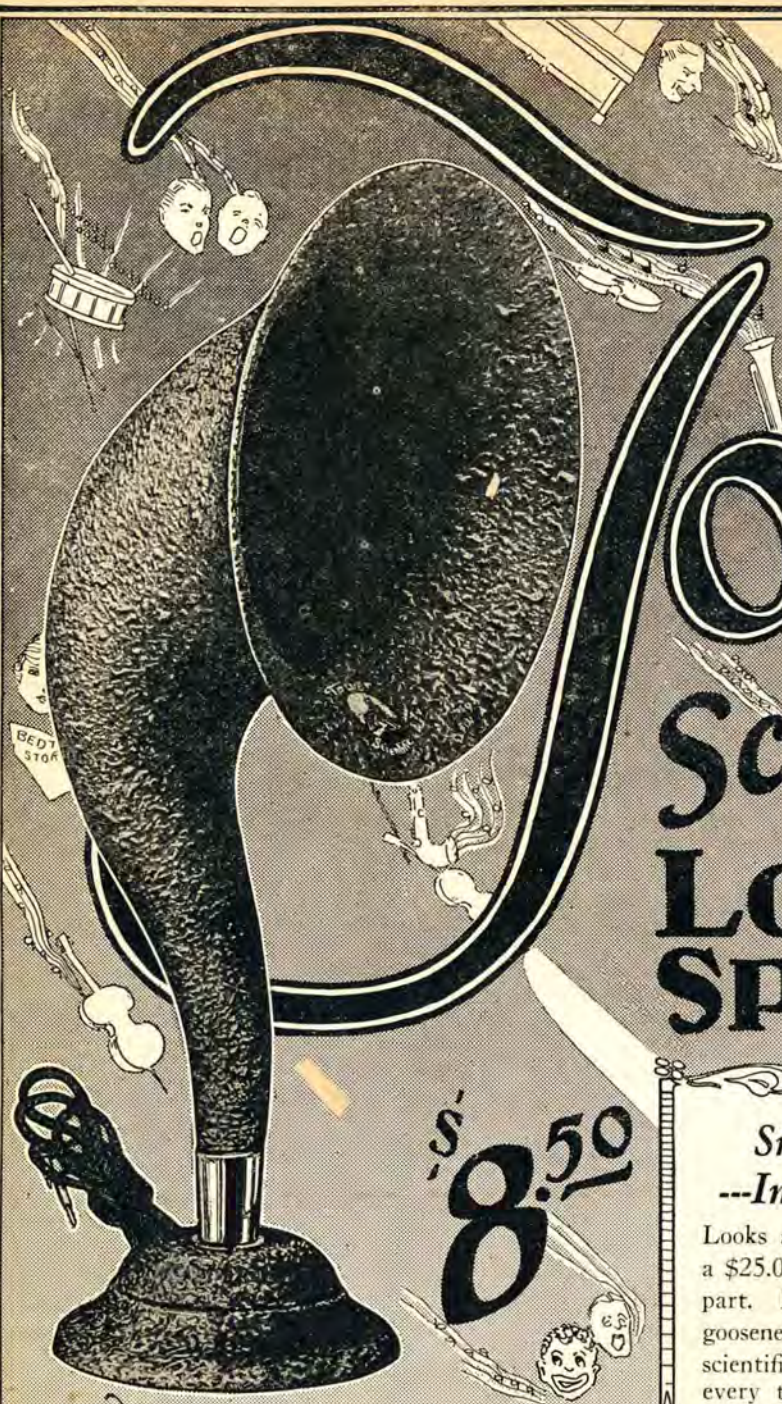

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Established 1917

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VOLUME VII SEPTEMBER, 1925 NUMBER 9

CONTENTS

Forecast of Contributions for October Issue

G. M. Best describes the construction of a new four-tube receiver having remarkable selectivity, sensitivity and tone quality. In another article he also tells how radio is used to help in detecting earthquakes.

Volney G. Mathison has written the real story of the radio compass under the title of "Piercing Neptune's Shroud." He not only explains how and why it works but he also brings realization of its wonderful value.

Every antenna owner will be greatly helped by reading Kirk B. Morcross' article "Check Up Your Antenna from Its Characteristics" wherein he shows the effect of resistance, inductance and capacity on radio reception.

R. Lewis Rockett has a good constructional article about an improved loop receiver using five tubes, three of which are radio frequency amplifiers and capable of being tuned below 200 meters as well as covering the radiocast band.

E. E. Griffin has built a detecting, oscillating and modulating radiocast wavemeter which may also be used as an efficient receiver. His account of its construction will enable others to do likewise.

M. K. Lock writes about "A Universal Meter for the Home Laboratory" and details the method whereby one meter can be used for many purposes.

D. B. McGown presents the practical data for the home construction of a quartz oscillator.

L. W. Hatry suggests the use of a loading coil as a means to de-tune an antenna and thus to reduce interference.

The fiction feature is "The Girl with the Madonna Voice," by H. P. Bridges, Jr.

Transmitting amateurs will be especially interested in "Heising and Grid Modulation Systems" by L. D. Grignon and F. C. Jones. The results of this clear-cut analysis show that grid modulation has many advantages over plate modulation of the carrier frequency. There will also be illustrated descriptions of several noteworthy amateur installations.

Dr. Maurice Buchbinder discusses various methods of eliminating oscillation in radio frequency amplifiers, pointing out the advantages and disadvantages of each method described.

Dr. John P. Minton follows up his article on the methods of loud speaker testing with a discussion of the limitations of commercial loud speakers of the small horn variety.

Carlos S. Mundt contributes a novel idea regarding a simple mast with a low center of gravity.

G. F. Lampkin tells "How Radio Circuits Work," analyzing the results shown by reactance diagrams.

NEW! *Radically different!*

No. 486 Eveready Layerbilt "B" Battery. 45 volts. Length, 8 3/16 inches. Width, 4 7/16 inches. Height, 7 3/16 inches. Weight, 14¼ pounds. Price, $5.50.

It's all battery. With every cubic inch packed to capacity, it contains about 30 per cent more electricity-producing material. All chance of loose or broken connections avoided by contact of full area of carbon plate against zinc plate. The scientifically correct construction.

The greatest improvement ever made in "B" Batteries

ABSOLUTELY new in construction—perfected through years of research, the new Eveready Layerbilt "B" Battery is as superior to the old type "B" Battery as a tube set is to a crystal.

Heretofore, all dry "B" Batteries have been made up of cylindrical cells —no one knew how to make them any other way. The new Eveready Layerbilt is made of *flat* layers of current-producing elements compressed one against another, so that every cubic inch inside the battery case is completely filled with electricity-producing material. Layer-building heightens efficiency by increasing the area of zinc plate and the quantity of active chemicals to which the plate is exposed.

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On 4-tube sets, 16 mil drain, it lasts 35% longer.
On 5-tube sets, 20 mil drain, it lasts 38% longer.
On 6-tube sets, 24 mil drain, it lasts 41% longer.
On 8-tube sets, 30 mil drain, it lasts 52% longer.

The new Layerbilt principle is such an enormous stride forward in radio battery economy that we will bring out new sizes and numbers in this Layerbilt form as fast as new machinery is installed. For the present, only the extra-large 45-volt size will be available.

Buy this new Eveready Layerbilt No. 486 for heavy drain service. It far exceeds the performance for which Eveready Radio Batteries always have been famous and is, we believe, by far the most economical source of "B" current obtainable.

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WEEI	Boston	WEAR	Cleveland		
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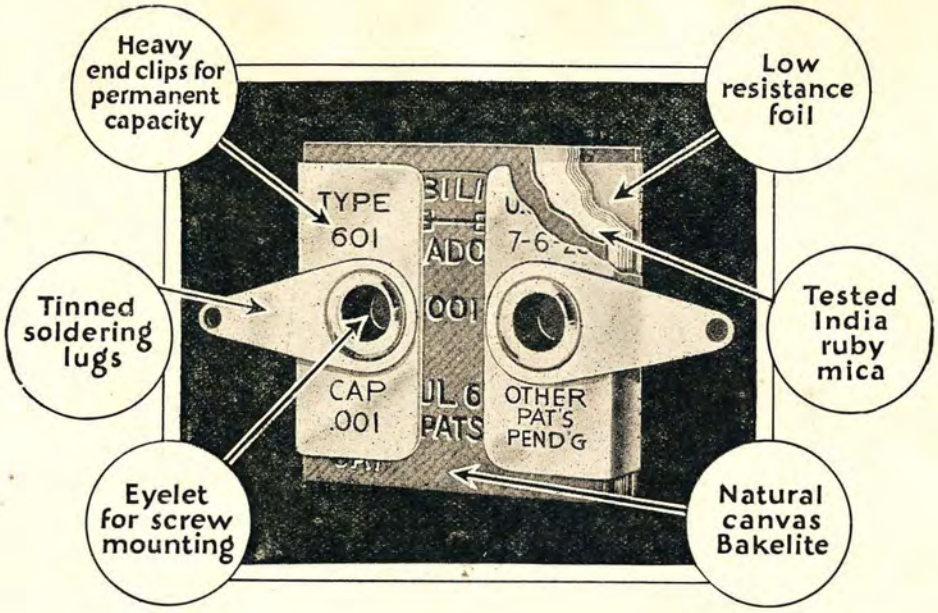
—they last longer



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This diagram indicates the efficient details of construction that have made Micadons the standard* fixed condensers of radio.

Dubilier engineers have developed these standard condensers of accurate and permanent capacity. Micadons are known the world over---and are used in 90% of all radio sets.

*Standard—*anything recognized as correct by common consent . . . of a high degree of excellence.—Webster*

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New and Improved
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But now - - -

Complete with built-in loud speaker of great volume and superb tone quality.

Encased in - - -

As fine a heavy genuine solid mahogany cabinet as ever graced any radio set.

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At sixty dollars - - -

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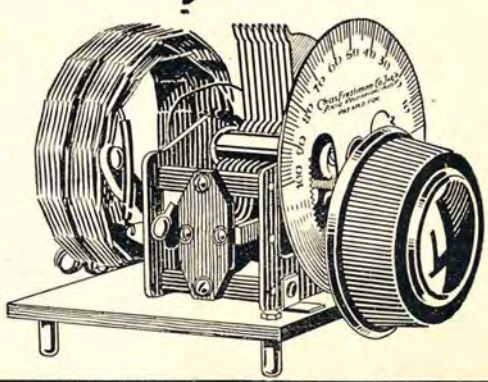
The new Freshman Masterpiece straightline wave length condenser with vernier attachment which assures hair-line selectivity—permitting you to tune in the station you want without interference over the entire wave length range. This is merely one exclusive feature of the

World's Greatest Radio Receiver

For sale at AUTHORIZED FRESHMAN dealers only



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MacMillan knew that Zenith—even one of the earlier models—would enable him to tune in stations all over the United States and Europe—even far-off Honolulu.

MacMillan knew that no other radio equipment would give him such extraordinary performance, such unfailing service.

When Arctic explorers of MacMillan's calibre stake their lives—repeatedly—on Zenith performance, one reason only can explain their choice—***Zenith has proved to be the best obtainable, at any price.***

Ask your nearest Zenith dealer for a demonstration.

Costs More—but Does More!

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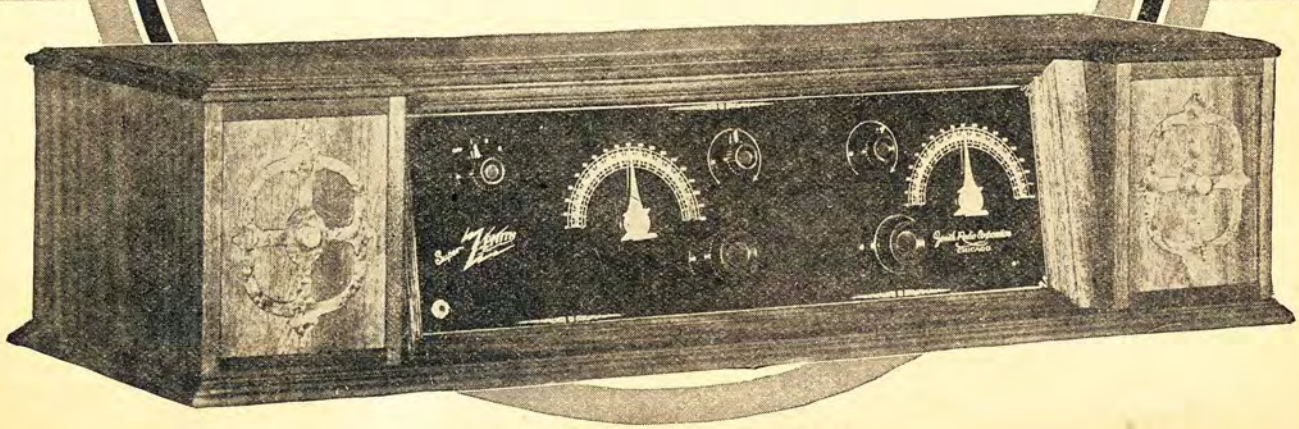

Prest-O-Lite

There are many improvements in the new Prest-O-Lite Battery

In this new battery you'll find all the good points and high quality that have made Prest-O-Lite an unfailing aid to better radio. And in addition there are many important refinements and improvements that make it the most attractive, most convenient battery you can buy.

This new battery has a beautiful stippled finish hard rubber case that blends with any furnishings. The case is molded in one piece, giving sturdy, leak-proof strength.

To make the battery convenient to carry, the handle has been given a comfortable rubber grip.

The oversize terminal nuts on the binding posts are easy to turn and insure perfect contacts.

Novel rubber insulators completely cover the tops and sides of the cell connectors, preserving the original fine finished appearance at all times and giving protection against accidental short circuits.

No effort has been spared to make this a battery you will be proud to own. Yet, like the rest of the Prest-O-Lite line, it is priced to offer you the biggest value of the day. Ask your dealer to show you this battery and the Prest-O-Lite Chart that helps you select the right battery for your set. Or write Indianapolis for a copy of our interesting handbook on radio storage batteries and how to charge them.

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KARAS HARMONIK

AUDIO FREQUENCY AMPLIFYING TRANSFORMER

These are the Audio Frequency Transformers used by Mr. Best in his wonderful, new hook-up published in this issue of Radio and recommended by him in his construction specifications.

The Triumph of a Masterpiece!

—A Marvel of Transformers that Brought *Real* Musical Quality to Radio Reception

JUST one year ago the Karas Harmonik Audio Frequency Transformer took the radio world by storm.

Nothing like it had ever been known before. For the first time, scientific study had been devoted to perfecting an audio transformer for the reception of broadcast music. The problem of amplifying high, low and medium frequencies to equal degree was finally solved. Bass notes were poured from the speaker in full strength and rich tone quality. The vital harmonics in rich overtones, formerly lost, were brought out in their full beauty by this marvel of audio transformers.

Music critics, who had always condemned radio music as false and distorted, approved the results of Karas Harmonik amplification with great enthusiasm. Prominent radio engineers subjected Karas Harmoniks to exhaustive laboratory tests—and pronounced it a technical masterpiece Technical editors who promoted the season's most successful hook-ups specified Karas Harmoniks in their circuits. The triumph of the Karas Harmonik was complete!

The Distinctive Qualities that Elevate Karas Harmonik Transformers to the Highest Pinnacle of Success in the Radio World.

1. Many thousands of turns of wire
2. Low ratio of turns
3. Extra large quantity of special formula iron in core
4. Controlled air gap
5. No core saturation
6. Minimum of Reluctance
7. Least Hysterisis and Eddy Current Loss
8. Low Distributed Capacity
9. Scientifically circular shielding preventing intercoupling of electrostatic and electromagnetic fields
10. Very High Primary Impedance
11. Extremely High Inductance
12. High and even Amplification of all Andio Frequencies.

But, for all of this, the enjoyment of Karas Harmonik amplification was too greatly confined to one class of radio enthasiasts. Home set builders bought Karas Harmoniks by the tens of thousands. They were free to pick and choose. *They* were most exacting in their demands for the newest and best developments.

It was the owners of factory-built sets who missed the delightful pleasure of real, true radio music in their homes. Set manufacturers were prevented by price from adopting Karas Harmoniks for their sets. So the ready-made set-buyer, unless he undertook to switch transformers, had to do without Karas Harmoniks.

Today there are in use, hundreds of thousands of sets—good sets—which could be vastly improved in musical quality by the simple operation of replacing the old transformers with Karas Harmoniks. Perhaps *you* own one of these sets. It may be all you desire from the standpoint of selectivity, of range, and other tuning qua ities. But, if it is not equipped with Karas Harmonik Audio Frequency Transformers, you are NOT getting *nearly* the musical quality you can just as well enjoy. Are you going to be content with anything short of the best?

You can install Karas Harmoniks yourself. It's a short, easy job. Or, any radio repair man can do it for you. Make up your mind to do it now—at once. Get a pair of Karas Harmoniks TODAY!

In large cities, most good dealers carry Karas Harmoniks—and in many small towns. If your dealer is out of them, order direct from us. Send no money. Just use the coupon below!

Karas Electric Co.,
4057 N. Rockwell St..
Chicago, Ill.

Karas Electric Co.,
4057 N. Rockwell St., Chicago, Ill.

Please send me_____pairs of Karas Harmonik Audio Frequency Transformers. I will pay the postman $7 apiece, plus postage. on delivery. It is understood that I am privileged to return the transformers any time within 30 days if they do not prove entirely satisfactory to me, and my money will be refunded at once.

*Name*_____

*Address*_____

RADIO

VOLUME VII SEPTEMBER, 1925 No.

Radiotorial Comment

WITH the probability of another radio conference to be called by Secretary Hoover at the end of the static season, there arise repeated rumors of radical changes in wavelength allocations. One of the most persistent of these rumors is that the amateurs are again to be crowded out of their upper band so as to make more room for the radiocasters. While no one can now accurately forecast the recommendations of the large group of radio men who may constitute the conference, there are certain fundamental facts which are significant of the improbability of this change being made this year.

In the first place, all except the "outs" are pretty well agreed that there are already enough stations on the air. Rather than increasing the number, the demand is for increasing the quality. Would it not be better to set certain standards to be met in return for the privilege of using a specified wavelength? Then when a station fails to meet the standards, another could be given its place if sufficient assurance is given that the newcomer will live up to them.

Although there is room for more stations between 150 and 200 meters than between 200 and 285, the present limit for Class A stations, there is every indication that the demand for this new space would as greatly exceed the supply as does the demand for the present wavelengths. Department of Commerce officials believe that a new rush of applications would follow the opening up of such a reservation and that within a short time the problem would be as bad as it now is with the more restricted band.

Finally, the matter of simple justice to the amateur requires that he not be deprived of this space. Like the Indian he has been continually crowded off his reservation, albeit making good use of what is left to him among the lower wavelengths.

But should these several considerations not suffice to prevent the opening up of a new band for radiocasting, there still need be no cause for alarm among the owners of the present types of receivers that will not tune to the lower wavelengths. In many cases the addition of a .0001 mfd. fixed condenser in series with the variable antenna condenser is all that is necessary. In other cases the coils may be tapped or enough turns removed to get down to 150 meters. So the radiocast listener, at least, need have no concern.

THE rapid growth of radio during the past four years has led many unthinking people to imagine that this modern miracle is revolutionary, both in its sudden growth and in its effects on our social life. But nothing can be further from the fact. Radio, like any other permanent advance, grew slowly for many years before it burst into bloom as nation-wide radiocasting, and its lasting effect upon our social habits and customs will be just as gradual. It is the result of evolution and not of revolution.

The main difference between evolution and revolution is a matter of time. Revolution attempts in a moment what evolution accomplishes in a generation or more.

For instance, the several stages in the development of the vacuum tube, the heart of the present day receiving and transmitting set, have been patiently accomplished during the past thirty years. The tube was practically perfected in its present form before there was any thought of radiocasting. And prior to that were years of endeavor in the development of the other electrical apparatus which makes radio possible today. In its entire history there has been no single spectacular invention that has suddenly upset the theory and practice of radio. Nor is there likely to be in the future.

Many people have been waiting for some revolutionary change in radio that will render all existing sets obsolete. But they are waiting in vain. Each year sees certain improvements, just as there are changes in automobiles, but the set of today will still be giving good service five years from now.

This tendency to wait for the revolution which will never materialize has been unwittedly fostered by the extravagant claims of some advertisers. The ideal which they set up, while impossible in the present state of the art, is accepted as the criterion in judging the performance of any set. But there is still many an improvement to be made before the perfect set will be even approximated. There will always be better sets coming, just as there will be better programs to be heard. But the present ones are well-worth while as an investment in the enjoyment of family life in the home.

Start of race at the Golden Gate, San Francisco.

Radio's Part in the Greatest Ocean Yacht Race

A Description of the Transmitting and Receiving Equipment Aboard the Yachts in the Tahiti Run

By D. B. McGown

ON June 10, 1925 there set sail from San Francisco four intrepid yachts, competing in the longest yacht race in history. These craft sailed, with the wind as their only motive power, for the port of Papeete, on the island of Tahiti, 3660 nautical miles from San Francisco. When it is remembered that the distance from New York to Liverpool is about 3000 nautical miles, it can be seen that this was a cruise of considerable magnitude, surpassing the feat of Columbus when he sailed from Spain to Watling's Island, these yachts being far smaller vessels than those of Columbus.

The yachts which entered the race were the IDALIA, ELOISE, MARINER and SHAWNEE, the race being won by the MARINER, which arrived at Papeete on July 1st, covering the distance in 20 days, 12 hours. The prize was a huge silver trophy offered by Sir Thomas Lipton. The venturesome spirit of those entering the race can best be appreciated by remembering that these ships were none of them over 60 feet long, or over 10 feet beam. To a landsman it would seem that such small craft would be unseaworthy in heavy weather, but as a matter of fact they are as safe as a large ocean liner and in many cases are more comfortable sea-boats, to anyone who is really a sailor.

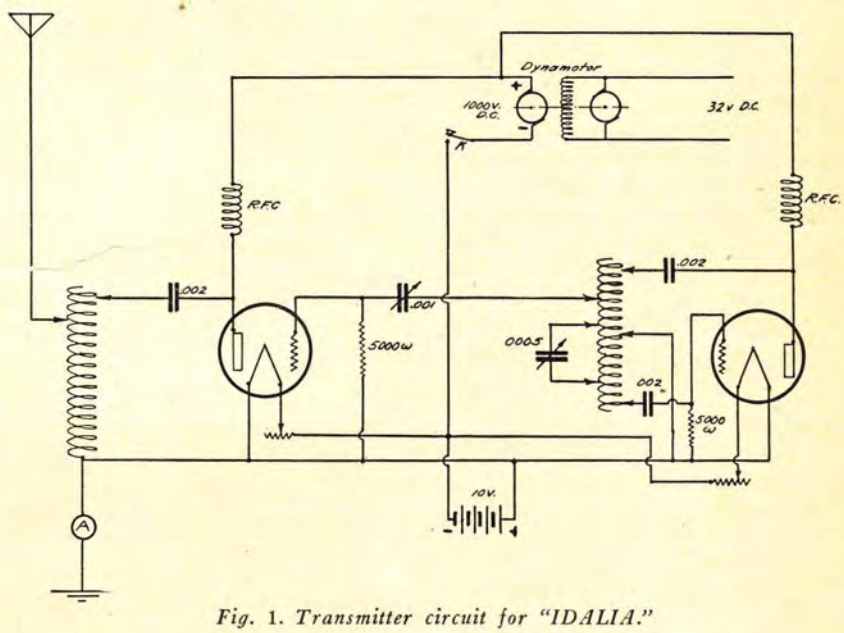
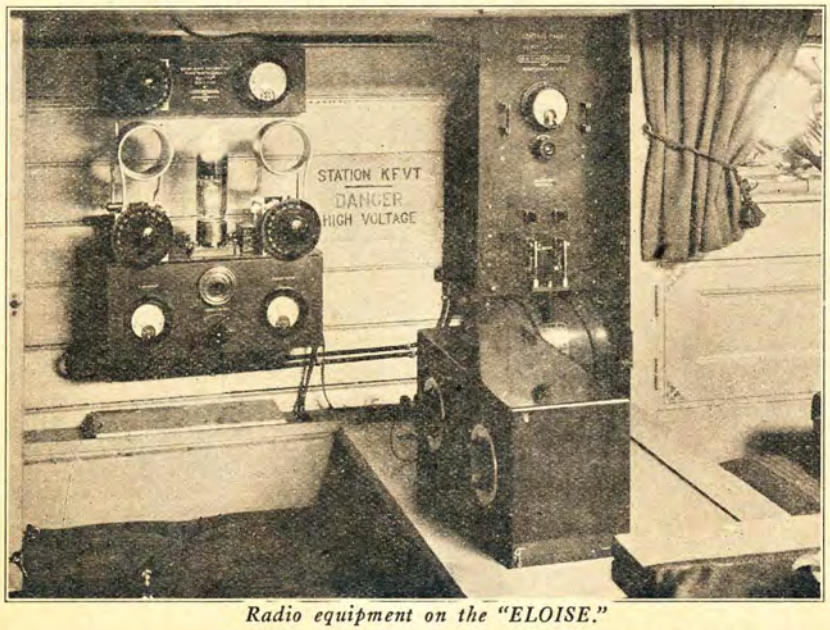


Fig. 1. Transmitter circuit for "IDALIA."



Radio equipment on the "ELOISE."

The IDALIA and ELOISE carried complete radio equipments on the trip, and since the use of radio on such boats is an innovation, the radio fraternity has been watching the race with more than usual interest. Space is at an extreme premium on such small vessels, both above and below decks, for every possible assistance is given to the spread of sails and consequent speed, and anything that would tend to interfere in the slightest with the speed of the vessel was forbid-

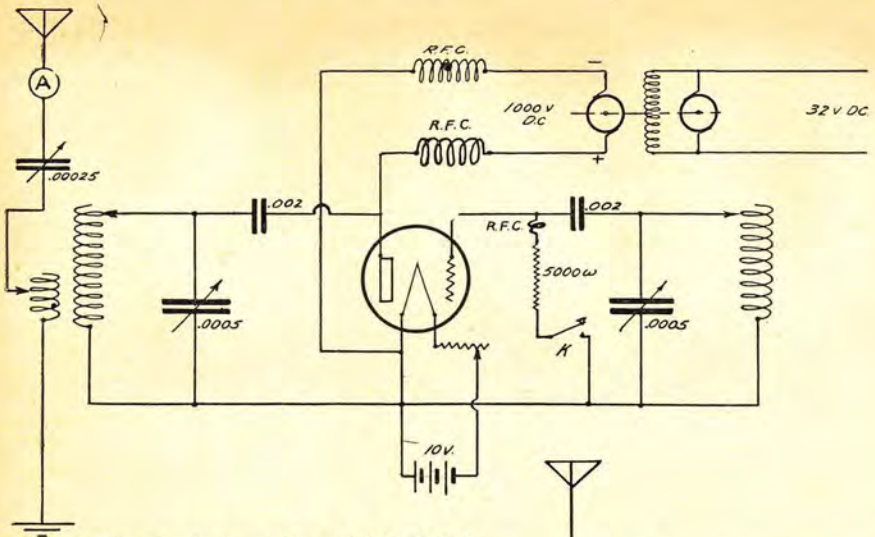


Fig. 2. Circuit of transmitter of "ELOISE."

den. Thus the construction of an elaborate antenna system was impossible and conditions necessitated crowding the apparatus into a tiny space below decks.

The accompanying pictures show the radio equipment on the IDALIA and the ELOISE and give a good idea of how compact it had to be, and the necessity for careful design. On the ELOISE, the apparatus is mounted in the main cabin, in a compartment built in the wall, and is so arranged that the entire apparatus may be concealed by folding up the panels, thus providing more room when the radio equipment is not in use. The receiving set and transmitting key are mounted on the hinged door, the transmitter being permanently mounted inside the cabinet. On the IDALIA, a slightly greater space was available and hence the apparatus could be mounted conveniently in a more accessible position.

The transmitter on the IDALIA, call KFVM, was designed and built by the ship's operator, Mr. Ray Newby, of San Jose, Calif. Mr. Newby is one of the oldest radio men on the Pacific Coast, having been employed in the radio business since 1907. The transmitter is of the "master oscillator-power amplifier" type, consisting of a 50 watt UV-203-A vacuum tube connected in a Hartley circuit, which energizes the grids of three similar type tubes which are connected in parallel. A schematic circuit diagram of the transmitter is shown in Fig. 1. As this equipment is to be used far away at sea, where no interference will be caused to nearby listeners, direct coupling was used, but it should be borne in mind that this circuit cannot be used for amateur work ashore, with the radio regulations as they are at the present time, as the latter require inductive coupling. The transmitter is mounted behind a plate glass panel, which affords good insulation and permits inspection of the apparatus at all times.

The power installation which is also used for lighting and auxiliary power, is identical on both vessels, consisting of a gasoline engine driving a 32 volt d. c. generator, which charges a set of lead storage batteries of 150 ampere hour capacity. A motor generator set operated from 32 volts d. c. provides 1000 volts d. c. for the plates of the tubes, the starting rheostat consisting of a number of heavy, cast resistance grids mounted behind the panel, and large enough to permit the full load current to pass through them without excessive heating. The rheostat switch is mounted on a leg of the table, and permits a voltage control from 500 to 1100 volts. The tube filaments are lighted from a separate 10 volt lead storage battery, the key being placed between the negative filament lead and the negative plate supply terminal. The receivers are mounted on the table to the right of the transmitter, one being a honeycomb coil regenerative set arranged to cover the waves from 150 meters up, and the other a special short wave receiver.

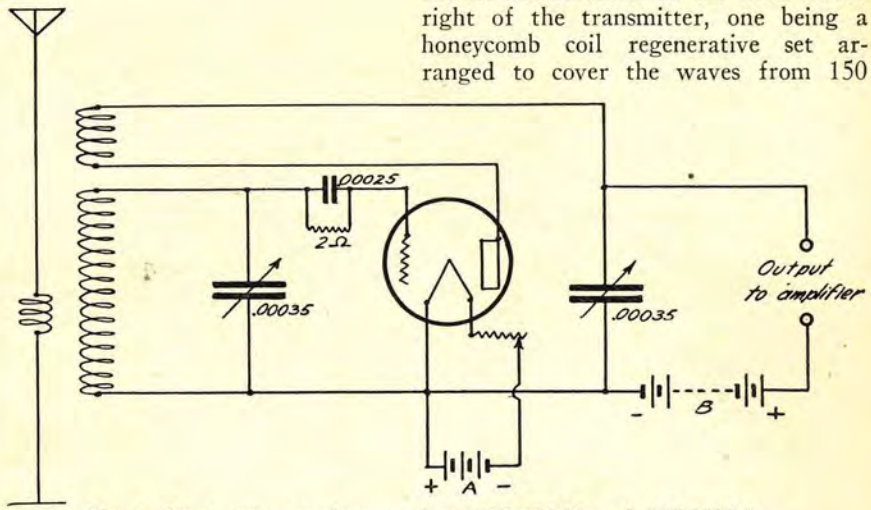
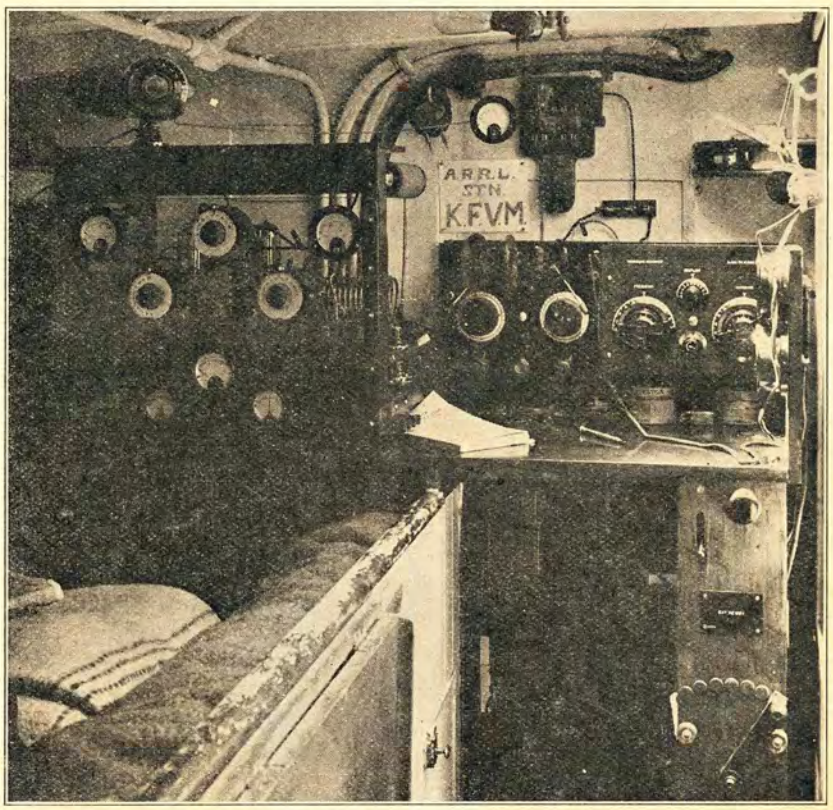


Fig. 3. Short wave receiver used on "IDALIA" and "ELOISE."

Besides the short wave tube transmit-

(*Continued on Page 68*)



Installation aboard the "IDALIA."

The Modified Best Superheterodyne

Part II--Baseboard Model

Complete Constructional Details for a New Eight-Tube Loop Model Covering the Range from 50 to 600 Meters

By Gerald M. Best

DUE to the greater ease of assembly and wiring, a baseboard model superheterodyne is more popular than the shielded, panel-mounted set described in August RADIO. The important modifications,—the improved oscillator system and the grid condenser and leak specified for the frequency changer—are incorporated in the new design, so that it is possible either to make these changes in sets constructed in accordance with previous directions, or build an entirely new set, as the reader prefers.

This is intended primarily as a loop receiver, although a separate antenna adapter may be added if desired. It requires only two tuning controls and with its two stages of audio frequency amplification, can be connected directly to the loud speaker.

The set has been designed to employ eight tubes, five of the C-301-A or UV-201-A type and three of the UV-199 or C-299 type, the latter being the most satisfactory intermediate frequency amplifiers where elaborate shielding is not used. Rheostats are minimized by the use of automatic filament cartridges. If it is desired to use large tubes throughout, it is better to use two intermediate stages, which will permit the omission of the voltmeter and 30 ohm filament rheostat necessary for the proper control of the small tubes.

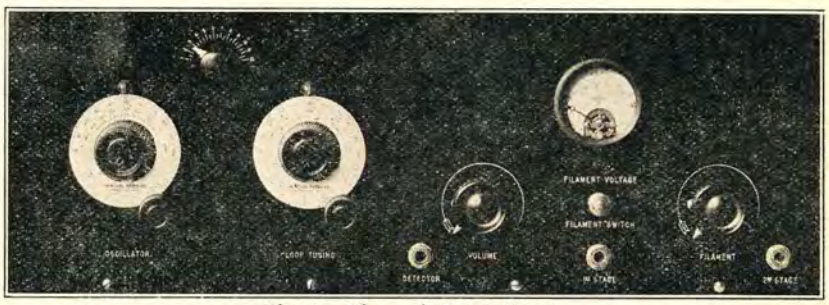


Fig. 1. View of Panel Front.

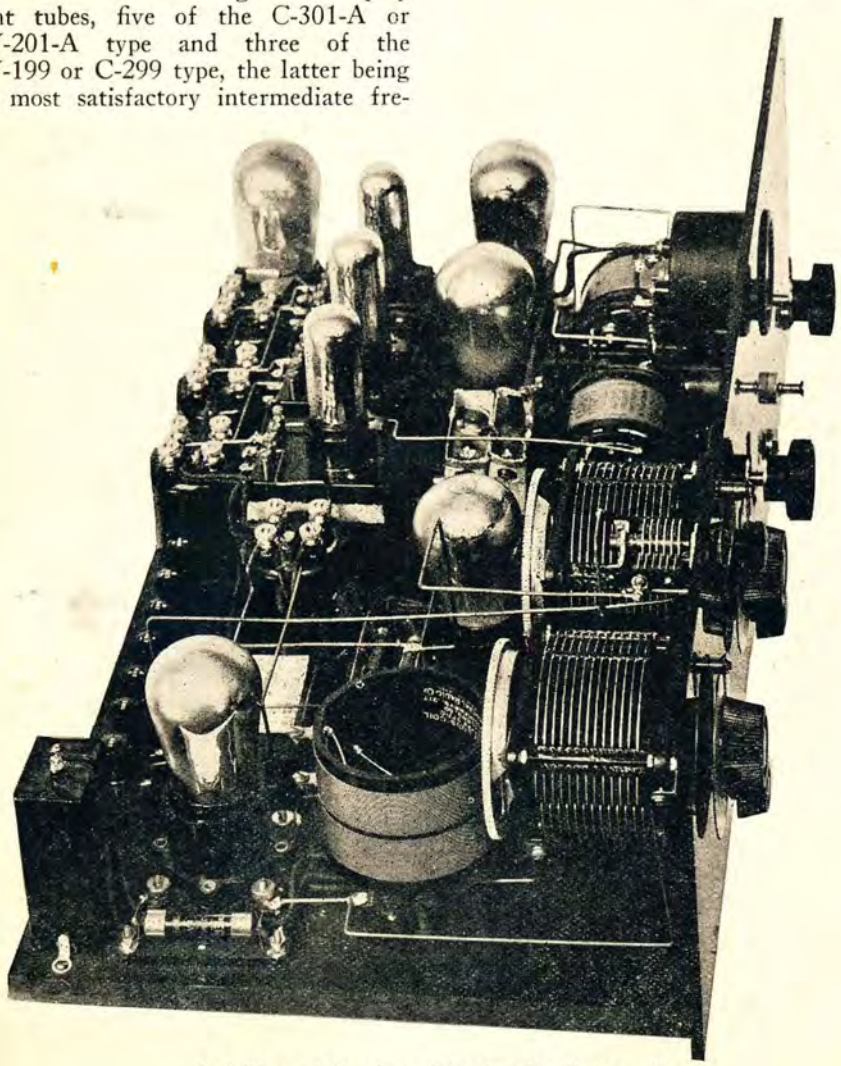
The general appearance of the panel is shown in Fig. 1, the oscillator and loop tuning condensers being at the left end with the feedback condenser mounted above them. To the right of the tuning controls are the volume control, filament rheostat and voltmeter, with the three output jacks arranged symmetrically below the rheostats, and the filament switch below the voltmeter.

Fig. 2 shows the drilling template for the panel. Many of the holes designated are for specific makes of apparatus, so that when the panel is ready for drilling, the templates generally furnished with each piece of apparatus should be used so as to make sure that the holes will be drilled in the right positions.

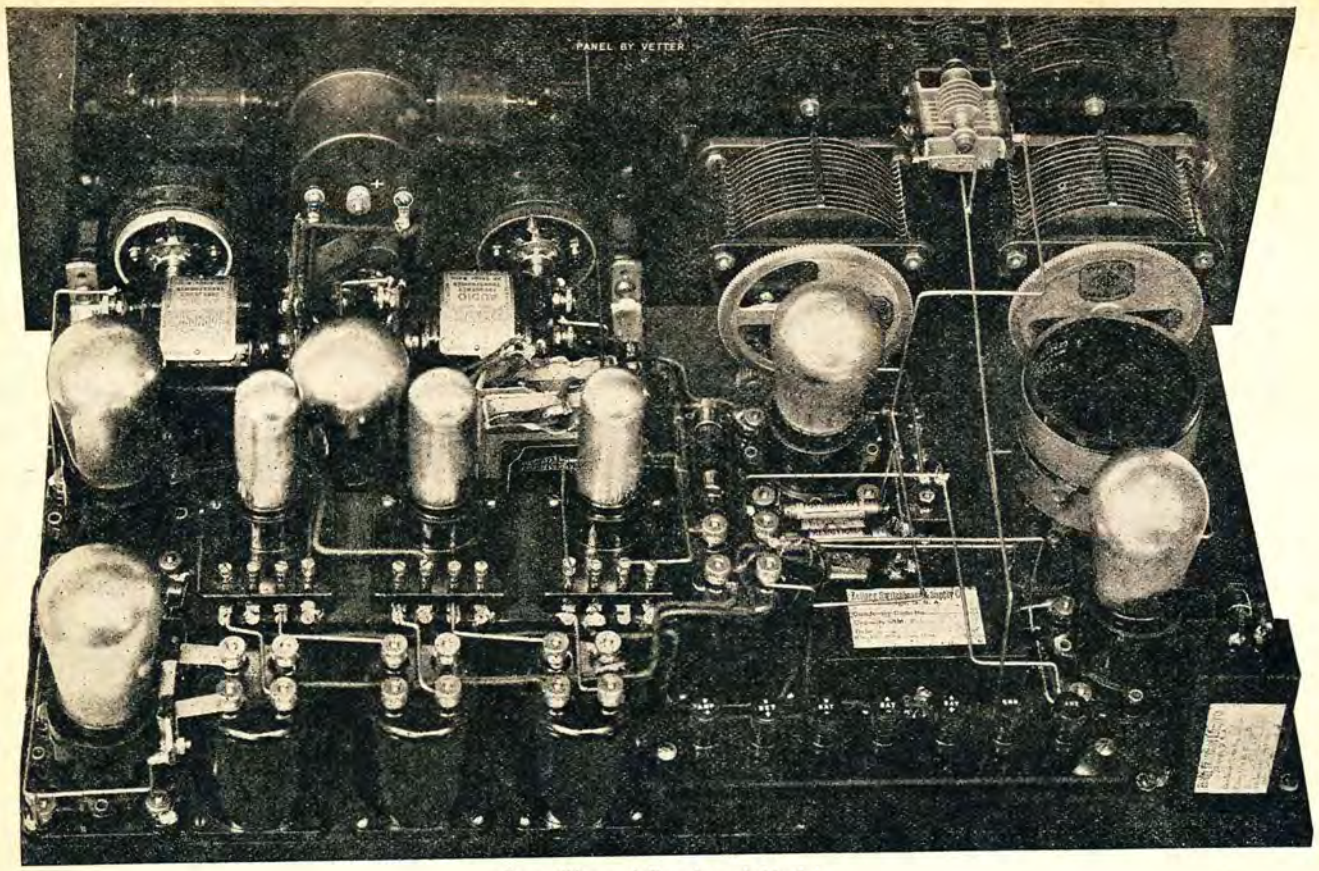
The illustrations show the appearance of the completed set, and will be of assistance in properly arranging the apparatus. The side view shows the method of mounting the oscillator coil, and the position of the frequency changer tube in back of the loop tuning condenser. In order to shorten the leads where possible, and simplify the work of wiring, the oscillator and frequency changer are mounted on the baseboard back of their respective panel controls, and while this does not lend to symmetry in the arrangement of the tubes, the increase in efficiency from shorter leads is obvious.

The shelf for the intermediate frequency tubes is made only large enough for three 199-type sockets, the detector tube being mounted on the baseboard. If intermediate frequency transformers of a type other than those shown are used, where the terminals are near the base of the transformer, it may be possible to omit the shelf and yet retain short grid and plate leads. This can best be determined when the parts are purchased.

FIG. 3 shows the schematic wiring diagram, which does not differ materially from that described last month. The oscillator tube is at the left, and is



End View of Receiver, Showing Oscillator System.



Rear View of Baseboard Model.

controlled by variable condenser C_2 .0005 mfd., in series with protecting condenser C_4 .006 mfd., the latter preventing the vacuum tubes being burned out in case the air condenser plates become shorted. Energy from the oscillator is fed into the frequency changer by means of a .1 megohm resistance R_3 in series with a fixed condenser C_5, which is made large enough so that it will not affect the total resistance of the circuit between the grids of the oscillator and frequency changer.

The loop antenna is tuned by condenser C_1, which is the same size as C_2, the grid condenser C_3 being a variable of not over 50 micromicrofarads (.00005 mfd.) maximum and the grid leak R_2 from 2 to 3 megohms, depending on the tube. A center tap loop is employed, energy being fed from the plate of the frequency changer through a small air condenser C_{10} having a maximum capacity of .00005 mfd., to one side of the loop antenna. The center tap of the loop is connected directly to the positive filament of the frequency changer.

The three intermediate frequency stages are transformer coupled, using transformers either of the shielded type or open core non-shielded, as desired. The tuned stage should be of the proper design to match the intermediate stages, and the tuning condenser C_7 should be of the value specified by the manufacturer, the value shown on the diagram being for the particular transformer used in the experimental layout.

The volume control is obtained by means of a 2000 ohm potentiometer shunted across the second intermediate stage, the potentiometer being arranged so that the circuit is open when the slider reaches its maximum position.

The three intermediate tubes are of the dry cell type and are controlled by a 30 ohm rheostat R_1. The detector tube is of the storage battery type, the filament current being controlled by an Amperite in the same manner as for the oscillator and frequency changer. The grid condenser C_8 should be .00025 mfd. and is shunted by a grid leak R_4 of 3 megohms. In the plate circuit of the detector tube is the radio frequency bypass condenser C_9, which is shunted across both the primary of the audio frequency transformer, and the 45 volt B battery, so that the high frequency component in the detector plate circuit is localized within the set.

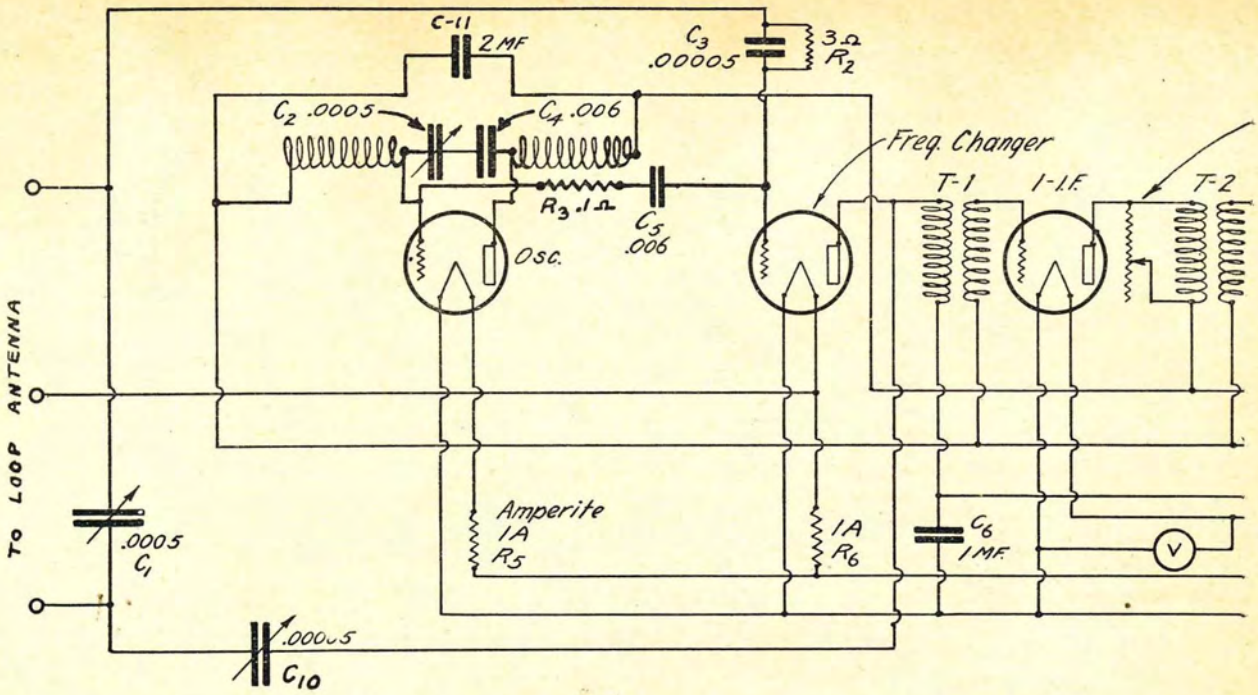
The two audio stages are connected in the conventional manner using shielded transformers such as the Karas Harmonik or other recently developed high quality makes and the tubes being storage battery type, supplied with either 90 or 135 volts plate, depending upon the volume required. Where normal room volume with a horn type speaker is required, 90 volts plate and 4½ volts C battery is ample, but for large rooms and where a cone type loud speaker is used, the additional plate voltage and 9 volt C battery should be supplied for best results. The new UX-112 tube recently announced will increase the output of the set if used in the last audio stage and requires a .5 amp. Type 112 Amperite in place of the .25 ampere size.

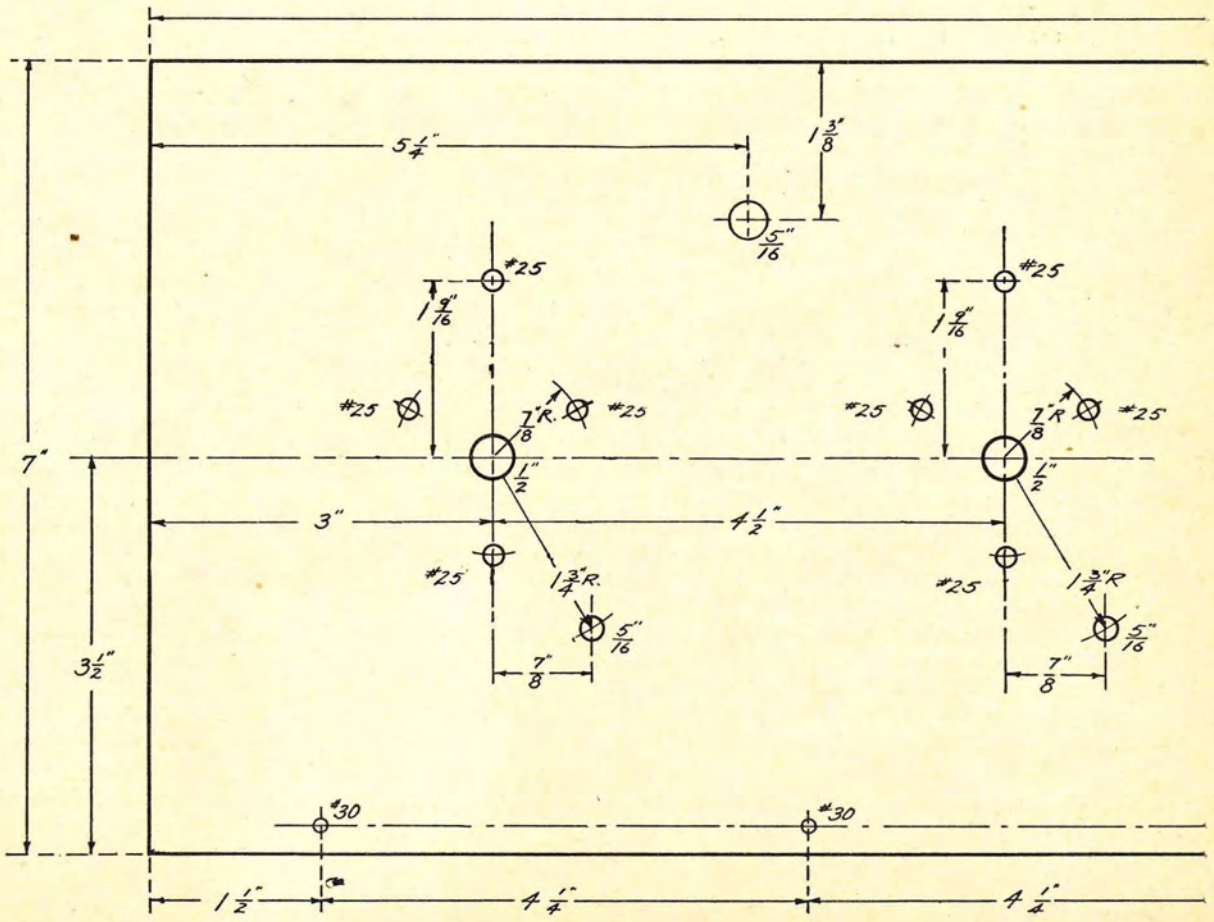
The by-pass condensers C_6 and C_{11} are shunted across the plate battery supply to the frequency changer and oscillator tubes respectively. If trouble due to high resistance in the B battery circuit is experienced, with resultant howling in the audio frequency stages, a small by-pass condenser of .006 mfd. or more may be connected from the positive B battery bus at the transformers, to the negative filament leads to the audio frequency tubes. This will also be necessary in case a protective resistance is placed in the B battery circuit, as was done in the shielded model.

Many of our readers find it difficult to wire up receivers from schematic diagrams, and so we have prepared a pictorial diagram, Fig. 4. in vertical perspective, showing the actual wiring for each piece of apparatus, each part being plainly marked with respect to the schematic diagram in Fig. 3. The picture is distorted in places to permit all the connections to be shown clearly.

IN assembling the set, the panel apparatus should be mounted first, and the connections to the jacks soldered before the panel is mouted on the baseboard, as some of the jack connections will be difficult to reach unless the wires are soldered first. Flexible wire is handy for these connections, and should be well insulated.

The tube shelf is made of wood, the dimensions being 2¼x7x¼ in., and is


C-11
2 MF
C3
.00005
3Ω
R2
C2 .0005
C4 .006
R3 .1Ω
C5
.006
Osc.
Freq. Changer
T-1
1-I.F.
T-2
TO LOOP ANTENNA
.0005
C1
Amperite
1A
R5
1A
R6
C6
1 MF.
V
.00005
C10


5 1/4"
1 3/8"
5/16"
#25
1 9/16"
7/8"R.
1/2"
3"
4 1/2"
1 3/4"R.
5/16"
7/8"
7"
3 1/2"
#30
1 1/2"
4 1/4"

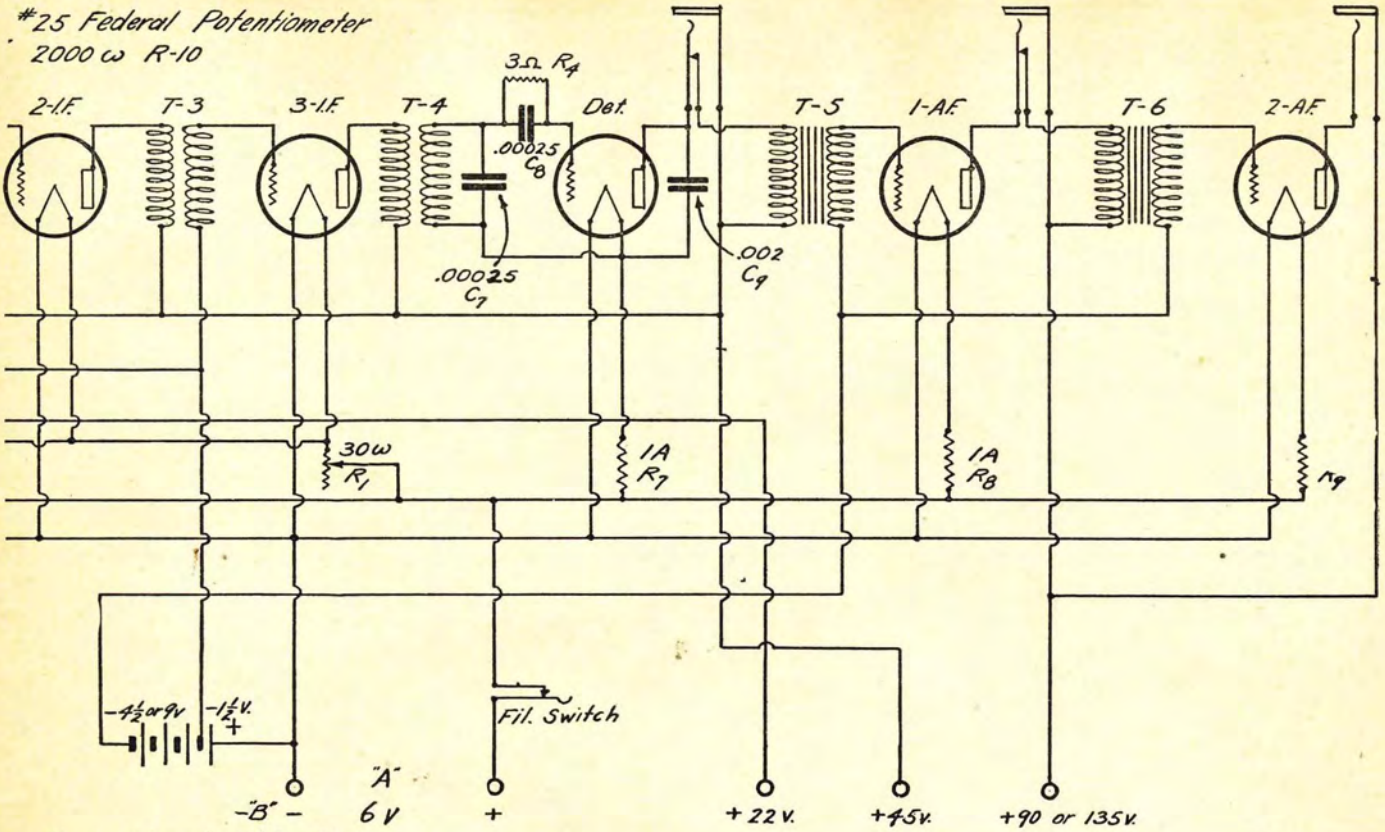


Fig. 3. Schematic Wiring Diagram.

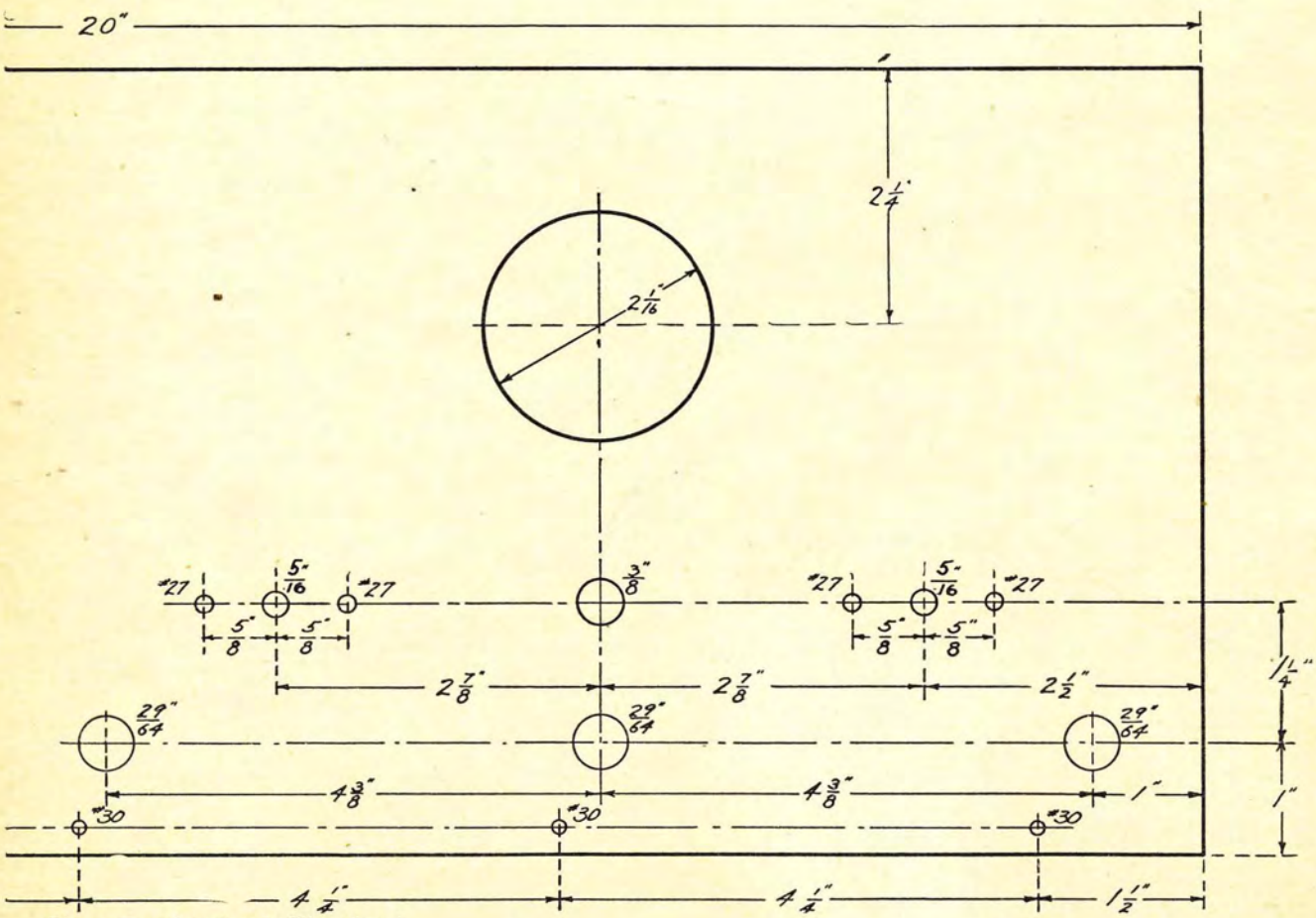
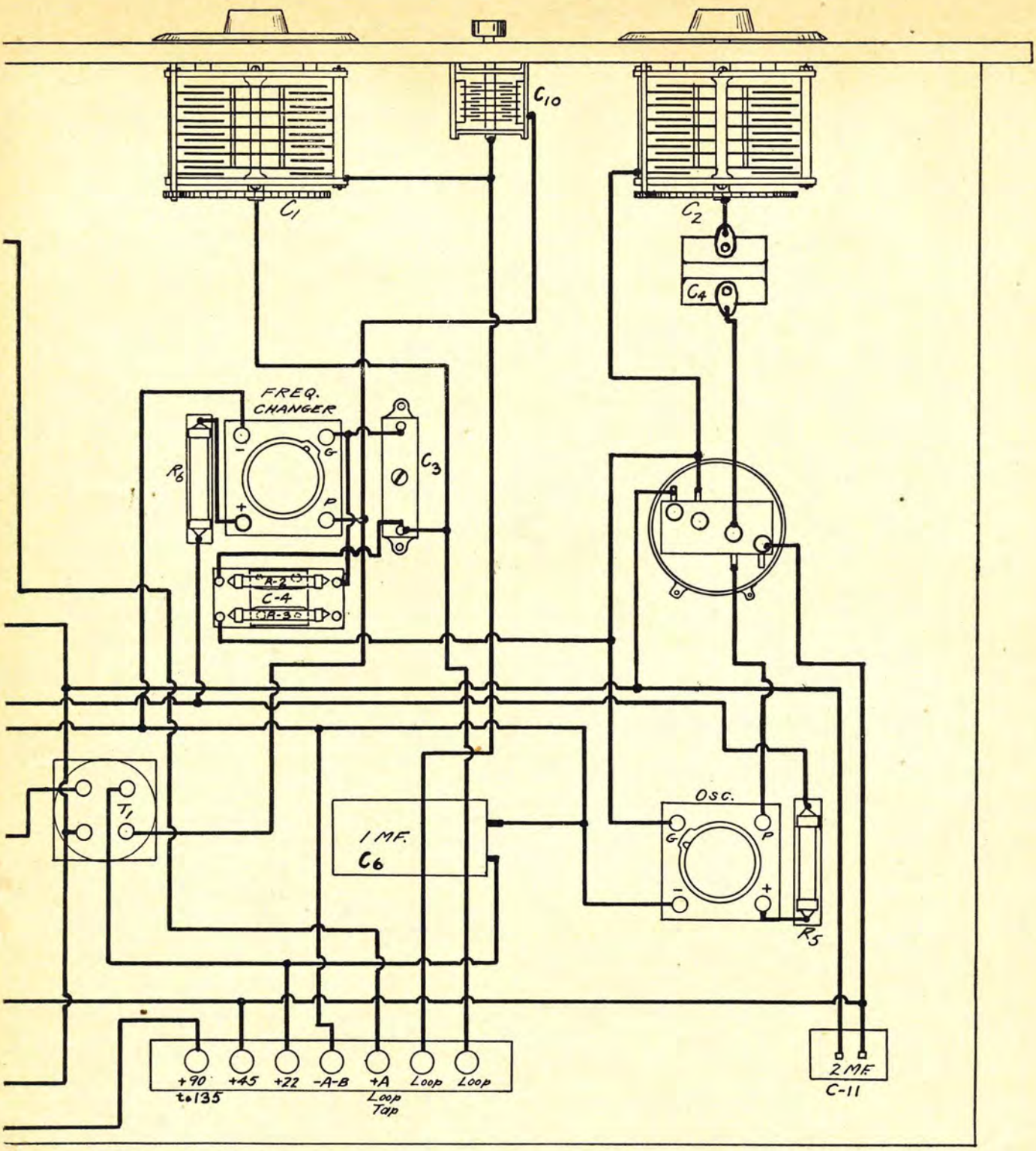


Fig. 2. Template for Drilling Panel.



Actual Arrangement of Parts.

AS soon as the wiring is completed, the *A* battery should be connected, and the tubes placed in their sockets. The automatic filament cartridges should be of the .25 ampere type, with the exception of a .5 ampere size in the last audio stage, and each one should be checked by shorting it out of the circuit temporarily. If the filament of the tube associated with the cartridge becomes brighter, the cartridge is O. K. The filament rheostat R_1 should be capable of reducing the voltage of the three 199-type tubes below 3 volts, with the *A* battery fully charged, and if this cannot be accomplished, a rheostat of higher resistance should be substituted.

After the filament circuit is found to be correct, connect the positive *A* battery to the 22 volt binding post, and see that the filaments of the tubes do not light, for if any of the tubes should light, there is a short circuit in the set and it should be located before connecting the *B* battery. Connect the positive *A* battery to the 45 volt and 90-135 volt terminals and repeat the above test, and if no trouble develops it is safe to connect the *B* battery, and the loop antenna.

After placing the tubes in their sockets, turn on the filament switch and adjust the intermediate frequency tubes to 3 volts. Plug in the headphones in the first audio jack, and set the volume control at a point about one-third between zero and maximum. Tune in a local station to maximum, with the oscillator and loop controls, and reduce the volume to a point where it will be comfortable with the headphones.

Move the oscillator condenser back and forth slightly to observe the degree of selectivity of the oscillator system, and if the two points where the station can be tuned in on the oscillator condenser appear to be broad, too much oscillator energy is being fed into the fre-

quency changer, and it will be necessary to change the resistance R_3 to some higher value than .1 megohm. Grid leaks of .25 and .5 megohms are easily obtainable and one of these values will be sure to provide the correct resistance for the oscillator circuit. If the volume control is set at too high a point, the

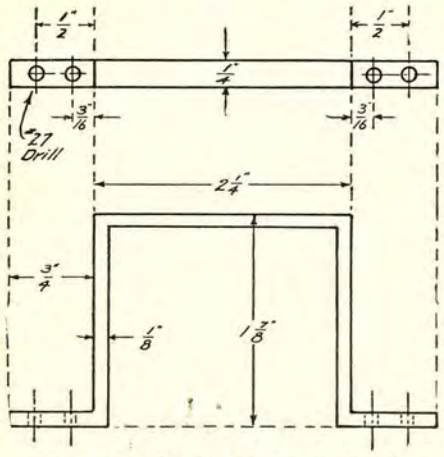


Fig. 5. Details of Brackets for Shelf.

tuning will be broad under any circumstances, so it is better to have the volume low when making this adjustment.

As has been explained many times, with the superheterodyne receiver a station can be tuned in at two places on the oscillator condenser dial, one setting being 45,000 cycles above the incoming frequency and the other 45,000 cycles below this frequency, when the intermediate amplifier is tuned to 45,000 cycles. Signals should be received at about the same degree of intensity at either point on the dial, and if it is found that this is not the case, grid condenser C_3 may be more than .00005 mfd., and should be adjusted to a lower value of capacity.

PARTS FOR THE MODIFIED BEST SUPERHETERODYNE, BASEBOARD MODEL

No. Required	Part	Circuit Designation	Makes That May Be Used
3	I. F. Transformer	T_1, T_2, T_3	Baldwin-Pacific, General Radio No. 271, Jefferson No. 150, Remler, Silver 60 KC.
1	Tuned Transformer	T_4	See Text
2	Audio Freq. Transf.	T_5, T_6	All-American, Dongan, General Radio, Jefferson, Karas Harmonik, Pacent, Premier, Rauland Lyric, Stromberg-Carlson, Supertran, Thordarson 2:1.
3	Jack		Carter, Erla, Federal, Frost, Marco, Pacent.
3	Oscillator Coils		General Radio No. 277-A, B and C
1	Oscillator Coil Mtg.		General Radio No. 274-B
1	Rheostat	R_1	Amsco, Bradleystat, Carter, Federal, Frost, General Instrument, General Radio, Pacent.
2	Variable Condensers	C_1, C_2	Acme, Bremer-Tully, Camfield, Cardwell, Ensign, General Instrument, General Radio, Karas, Marco, National, N. Y. Coil, Phoenix, Remler, Signal, Silver-Marshall, U. S. Tool.
3	Tube Sockets, Plain Type 199		Amsco, Benjamin, Erla, Frost, General Radio, Kellogg, Marco, Remler, Silver-Marshall.
5	Tube Sockets, Cushioned		Benjamin, Frost
1	Voltmeter		Hoyt Model 17, Jewell Pattern 135, Weston Model 506 or 301.
1	2 mfd. Fixed Cond.	C_{11},	Dubilier, Kellogg, N. Y. Coil
1	1 mfd. Fixed Cond.	C_6	Dubilier, Electrad, Kellogg, N. Y. Coil, Federal.
1	.00025 mfd. Fixed Cond.	C_7	Dubilier, Electrad, Federal, Kellogg, N. Y. Coil.
2	.006 mfd. Fixed Cond.	C_4, C_5	Dubilier, Electrad, Federal, Hilco, Kellogg, N. Y. Coil.
1	.002 mfd. Fixed Cond.	C_9	Dubilier, Electrad, Federal, Hilco, Kellogg, N. Y. Coil.
1	.00025 mfd. Fixed Cond. with G-L mtg.	C_8	Dubilier, Electrad, Federal, Hilco, Kellogg, N. Y. Coil, XL.
2	.00005 mfd. Var. Cond.	C_3, C_{10}	Amplex, Continental, XL Model G, Chelten.
2	Grid Leak-3 megohm	R_2, R_4	Aerovox, Amsco, Daven, Durham, Electrad, Filko, Freshman, Rogers.
1	Grid Leak-.1 megohm with mounting	R_3	Aerovox, Amsco, Daven, Durham, Electrad, Filko, Freshman, Rogers.
1	Potentiometer, 2000 ohms	R_{10}	Centralab, Federal
7	Binding Posts		Amsco, Eby, General Insulate, General Radio.
4	Automatic Fil. Cartridges	R_5, R_6, R_7, R_8	Amperite No. 1A.
1	" " "	R_9	Amperite No. 112.
2	"C" Batteries		Eveready No. 751.

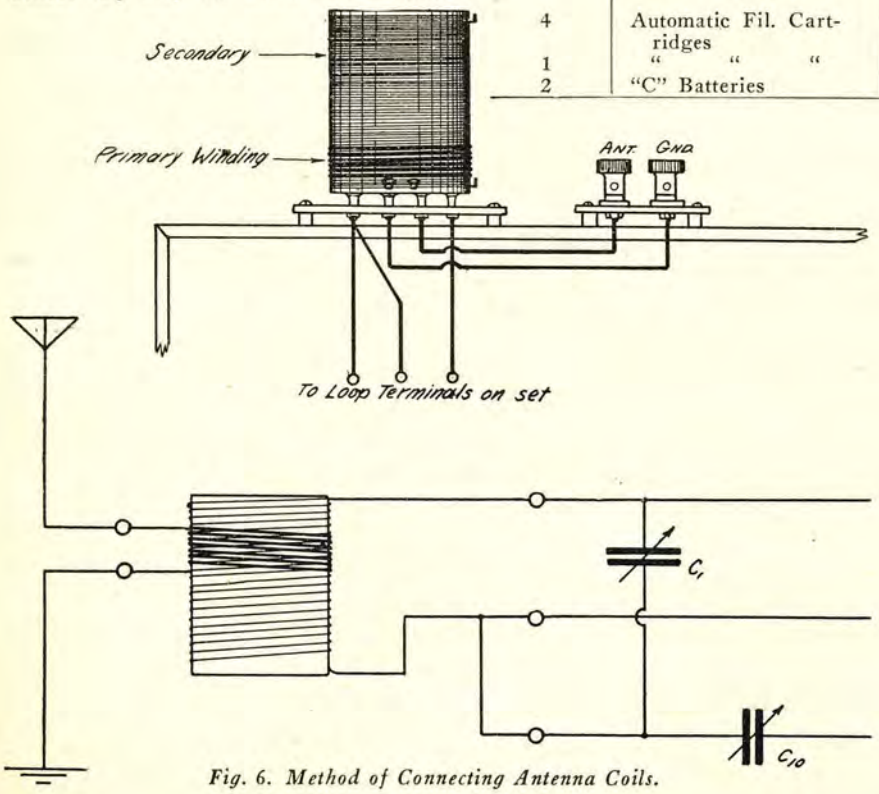


Fig. 6. Method of Connecting Antenna Coils.

The adjustment of condenser C_{10} may be made from time to time, while tuning distant stations, or can be left in a permanent position, as desired. If the latter is preferable, adjust the set to the lowest wavelength at which the set is to be operated, with any given oscillator coil, and turn the feedback condenser until the set breaks into oscillation. Then back off the capacity slightly and you have the proper adjustment for the longer waves. If the set oscillates continuously at all times, this condenser may be defective and should be temporarily cut out of the circuit to see if the oscillations will cease. If the oscillator tube does not oscillate, and no stations are heard at any setting of the oscillator condenser, the trouble may be due to a defective tube, or incorrect wiring of the oscillator coil. Try reversing the con-

(*Continued on Page* 70)

Future Developments in Audio Frequency Amplifiers

A Forecast of the Probable Trend in Transformer and Tube Developments, Together with an Account of Test Methods Used

By G. M. Best

IN the preceding chapters of this series, the various forms of audio frequency amplification possible with existing apparatus have been discussed in detail, and the reader has no doubt formed his opinion as to the merits of each method, both from the discussion and from his own experience.

While the future cannot be forecast in great detail, it is safe to predict that the next few years will see long steps in advance toward perfection of audio frequency amplifying devices. Two main avenues of approach are open; one by way of vacuum tube development and the other by improvement of audio frequency intertube coupling devices.

At present the obvious advantages of resistance and impedance coupling are available only at the price of low amplification per stage, since such coupling devices cannot step up the voltage under normal conditions and therefore limit the gain to the amplification constant of the tube. It is apparent from the curves shown in the last chapter, for various types of impedance coupling, that if tubes having amplification constants as high as 30 or 40 were available to the radio constructor, impedance or resistance coupling could compare well with transformer coupling in amplification per stage and at the same time retain superior frequency characteristics. It is an open question, however, whether vacuum tube manufacturers will undertake to place such a tube on the market at the present time, since the price would have to be fairly low to compete with the standard tubes of low amplification constant.

Present day transformers, though still far from perfect, are a far cry from the inefficient, poorly designed products of several years ago. The future may be expected to bring still greater improvements, as manufacturers begin to recognize the principles of design and the problems to be met. Too many transformers in the past were built to sell and not to amplify. Many were unintelligent copies of some transformer already on the market and others, if tested at all, were tested at some single frequency, with no thought for what might happen at other frequencies.

But today we find a number of transformer manufacturers giving thought to means of improving their products and undertaking extensive tests to determine their degree of success. The new high power radiocast stations have a practically perfect frequency characteristic from 30 to 5000 cycles, and the new cone type loud speakers will force the development of the audio amplifier as has no other means. Of what avail is a high class radiocast station and a fine reproducer, if the medium in the form of the audio amplifier cuts out the upper and lower extremes of the musical scale, as do 75 per cent of the present amplifiers in general use?

The impedance relations set forth earlier in this series show that good transformer design requires the highest possible primary inpedance consistent with other factors. Present grades of core iron make possible higher primary impedances only by increasing the number of turns of wire or the size of the core or both. In this direction, however, there is the serious limitation of distributed capacity in the secondary winding, and the primary also if it is very large. Curves shown in previous chapters demonstrated the disastrous effect of too great an effective capacity across the secondary winding. There is, therefore, a limit to the number of turns which can be successfully employed in the secondary, which limits the primary winding to as few turns as possible consistent with a good step-up ratio and yet have sufficient turns to keep its impedance high. The interwinding capacity effect offers the possibility of some advance in this connection, for by choosing some moderate ratio, the primary and secondary turns may both be increased proportionately beyond the point where falling off at high frequencies begins, thus improving the low frequency characteristic. Then, by the cut and try method, the windings may be so proportioned that the inter-winding capacity will bring up the high frequency characteristic to its proper flatness. Some of the transformers on the market already embody this feature to a great degree.

Progress in the direction of larger cores or better proportioning of coils can be small at best. The real hope of the future is that some core material having far greater permeability, such as Permalloy, will be used. Because the inductive component of the impedance of any coil having a magnetic core is directly proportional to the permeability of the core, if we had a kind of iron whose permeability was say 100 times that of the silicon steel now in use, it would be pos-

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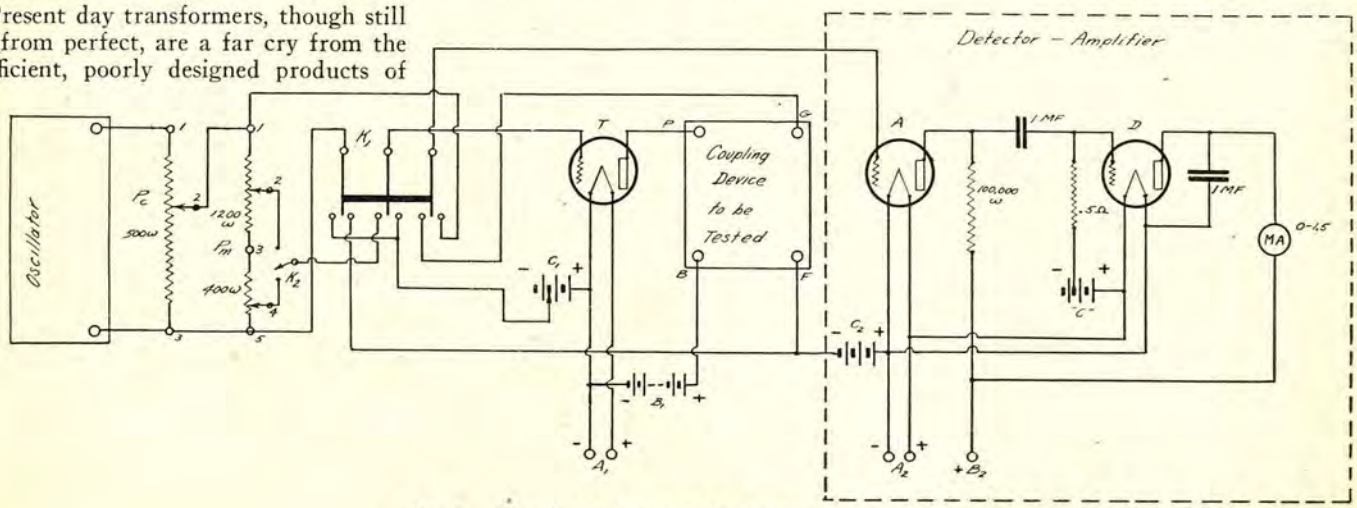

Fig. 1. Circuit Used in Audio Frequency Tests.

The Facts About "LOW LOSS" Radio Apparatus

A Consideration of the Effects of a Coil's Power Factor on Its Performance in a Receiver

By Glenn H. Browning

AT the present time there seems to be a maddening rush for so-called low-loss coils. Manufacturers have sensed this demand, and have put on the market spider web, honey comb, basket weave, and a host of other kinds of trick coils with and without a dielectric support, in order to cater to a popular demand. This movement towards reducing losses in various pieces of radio apparatus has been in good faith, both on the part of the purchaser, and the manufacturer, and will have a lasting effect on the radio industry. However, as will be pointed out, not every coil that looks efficient proves so when subjected to laboratory tests.

The worth of a coil depends upon its resistance. This resistance must be measured, not at a thousand cycles per second or ten thousand cycles per second, but at the frequencies at which it is to be used. If it is a tuning coil, or a radio frequency transformer to be used in the reception of radiocast signals, the resistance should be known at one million cycles (300 meters) and also at intervals down to five hundred thousand cycles (600 meters).

Besides the value of the radio frequency resistance of the coil, the inductance must also be known. This will be easily understood when you consider that a coil having six turns of wire on a 3 in. tube might have 3 ohms resistance at a million cycles a second, while another coil, having 12 turns around the same size tube would have 12 ohms resistance at a million cycles. The first coil would be no better than the second for radio work, for the second has approximately four times as much inductance, as well as four times the resistance.

Thus three things must be specified when determining the worth of a coil; first the resistance; second the inductance, and third the frequency at which the resistance was taken. It turns out that these three quantities may be combined conveniently into a fourth quantity, which we will call n, which varies little over the radiocast band of frequencies. Thus n will be defined as $n = R \div 2\pi f L$ where R is the resistance of the coil, whose inductance is L at the frequency f and π is the ratio of the circumference of a circle to its diameter. British engineers call this term the "power factor" of the coil and are thoroughly alive to the importance of the term.

Fig. 1 shows the radio frequency resistance of a number of coils where resistance is plotted against wavelength,

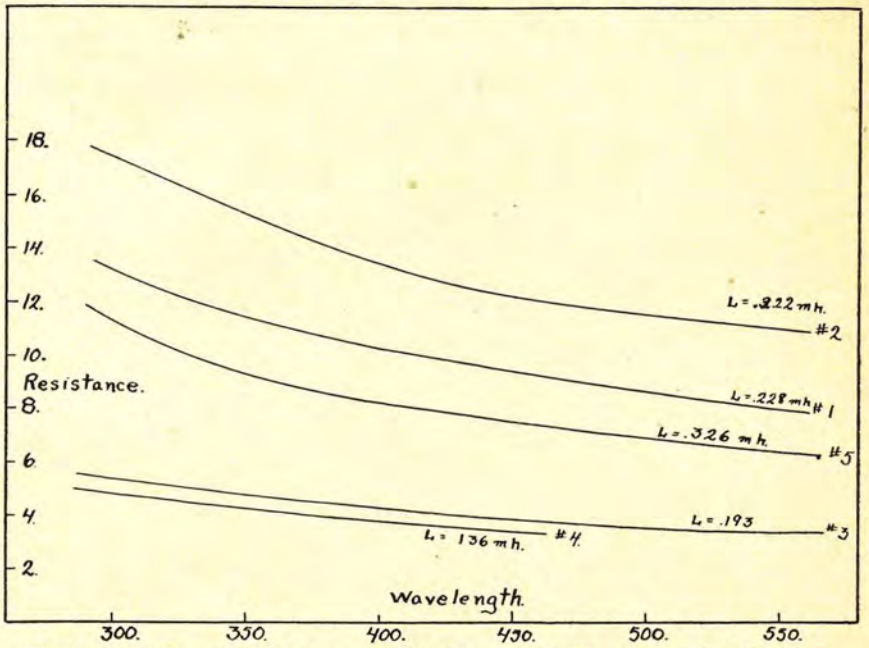

Fig. 1. Variation of Radio Frequency Resistance with Wavelength for Five Coils.

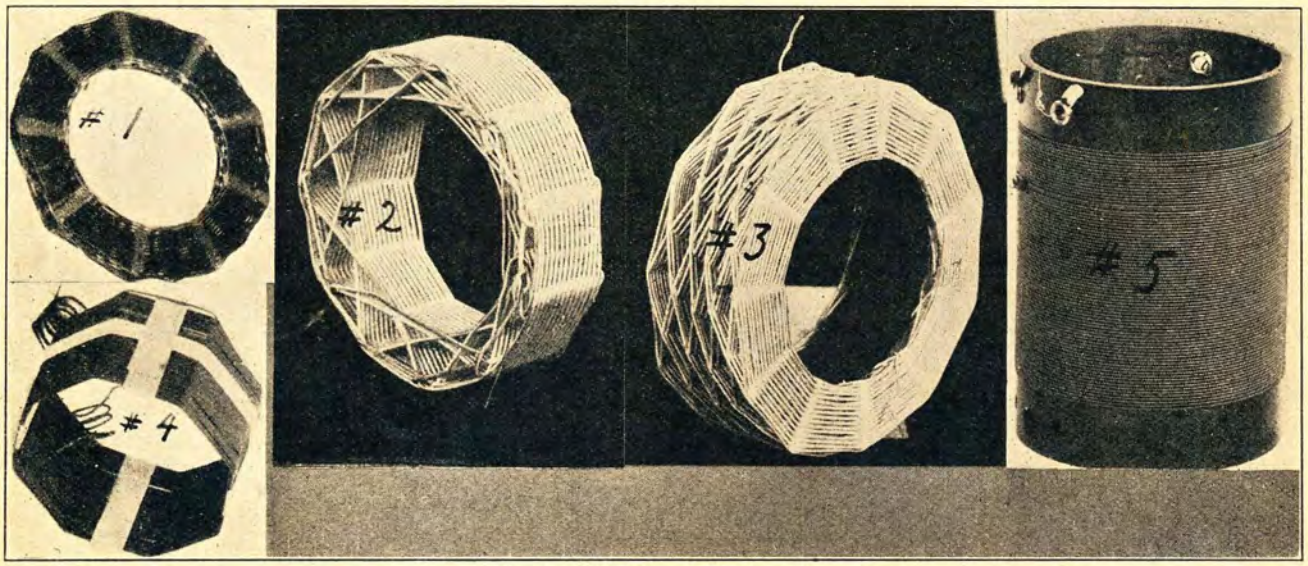

Fig. 2. The Five Coils Tested.

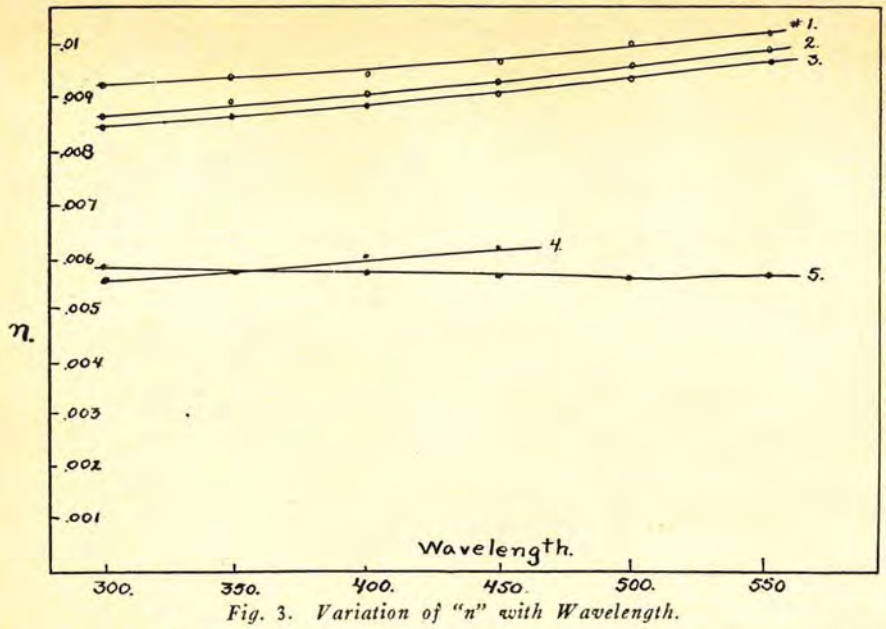

Fig. 3. Variation of "n" with Wavelength.

the inductance of each coil being also given on the chart. Fig. 2 shows each of the coils tested. Fig 3 shows the quantity n plotted against wavelength, and gives an idea of the value of a coil when used in a radio circuit. The smaller the value of n, the lower the loss in the coil, and the better it is for use in the reception of radio signals. When the value is small, such an n equals .005 or .006, the tuning of the system shown in Fig. 4 would be very sharp. This means that stations say ten meters apart could be easily tuned out. However, if n was as large as .01 or greater, a marked loss in selectivity would be noticed.

From these charts, it is easily seen how a person might be confused by simply observing the high frequency resistance of a coil without considering its inductance. Notice that coil No. 3 has a resistance of only 5.8 ohms at 300 meters, but its inductance is only .193 millihenrys, so that when n is computed, it becomes .0085, which is large and indicates that the coil is not nearly as suitable for a radio circuit as coil No. 4 or 5.

Before showing how n affects the efficiency of a circuit, it will be necessary to say a few words about losses in good condensers: The "low loss" movement did the radio industry a real service here, for the condensers of a year ago, with bushed rotors and bakelite end plates did have losses which, in some cases, amounted to 100 ohms at 300 meters. Such condensers cut down the efficiency of a circuit much more than the coil did. Today, however, good condensers have an equivalent resistance of less than 1 ohm at 300 meters wavelength. When such a condenser is used in an oscillatory circuit, its loss is negligible in comparison to the coil, so that in the calculations which follow, we shall assume a perfect condenser which is almost realized in practice. Consider the circuit shown in Fig. 4.

We have an untuned antenna circuit coupled loosely to circuit LC. As the signal strength received with such a tuning system will be proportional to the voltage (e_g) on the grid-filament of the detector, we wish to determine upon what quantities eg depend. (This voltage is the difference of the electrical pressure between top and bottom of the coil L.)

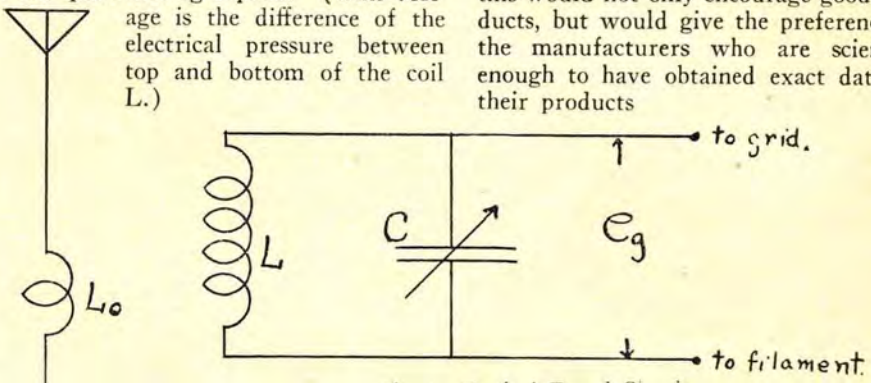

Fig. 4. Typical Tuned Circuit.

Now $e_g = iL2\pi f$ where i is the current in the oscillatory circuit LC, L is the inductance of the coil and f is the incoming frequency.

The current i depends upon whether the condenser C has tuned inductance L to resonance. When C is tuned for maximum signal strength, $i = E \div R$, where E is the induced emf, and R is the resistance in circuit LC, which in this case is the resistance of the coil L. The E, or induced emf, is that set up in coil L, due to an incoming signal through coil L_o. (This equation assumes that the coupling between L_o and L is loose.) Substituting the value of i given above in the equation for e_g we have:

$$e_g = \frac{2\pi f L E}{R}$$

If we introduce the value of n into the above equation we have:

$$e_g = \frac{E}{n}$$

This equation shows very plainly that we should keep n as small as possible if we want e_g to be large. It also shows that it makes little difference whether we use large condensers and small coils, or large coils and small condensers, so long as n for the coil is the same.

It is also true that for the band of wavelengths used in radiocasting, that it makes little difference whether a coil has a dielectric support or not. For example, coil 5 is wound on a bakelite tube, while coil 4 is built so as to be self-supporting. As will be noticed by Fig. 3, coil 4 is slightly better at 300 meters while coil 5 is better from 350 to 550 meters.

The conclusions to be drawn from the data presented are that not all so-called "low-loss" coils are efficient when actually measured. Of all the coils shown, the single layered solenoid has smallest n and consequently is best suited for use in a radio receiver. The high frequency resistance per unit inductance at a given wavelength is the best way to determine a truly efficient coil. The lower the value of n the sharper the tuning and the lower the loss in the circuit. It is hoped that those buying apparatus will be inquisitive enough to demand such data from a manufacturer, as this would not only encourage good products, but would give the preference to the manufacturers who are scientific enough to have obtained exact data on their products

John L. Reinartz, first operator of the MacMillan Arctic Expedition on board the arctic schooner "Bowdoin" sitting at his Zenith-Reinartz short wave transmitter now in the Arctic. It is from this radio room and by this man and his associate operator, John McGee, on board the "S. S. Peary" that the public is receiving its messages from the Arctic.

Loud Speaker Testing Methods

Suggestions Applicable to Home as Well as Shop Tests for Quality of Reproduction

By John P. Minton

THE editor of one of the technical magazines recently said that the quality of the sound from his radio set seemed to be poor. He had tried all the ideas he could think of to improve it, but had not succeeded in obtaining satisfactory results. He had concluded that the loud speaker was the source of his trouble, and with this particular part of his set he was not able to attempt an improvement He could tinker, so to speak, with coils, tubes, batteries, wires, etc., but he was at a loss as to how to tinker with the loud speaker itself.

This is true—none of the fans know how to tinker with a loud speaker. Certain types of loud speakers are well nigh hopeless for the amateur to apply his innate desire for "tinkering," and for this reason, care in the selection of a loud speaker at the beginning should be exercised. The present short discussion of the testing of the commercial loud speakers of today will, without doubt, be helpful to many in suggesting methods for doing their own testing.

The usual method employed is the listening test with actual radio signals. This is a good test and an important one, but the experimenter cannot make use of it satisfactorily unless he has at least a half a dozen loud speakers to compare with one another. The speakers must be tried on various sets and comparisons made with speech and music from a number of different stations at various times. Logical conclusions of a comparative nature can then be drawn with considerable degree of certainty by a person who has been well trained to make just such tests. Fig. 1 illustrates this method of test.

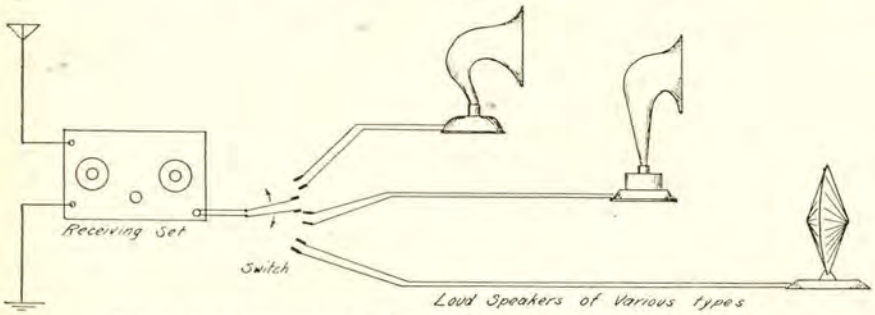

Fig. 1. Comparing Loud Speakers by Means of a Receiving Set.

Another method utilizes the voices of various people as they speak into a high quality microphone or, better still, the high quality condenser transmitter. The voice current generated by either one of these instruments is fed into a resistance coupled amplifier which is as free from distortion as is possible to make it. From this amplifier the speech current is led to the loud speakers to be tested. This scheme of testing loud speakers, as illustrated in Fig. 2, gives very valuable results. Any distortion due to a receiving set or to the radiocast station is eliminated. The final result, then, will be characteristic of the loud speaker itself in direct comparison with the speaker's voice at the microphone.

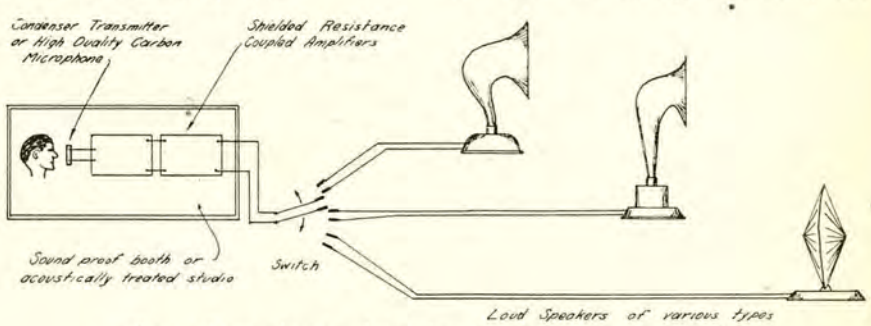

Fig. 2. Comparing Loud Speakers by Means of Actual Voice.

Usually the speaker is in a sound-proof booth and the listener is just outside. At any moment the doors can be opened as the speaker continues to talk without change in his voice or position, and we are then able to listen to his voice directly and thus are able to make the comparison between the original and the reproduction. A piano or other instrument may also be placed in the booth. In the Technical and Test Laboratory of the Radio Corporation of America is a studio whose acoustic characteristics are similar to those of their radiocast studios. Studio conditions can thus be obtained any time.

A third method used in loud speaker testing is electric phonograph reproduction. In place of the usual sound box into which the phonograph needle is placed, an electric sound box, as it may be called, is adapted so that the needle, actuated by the record, is connected to a loud speaker unit of either the usual bipolar or balanced armature type. The needle's motion in the groove of the record causes corresponding vibration in the unit, and these in turn make possible the generation of corresponding electric currents. These currents are fed through a suitable amplifier for amplification and then led to the loud speaker. In this scheme of testing we have perfect control over the testing conditions, but it has the disadvantage that any distortion which is in the records is reproduced in the loud speaker.

These three methods all employ the ear for observation. The ear can judge with great accuracy the human speech. We can tell instantly if a voice sounds natural, evenly balanced and whether or not it can be understood with perfect clearness. Such cannot be said so positively regarding music. Music will stand for a lot of abuse and distortion as far as the average listener is concerned; he will not be so conscious of these defects, particularly while listening to music over the loud speaker. Therefore, the second method is the most useful, the others being used for preliminary tests.

But the most important factor in making these tests is some permanent record of loud speaker performance as the basis for precise comparison and also as a legal means to substantiate claims. Fig. 3 shows the set-up employed, a loud speaker replacing the personal voice at the sending end and a highly sensitive current measuring system replacing the loud speaker at the receiving end.

By means of a vacuum tube oscillator electric currents can be produced whose frequencies cover a range from 10 cycles to as high as we desire to go—say 20,000 cycles. The human ear will perhaps include a range of frequency from 20 to 16,000 cycles. Above and below these

(*Continued on Page 66*)

Rescuing Uncle Marmaduke

By John Eugene Hasty

YOU know, I rather think there might be something in what these philosopher gents say about the darkest hour coming before the dawn. Of course, I imagine that dawn has been following the darkest hour for so many years that it's quite a habit with it by this time; but what I mean to say is that when a fellow gets in a bad jam and then up pops some friend to rally around him in the time of need, it sort of brings home the truth. Here I was facing the disagreeable experience of starving to death—or what is worse, having to go to work—when Bill Curtiss drifts into the picture, and . . . . But maybe I had better start at the beginning.

Curtiss is one of these amateur radio sharks, you know. We'd always been more or less chummy, having both been turned out of the same school—Curtiss with a diploma and I with a reprimand from the dean; so when I decided to become one of the great audience of radiocast listeners, he volunteered to run down to the old homestead and give me some top hole advice as to whether I ought to get a superiodine or a degenerative set. Then this other affair broke loose; and for the time being I forgot all about him.

"All of a sudden there came from it three distinct raps."

I was in my room at the club, restoring old tissues with a bit of the pure and unadulterated dreamless, when the telephone rang. Feeling more or less of a blank, I jerked myself out of the downy couch and groped through the cold, gray dawn to the phone. It was my sister Ruth calling. Just what she was doing in the city at that ghastly hour, I couldn't quite fathom; but finally it began to percolate through the old bean that she was all upset about something and wanted me to meet her at breakfast at the St. Francis. One thing about Ruth: when she makes up her mind about a thing, you might just as well give up the struggle. I mean to say that she's firm. Adamantine. The old rock of Gibraltar and that sort of thing. So an hour later, I was sitting across the table from her, waiting for the news. It wasn't long in coming.

"Reggie," she said, after the waiter had taken our order and had toddled out to the kitchen for a game of checkers with the cook, "Reggie, what would you call a man who hid behind a woman's skirt?"

"In view of the present styles," I peeped, "I'd call him a magician. But if you've got any more riddles, save 'em until later in the day. Right now I'm a bit thick."

"Perhaps you're not too thick to get this:" she came back. "You and I are just about to lose every cent we possess. Uncle Marmaduke . . . ."

"What!" I shouted. "You don't mean to say he's mixed up with another chorus girl?"

"Worse than that. This time it's a medium."

"Medium?" I repeated, "Referring to a steak?"

"Don't be an ass, Reggie, I'm talking about a spiritualist medium — Mrs. Hoagworth, the new housekeeper. Of course, you know about *her*."

"I don't," I breathed, all aquiver, "tell me."

She did, to considerable length. It seemed that this estimable Mrs. Hoagworth is a spook sister; one of these ladies who pals around with ghosts, and goes in for table rapping, slate writing and messages from the great beyond. According to Ruth, she's jolly well succeeded in getting Uncle Marmaduke all wrapped up in the subject, and has put in a direct leased wire to the spirit world in order to give him all the advance tips.

"It's positively outrageous the way he follows that woman's advice," Ruth went on, "Absolutely hides himself behind her skirts; won't do anything or say anything without first asking Mrs. Hoagworth what the spirits have to say about it. And lately, mind you, she's been teaching him how to receive spirit messages on his own hook."

"Oh, well, it could be worse," I said, champing on a piece of toast which the

waiter had just brought in, "It's certain that any communications he might have with the spirits won't turn up as Exhibit A for the plaintiff in a breach-of-promise suit. If the old boy gets any fun out of it, let him proceed. I'd say it was all quite harmless."

"Harmless!" Ruth snapped, "Harmless! Do you know what the spirits have been advising him to do? Why, to turn over the entire Rockford-Peebles estate to the spiritualist cause, which means to Mrs. Hoagworth. If that woman succeeds with her plot, you and I will be left without a penny. We'll be paupers. And yet you can sit there calmly eating your breakfast, and say it's harmless."

Of course, that was a horse with a different face—as the expression goes. I mean to say that after having been raised in the lap of luxury so to speak, it's a bit muggy to be informed that you appear to be a winning candidate for the bread line.

"But—but what am I going to do about it?" I stammered, gulping down the toast.

"You're going home with me," Ruth said, "and you're going to stay there until you've rescued Uncle Marmaduke from that old dragon's clutches. The car is waiting for us outside. Here, waiter, let us have the check; never mind the coffee. Come on, Reggie."

That's the kind of a girl Ruth is. I mean to say firm. Righto!

BEING a light hearted and care-free chap who loves to revel among the bright lights, I usually find our country place a bit depressing. On this particular day, it seemed even more so. The lawn was overgrown with rank grass, the hedges needed trimming, and there was a sort of a run-down, gloomy air about the place which reminded me of the old mansion in the book where they break in and find the body of the eccentric millionaire who had been struck over the head with a blunt instrument by parties unknown.

"What, Ho!" I said to Ruth, "The home of my happy boyhood days has a lean and hungry look. What's wrong—gardeners on a strike?"

"Uncle Marmaduke has discharged all the servants, excepting the cook," she informed me, "It was the will of the spirits."

Inside of the house, things were just as bad: dust over everything, the blinds drawn, and the place so deucedly quiet that it gave a chap an uncomfortable, creepy feeling between the shoulder blades. When I heard a step on the upper landing, I leaped like a frightened young gazelle. Looking up, I saw a large, solid female coming down the stairs. I judged it was Mrs. Hoagworth. I can't say there was anything spiritual about her. Rather beefy, in fact. The sort of a woman who looked as if she might be dangerous to the chap who would try to thwart her. She didn't say anything; but before she disappeared into the library, she shot me a grim, forbidding glance. It made me feel as if I were something the dog had dug up and brought into the parlor. I mean to say it seemed that she resented my being there; and was just biding her time to slip a slug of poison into my coffee.

The whole business was getting on my nerves. Somehow I caught myself tiptoeing about as if there had been a death in the family. If there had been anyone about to talk to, I would have probably spoken in a whisper. But there wasn't. Ruth had gone to her room; Uncle Marmaduke was taking his afternoon nap; and the Hoagworth woman had vanished somewhere in the rear of the house. Finally, the afternoon dragged itself out; and Ruth came down to dinner. Uncle Marmaduke had a tray sent up to his room; so Ruth and I ate by ourselves—by candle light. The electric current had been shut off—another idea which had been passed on to Uncle Marmaduke from the spirit world.

Right after dinner, I decided that if there were any rescuing to be done, it had better be done with dispatch; so I toddled up the stairs and knocked at Uncle Marmaduke's door. For a minute or so, there was nothing but silence; then I heard him tell me to come in—in one of those sad, faint voices that sound like the bleat of a far-off sheep. I opened the door and oozed in. Even in the candlelight, I could see that the poor old chap was pretty far gone. He was huddled up in an arm chair by the fireplace, looking pale and wan, as the poets say.

"Cheerio, Unc," I said, in my sprightliest manner, "What's wrong? The old liver out of joint? What!"

He gave me a cold, fish-like hand, and wearily waived me to a seat before replying.

"I'm afraid I'm not long for this world, Reggie."

"Oh, nonsense," I retorted, "You're quite long enough. Five feet, nine inches, if I remember correctly; or is it five feet, ten?"

But the wise crack didn't register with him at all. He continued to stare off into space and to speak in a solemn, crushed voice.

"I've been a wicked man in my day, Reggie, a very wicked man. I must

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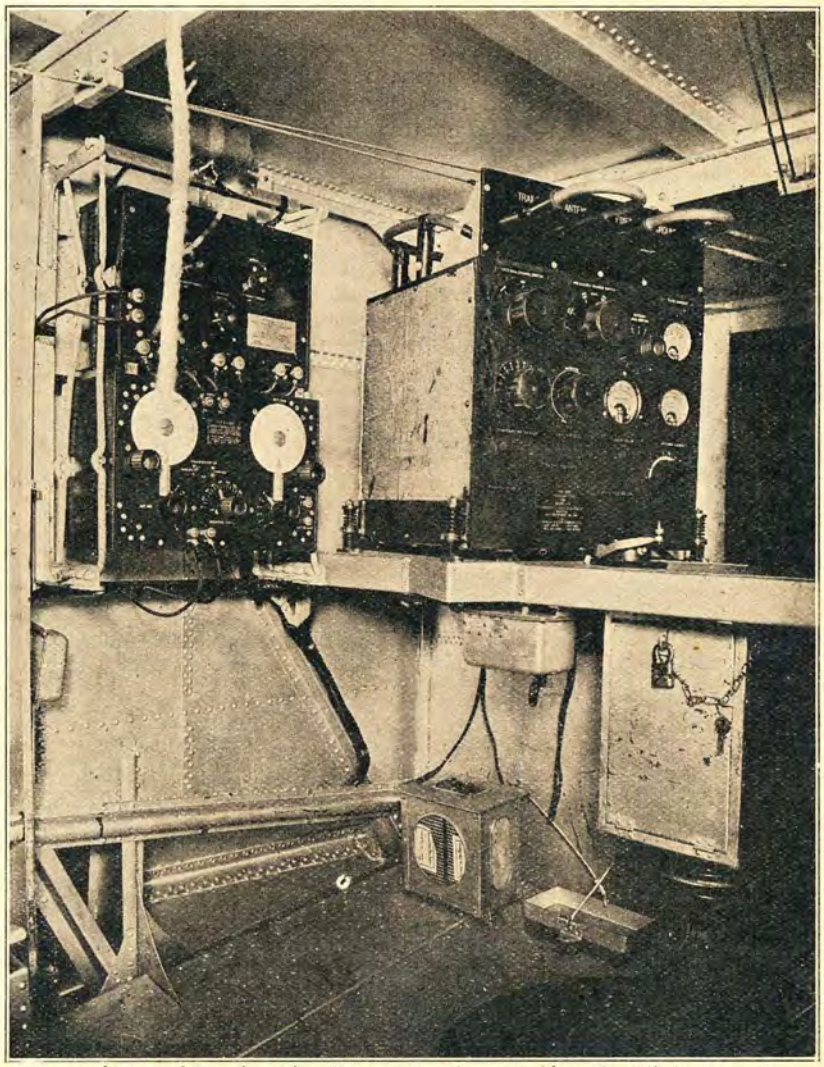


Transmitter and Receiver for Use on Seaplane Making the Flight From San Francisco to Honolulu in September.

Electrical Instruments for Radio Sets

An Account of the Theory and Construction of Different Types of Ammeters and Voltmeters

By M. T. Rogers

THERE are four general types of meters used for measuring current flow (in amperes or milliamperes) and battery potential (in volts), but three of the four have very decided limitations. The simplest and cheapest to build is the "solenoid type" of meter. It can be used for measuring current flow and battery voltage, but because of its construction requires a large amount of current to operate the moving system and so is the least desirable of all types. Such meters are usually built for testing dry cells and *B* batteries and if left across the terminals of a battery for any length of time, will not only draw down the battery, but the readings on the scale will vary several per cent because of the heat developed. Up to the present time, meters of this type have been supplied as pocket meters only.

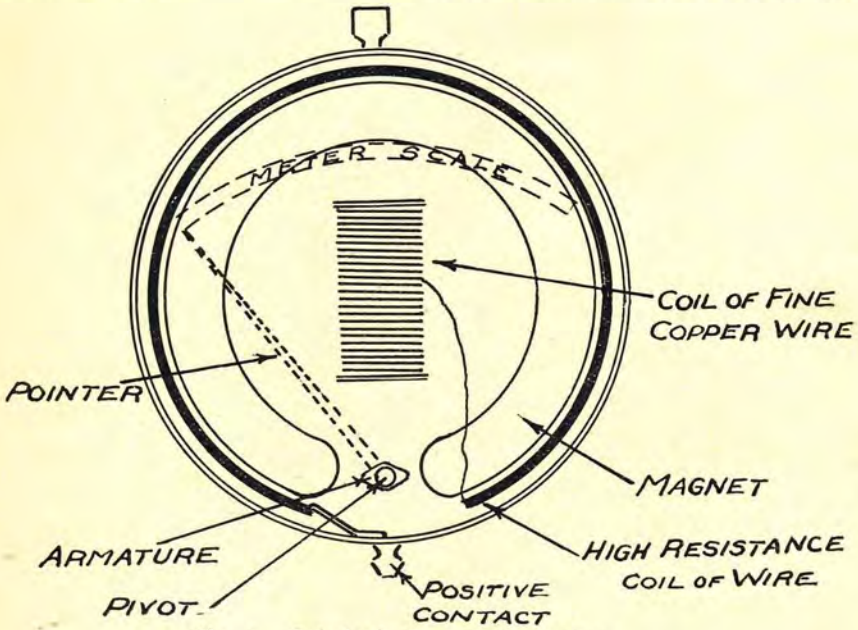


Fig. 1. Polarized Vane Type of Meter.

A step in advance of the solenoid is the "polarized vane" type, of which Fig. 1 is a diagrammatic sketch. This type is equipped with a magnet which, by the natural force of its magnetism, holds in a certain position an armature of soft iron, which is attached to the pivot. The current flows through the contact, a coil of high resistance wire and thence to the spool of fine wire, which becomes an electro magnet that tends to have an action on the armature. As the pull of the electro magnet opposes the pull of the permanent magnet, the armature turns and the pointer, attached to the same pivot, travels across the scale. This type of meter has been used for many years by different manufacturers and one in particular claims to have accomplished considerable in the way of supplying high resistance and an accurate scale at all points. Generally speaking, however, meters of this type draw too much current for satisfactory use and they cannot be left in the circuit indefinitely, as they would subject the battery to too large a load.

A third principle is the "repulsion type." This meter is generally used for measuring alternating current but can be calibrated to work on direct if desired. Perhaps its greatest claim to recognition in the radio field is the fact that it can be supplied in small cases. Because of the principle on which it is constructed, it too, draws considerable current and cannot be left in the circuit indefinitely. It must be used with a switch when mounted on the panel. Fig. 2 shows the construction. A coil of wire is mounted on a spool, and through this coil the current to be measured flows. Fixed within the spool is one piece of soft iron and attached to the pivot of the meter is another, the pointer also being attached to the pivot. As the current flows through the coil, the latter becomes an electro magnet and immediately has an effect on the two pieces of iron, giving them the same polarity. As the magnetic law is that "unlike poles attract, like poles repel," the two pieces of iron repel each other, and as one is fixed, it follows that the other must move, and being attached to the pointer, through the pivot, it travels as shown in the sketch and the pointer moves across the scale.

The greatest objection to this type of meter is that it must draw considerable current in order to have power enough to make the pointer travel across the scale. It has the great advantage, however, of being built without a magnet and so can be placed in a very small case.

By far the most satisfactory instrument built for receiving sets is the "moving coil" type pictured in Fig. 3. It can be used for measuring the smallest currents common to radio reception, and when built as a voltmeter, can be left in the circuit without damage to itself or to the battery. It is a "high resistance" meter.

The moving coil principle was developed by a French scientist named D'Arsonval and is spoken of as the D'Arsonval movement. Between the pole faces of a permanent magnet is placed an iron core, allowing a gap between it and the pole faces large enough to permit an aluminum frame to swing

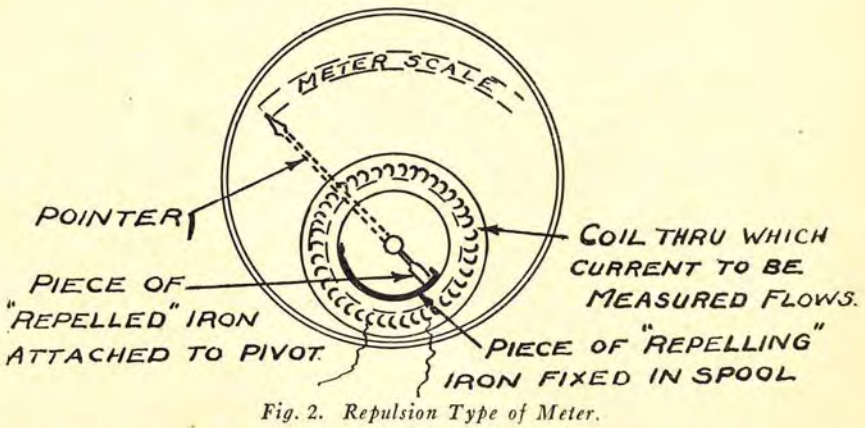


Fig. 2. Repulsion Type of Meter.

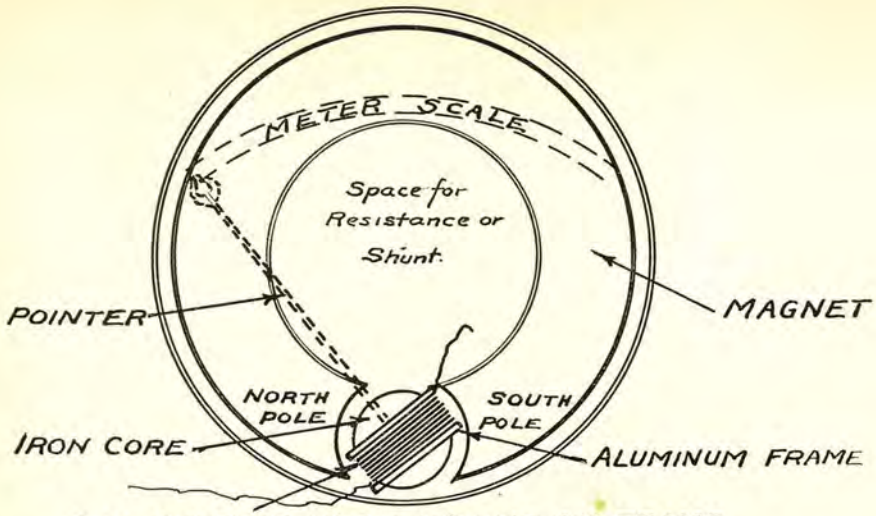


Fig. 3. Moving Coil Type of Meter.

freely. On this frame is wound a coil of very fine wire, through which a certain percentage of the current to be measured passes. As this current passes through the coil, the latter becomes an electro magnet, with north and south poles, which are immediately affected by the north and south poles of the permanent magnet. As the magnetic law is that "unlike poles attract—like poles repel," the north end of the electromagnet is drawn toward the south pole of the permanent magnet and vice versa —which means that the aluminum frame is swung around and the pointer, attached to the frame, travels across the scale. Every meter of this type is in reality a millivoltmeter, as the coil is built in such a way that a small current flow through it causes the action described. External to the coil, but within the meter case where possible, is a shunt, if the instrument is an ammeter, or a resistance or multiplier, if it is a voltmeter. An example will describe how this is handled.

Ohm's law, the law governing the flow of electric current, is

$$I \text{ (current in amp.)} = \frac{E \text{ (voltage).}}{R \text{ (resistance in ohm)}}$$

If there are 10 ft. of fine wire on the aluminum frame having a resistance of 1 ohm per foot, the total resistance is 10 ohms. The frame is then set in position and it is found that .10 volts (100 milvolts) are necessary to send the pointer across the scale (that is, the frame moves through 90 degrees because of the magnetic pull exerted.) Then $I = \frac{.100}{10} = .010$ amperes which is the current used, under .100 volts pressure to cause full scale deflection.

For an ammeter capable of measuring 5 amperes we permit the current to flow through a shunt and simply draw off enough current to cause full scale deflection,—in the case being considered —.01 amperes. The shunt is made to carry exactly 4.99 amperes while the .01 amperes are drawn through the meter. See Fig. 4. For a voltmeter capable of measuring 6 volts, the following specifications are required: A voltmeter is placed "across the line," from positive to negative, and as it measures pressure, like a steam gauge, it must re-

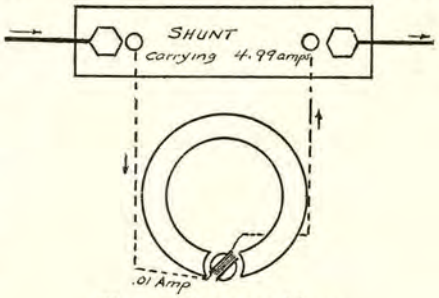


Fig. 4. Ammeter Shunt.

sist the flow of current. The meter itself requires .100 volts to cause full deflection and the balance must be used up in resistance. That is $\frac{6-.1}{6}$ or $\frac{59}{60}$ of the current is stopped while 1/60 flows through the meter. See Fig. 5.

Then it is seen that electrically, the construction of a meter is simple—the difficulties are mostly mechanical. It is easy to supply a piece of metal that will carry all the current except that needed for operating the moving system, but it is difficult to get that metal into a small

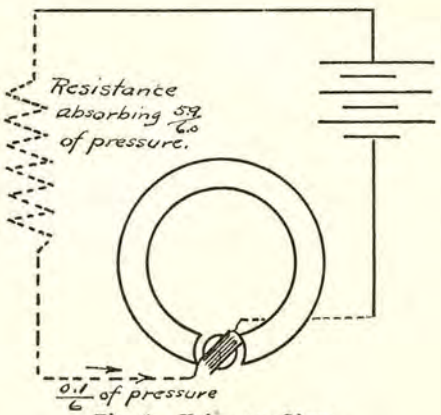


Fig. 5. Voltmeter Shunt.

place where it won't affect other things. It is easy to build an aluminum frame but hard to mount it, if it is too small to handle readily, so that it will swing freely between pole faces and core. The difficulty of getting the necessary resistance for a higher range meter in a small case is mechanical rather than electrical; it is a matter of clean design and careful workmanship.

Generally speaking, any meter manufacturer would prefer to build large meters for he has more space for shunts and resistances, his coil is easier to assemble and he can get better balance. But the radio industry demands small meters, which are in keeping with the rest of the set; instruments that add to rather than detract from the appearance. They want "wrist watch" construction with an accuracy equivalent to the best of the larger watches, and the meter manufacturers are striving to please. One company produced a moving coil meter two inches in diameter in December, 1924, and their whole production for three months was taken by two set manufacturers. This year will undoubtedly see other 2 in. or possibly smaller D'Arsonval meters offered to the trade, although it seems at this writing, as though this was the smallest size really practicable. And it is possible that some other type of meter may be developed that will offer enough electrical resistance to make it satisfactory for radio sets, for high resistance is a characteristic that every successful meter must have. If the resistance is low, too much current is drawn by the meter to permit its use for measuring currents such as are drawn by radio tubes or for obtaining the voltage readings on batteries.

AUSTRALIAN DOINGS

Work is progressing on the Australian beam stations for communication with England and Canada, the sites have been selected and are being prepared for the erection of the apparatus, which is at present in course of manufacture, and the personnel for operating these stations is being trained. The wavelengths have not yet been disclosed but will probably fall between 30 and 50 meters. The scheme calls for the erection of two stations for working duplex, one with England and the other one with Canada, together with six feeder stations situated in the various State Capitols to handle traffic originating at or destined for those cities. The main stations are being erected near Melbourne and remotely controlled from that city. Provision will be made for the expansion of the service to other countries later. The charges are to be one third lower than the existing cable rates, and it is expected that the time occupied in transmission will be less on account of the elimination of relay-points, and the use of high-speed automatic transmission.

Wavemeters

A Description of Various Types Best Adapted to Different Kinds of Receivers

By G. F. Lampkin, 8ALK

THE experimenter who in radio has found his heart's desire, and has come on up to receiving sets of the superheterodyne type, is never satisfied. That is why his set is now a super, instead of the original crystal layout; it is why he is ever on the lookout for information of one kind or another in his field; and is why he, himself, is able to contribute to that field. In the broadening of his knowledge beyond that of mere set construction, into the realms of 'why, and how, he more than likely will run into an instrument called the wavemeter — for it is the fundamental radio measuring device.

A wavemeter, as the name indicates, measures wavelength, or more truly, frequency. It consists merely of a coil and condenser, connected as in Fig. 1, with

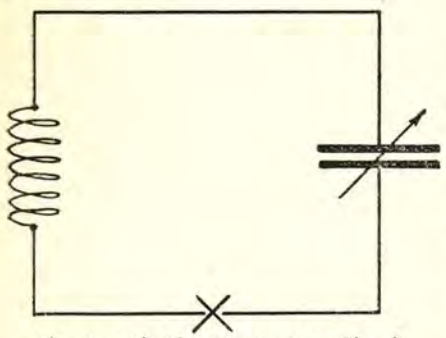


Fig. 1. Simple Wavemeter Circuit.

a device of some sort to show when the meter is in tune. The user of a receiving set knows his set is in tune with a station when he hears their signals, and if the set is up to date, he can mark the condenser setting and return to the station at will. Similarly, on a wavemeter, the condenser settings are marked; but instead of being put down as stations, the markings are made as wavelengths. More often a graph is drawn, which gives a wavelength for each point on the dial.

The wavelength to be measured may be that of a local transmitter, of a distant transmitter, or the wave to which a receiving circuit is tuned. The type of device used to show when the wavemeter is in tune, or resonance, depends on to which of these uses the wavemeter is to be put. If it is desired to measure the wave of a local transmitter, from which appreciable energy can be picked up, a current-indicating device is used; such as a milliammeter, a thermo-galvanometer, or a flashlight lamp. These are inserted in series with the wavemeter circuit at *X*, and the meter placed near the transmitter. When the condenser is tuned to give maximum deflection on the meter, or maximum brilliancy of the lamp, the circuits are in resonance; and the wavelength of the transmitter may be read from the wavemeter condenser setting. A neon tube may also be used for this type of measurement. This is the little tube that is used in an automobile ignition tester; and which glows red when touched to a spark plug on which there is voltage. The tube is removed from the tester, and is connected across the wavemeter condenser. At resonance there is a maximum voltage across the condenser, which will cause the neon tube to give the brightest light. However, these types of resonance indicators are not in common use, as too much energy is required to give the indication.

In all wavemeter measurements the distance between the meter and the circuit should be as great as possible; in other words, the coupling should be loose. If a station is too close to a receiving set, it can be heard at more than one point on the dial, and marking the setting for the station will not mean a thing.

In the same way, if the wavemeter coupling is too close, the readings will not be accurate—resonance may be obtained at more than one point. It is best to get just enough of an indication to see easily, and use this for adjustment.

For the experimenter who uses regeneration, the most accurate instrument is the heterodyne wavemeter; which is nothing more than a one-tube regenerative receiver with a few precautions taken to make sure the readings of the condenser will always be accurate. The circuit diagram is shown in Fig. 2. A tickler is used, but it is not movable; the number of turns necessary to make the set oscillate is found by the cut and try method, and then left fixed. The .005 mfd by-pass condenser is used in the plate circuit to destroy any tuning effect of the *B* battery and phones; a grid condenser and leak take care that changes in the filament setting cause no change in the tuning; and the whole outfit is shielded, with only a one-turn pickup coil outside the shielding. These precautions are simple, and if followed, the meter will be fairly accurate. A UV-199 tube with a 4.5 volt *C* battery used for an *A* battery, and another *C* used on the plate, will make a compact unit. The tube will oscillate readily with only the 4.5 volts on the plate, and will be steadier than if a higher voltage is used.

The heterodyne wavemeter is placed within two or three feet of an oscillating receiver, and tuned until a beat note is heard in the phones. The phones may be either in the receiving set or in the wavemeter. When the beat note goes to zero the circuits are exactly in tune, and the reading may be taken. The accuracy of the method will be seen when it is remembered how sharp the tuning of a regenerative receiver is on the carrier wave of a distant station. With the wavemeter set up near the receiver, any station within range which is transmitting, may be found at will. The wavelength of the station is looked up in the newspaper, log chart, or call book, and the wavemeter set to this wave. Then the receiver is tuned to zero beat with the meter, the meter is turned off, and a little more adjustment brings in the station. It was in this manner that amateurs first

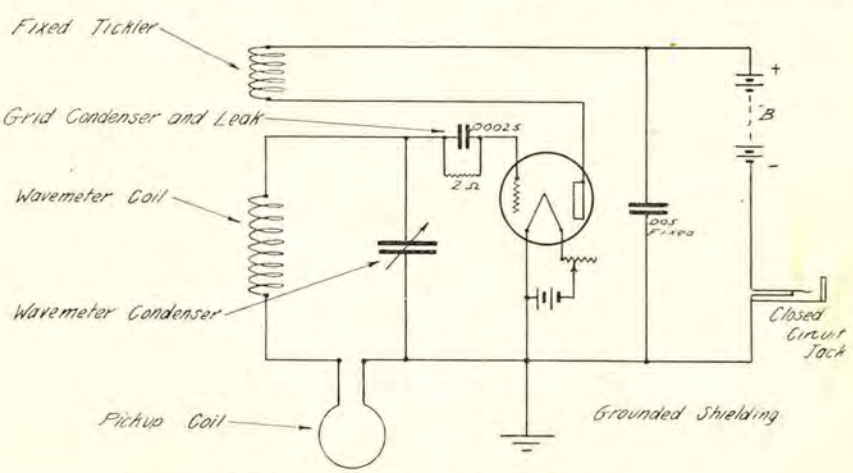


Fig. 2. Heterodyne Wavemeter Circuit.

established contact across the Atlantic. If a station is already tuned in, it is but a second's work to turn on the wavemeter, adjust to zero beat, and read the wavelength.

Another accurate method which may be used with a regenerative receiver is called the resonance click method. If a finger is touched to the grid of the oscillating set, a click will be heard as the oscillations stop. Similarly, if the simple wavemeter circuit of Fig. 1, without even the indicator at *X*, be coupled to the oscillating receiver and run through the wave, a click will be heard. This is because the wavemeter, when in tune, absorbs enough energy from the receiver to stop it oscillating, and the click results. This point on the wavemeter dial may be found very closely; if the coupling is too tight, two clicks will be heard, and the wavemeter must be moved away until only one comes through.

When it is desired to use a wavemeter with a non-oscillating receiver, such as a neutrodyne, the heterodyne and resonance click methods are useless. For there can be no beat note, nor resonance click, when there are no oscillations present. The remedy is to cause the wavemeter to generate a modulated wave. This can be done with the heterodyne wavemeter by connecting in an audio transformer as shown in Fig. 3. This makes the circuit oscillate at an audio frequency—i. e., howl. The howl will be sent out on the wave to which the wavemeter is tuned and may be picked up by a non-oscillating receiver. The connections to the transformer must be reversed if the circuit does not howl. The by-pass condensers on the transformer may have their capacities adjusted to give any desired musical note. Often a grid leak, connected promiscuously between transformer terminals, will cause a pleasing note.

The simpler way to give off a modulated wave from the wavemeter is to connect a buzzer in one of the circuits *a* or *b* of Fig. 4. The note is more likely to be ragged and broad than in the case of the audio oscillator. The buzzer is started working, and causes the wavemeter circuit to give off a signal whose wavelength is the same as that to which the meter is tuned. Of course, the coupling of the buzzer to the wavemeter circuit must not be too close, or the signal will be very broad, and will not be exactly the same wavelength as that which the dial reading shows. To measure the wavelength of a weak signal the phones and crystal detector may be connected, as in circuits *c* or *d* of Fig. 4. Neither of these connections will affect the accuracy of the circuit greatly.

The buzzer, and the crystal detector with phones, are the old standbys of pre-radiocasting days. They are used chiefly on damped waves, and have the inherent broad-tuning qualities of a damped wave so that the heterodyne wavemeter is the most convenient and the most accurate for the experimenter. Certain precautions must be observed in construction so that when the dial settings are once recorded they will always remain the same. All connecting wires on a meter should be run short and rigid and the condenser must be mechanically good, with bearings that will not wear and give play. The losses in the condenser are not overly important, though most condensers today which are good mechanically are also good electrically. The dial on the condenser shaft must be tight, for if it slips the readings will be worse than useless. It is best to spot a hole in the side of the shaft in which to drive the dial set screw. The wavemeter coil must of course be a permanent job. As cardboard forms for the coil are liable to shrink, wood or fibre should be used when possible. It is common to make several coils of different sizes for the wavemeter, to be used with the same condenser and indicator. A graph is drawn for each coil, and in this way the whole range of wavelengths is covered.

The wave range in which the experimenter is most interested is usually the radiocast band; the wavemeter to cover this range would use approximately the same size condenser and coils as are used in a radiocast receiver. The same is true for any other band.

After the wavemeter is built it must be calibrated, the dial settings being marked in terms of wavelength. The most convenient way is to tune the receiving set to one of stations KDKA, WBZ, WGY, WSB, WRC, WCAP, WEAF, or WWJ. Other stations of course may be used, but the wavelengths of these stations have been checked many times by the Bureau of Standards, and have been found to be always the same, within .1 or .2 of a per cent. With the station tuned in as closely as possible, the wavemeter is tuned to the receiver, and the setting recorded. The wavelength of the station can be found in most newspapers, or in a call book. With six or seven points over the meter scale recorded, a graph may be drawn, and then the wave for any point on the dial may be read off. If the condenser has semi-circular plates, the curve should look like that shown in Fig. 5; but of

(*Continued on Page 76*)

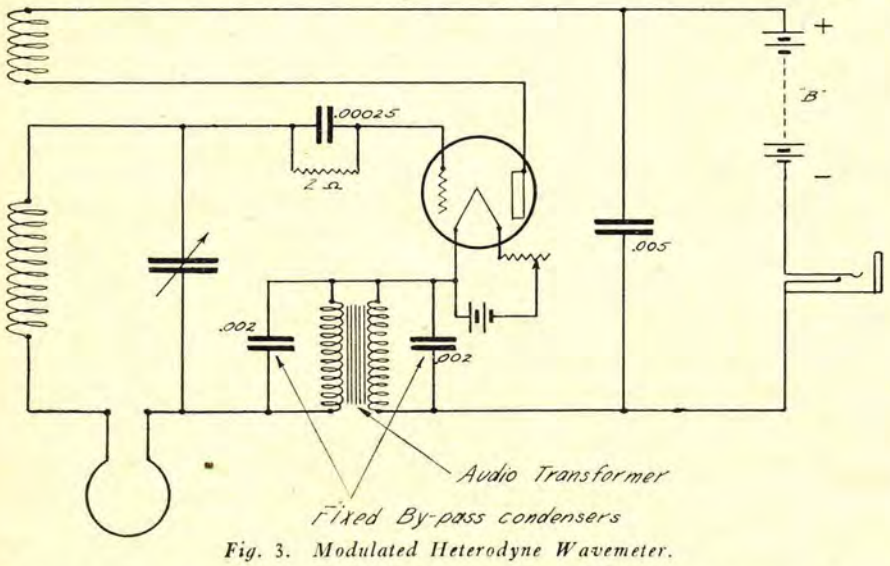


Fig. 3. Modulated Heterodyne Wavemeter.

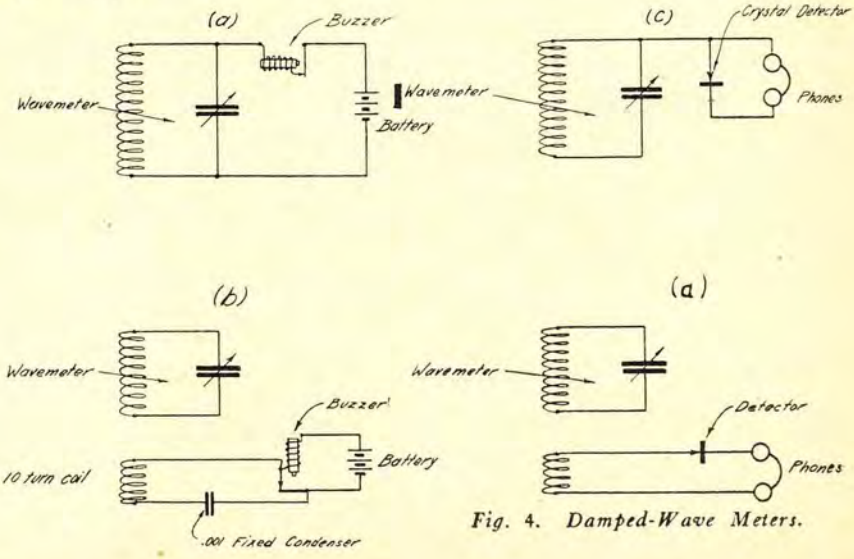


Fig. 4. Damped-Wave Meters.

R-240
RESISTANCE CALCULATIONS

Resistance is the measure of the opposition offered to the flow of electric current through a substance. The unit of resistance is the *ohm,* which is the resistance offered when a force of 1 volt produces a flow of 1 ampere. Thus resistance in ohms equals volts divided by amperes.

When using very high resistances the megohm (1,000,000 ohms) is used as a unit. Also for very small resistances the microhm (one millionth of one ohm) is used.

The resistance of various commercial sizes of wire is given in the following table. This represents the resistance offered to direct current. The resistance as given is in ohms per 1000 ft. of wire. Obviously the resistance of 100 ft. is 1/10, of 10 ft. is 1/100, and of 1 ft. 1/1000 the value shown.

Wire Table

No.	Diam. in mms.	Ohms per 1000 ft.	No.	Diam. in. mms.	Ohms per 1000 ft.
10	2.588	.9989	27	.3606	51.47
12	2.053	1.588	28	.3211	64.90
14	1.628	2.525	30	.2546	103.2
16	1.291	4.016	32	.2019	164.1
18	1.024	6.385	34	.1601	260.9
19	.9116	8.051	36	.1270	414.8
20	.8118	10.15	38	.1007	659.6
22	.6438	16.14	40	.0798	1049.0
24	.5106	25.67	42	.0633	1667.0
26	.4049	40.81	44	.0502	2652.0

An easy way to remember the wire table is to note that the resistance is approximately doubled for every third increase in gauge number and that the diameter is approximately halved for every sixth increase in gauge number (or multiplied by .707 for every third). Thus 1000 ft. of No. 10 copper wire has a resistance of 1 ohm, No. 13 of 2 ohms, No. 16 of 4 ohms, etc., and No. 10 has a diameter of 2.588 m. m., No. 16 of 1.29 m. m. etc. (or No. 13 of 2.588+ .707=1.83). It is also of interest to note that the weight is halved for every third increase in size and likewise that the number of feet per pound is doubled. The key figures to be remembered are shown in the following table:

Gauge No.	10	11	12	For every 3rd size larger
Resist. in ohms per 1000 ft	1	1.26	1.59	double
Diam. in mm.	2.588	2.31	2.05	times .707
Lb. per 1000 ft.	31.4	24.9	19.7	halve
Ft. per lb.	31.4	40.2	50.7	double

The practical method of figuring resistance is from the drop in voltage which it produces. Thus, what resistance should a rheostat have so as to deliver 3 volts to a 199 tube from a 6 volt storage battery? The tube filament draws .06 ampere, the drop is 6—3=3 volts.

$\therefore R=E\div C=3\div .06=50$ ohms.

R-144
HIGH FREQUENCY RESISTANCE

The resistance offered to the flow of high frequency alternating current is greater than that offered to direct current because more of it tends to flow in the outer portion than in the center of the wire. This so-called skin effect reduces the effective current-carrying area of the wire and thus offers greater resistance. This effect is independent of the opposition offered by the inductance or capacity of a circuit.

The resistance increases as the frequency of alternations increase, radio frequencies often being several times the direct current resistance. It can be calculated approximately for certain simple forms of conductors, but in practice is usually obtained by actual measurement.

The accompanying chart may be used to determine the factor by which the direct current resistance should be multiplied to give the resistance of different sizes of a straight piece of cylindrical copper wire at given frequencies.

The chart has two sets of curves: *A. B* and *C* and *I, II* and *III*... Curve *C* is a continuation of Curve *B* which in turn is a continuation of *A,* this being done to save the space that would otherwise be required to show them as one continuous curve. Likewise, *I, II* and *III* should be regarded as one continuous curve.

The left hand edge of the chart shows the frequency in kilocycles from 10 to 100 for Curve *A*. These numbers should be multiplied by 10 if used with *B,* thus giving values for

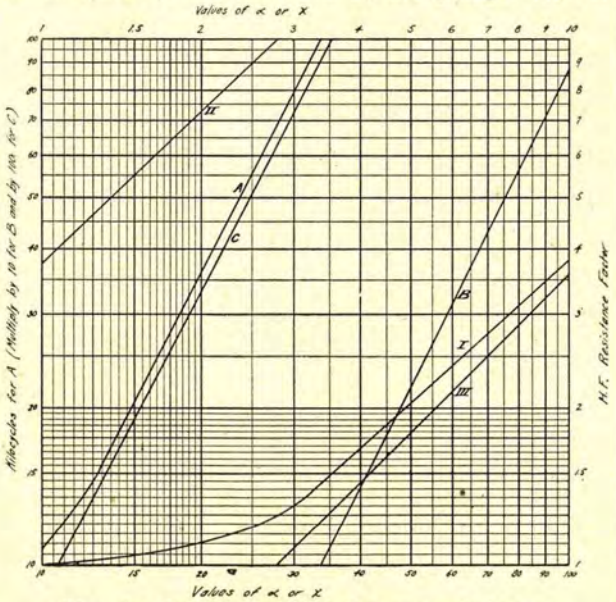
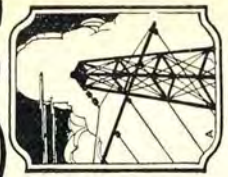


Chart for Calculating High Frequency Resistance.

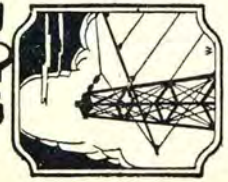
for The RADIO NOTE BOOK



Useful Facts and Theory

Classified According to Dewey Decimal System

Tear out page, cut along black lines, punch holes with pencil where indicated, and file numerically in standard notebook in accordance with Index Sheets Nos. 1 and 2.



R-144
HIGH FREQUENCY RESISTANCE
(Continued)

100 to 1000 kilocycles. Likewise they should be multiplied by 100 if used in conjunction with *C*, for which the compounding frequencies are from 1000 to 10,000 kilocycles.

The curve *A B C* is first used to find the value of a factor *a* as read on the top of the chart for *A* and *B* and on the bottom of the chart for *C*. Thus *a* for 70 kilocycles is found by following the 70 horizontal line until it intersects *A* and then following the imaginary vertical line until it cuts the top line at 2.8, the value of *a*. Likewise the intersection of the 70 horizontal line with *B* for 700 kilocycles gives 9 as the value of *a*, and its intersection with *C* for 7000 kilocycles gives 29.5 on the bottom line for *a*.

This factor *a* is multiplied by the diameter of the wire in millimeters, as taken from the wire table, to give another factor *X* which is read at the top or the bottom of the chart, according as it is less or greater than 10. By following the vertical line from X until it intersects *I, II* or *III* and then following the horizontal line from this intersection until it cuts the right-hand side of the chart we find the final factor by which the direct current resistance must be multiplied to give the desired high frequency resistance. Thus intersections of X from 1 to 10 with curve *I* gives resistance factors from 1.005 to 3.8; for X from 10 to 27.7 the intersection with *II* gives final factors from 3.8 to 10; and for X from 28 to 100 the factors increase from 10.15 to 35.61.

This chart is made up from tables published in U. S. Bureau of Standards Circular No. 74 for frequencies up to 3500 kilocycles. For higher frequencies the *C* line is merely projected.

As an example of the use of the chart, suppose that we are required to find the high frequency resistance of 100 ft. of No. 22 wire at 700 kilocycles (429 meters).

For 700 kilocycles from Curve *B* we find *a* to be 9. The diameter of No. 22 wire is .6438 millimeters. Therefore X=9x.6438=5.79. The corresponding high frequency resistance factor from Curve *I* is 2.3. The wire table shows the d. c. resistance of 100 ft. of No. 22 wire to be 1.614 ohms. Consequently its resistance at 700 kilocycles is 1.614x2.3=3.7 ohms.

The operation is reversible so that with the chart it is possible to easily solve otherwise difficult problems. For example, at what frequency is the resistance of 100 ft. of No. 27 wire equal to 10 ohms?

From the table the d. c. resistance is found to be 5.147 ohms and the diameter .36 millimeters. The high frequency factor =10÷5.147=1.94. The corresponding *X* from Curve *I* =4.7. The corresponding a=4.7÷.36=11. Consequently the frequency, from Curve *B*, is 120 kilocycles.

The calculation of the high frequency resistance of coils is more difficult than the actual measurement. To obtain the least skin effect for a given weight of conductor it is necessary to increase the superficial area and by the use of tubing or stranded cable.

R-240
RESISTANCE CALCULATIONS
(Continued)

What filament voltage will be delivered to 5 "A" tubes in a Neutrodyne set from a 6 volt storage battery through 100 ft. of No. 14 wire?

R=.25 ohms. *C*=5x¼=1.25 amperes.
.25=*E*÷1.25 *E*=.25÷1.25=⅕ volt drop.
∴ voltage delivered=6—⅕=5⅘ volts.

What resistance should a rheostat have to cut this voltage down to 5 volts for these tubes?

Desired voltage drop=5⅘—5=.8 volts.

C=1.25 *R*=.8÷1.25=.64 ohms.

What resistances are necessary to cut down 130 volts from a plate current supply set to 45 volts for the six detector and intermediate amplifier tubes of a superheterodyne and to 90 volts for the first audio tube, using C-299 tubes?

Assume that the current drain of the first six tubes with *C* battery is 5 milliamperes (.005 amp.) The required voltage drop is 130—45=85 volts. R=85÷.005=17,000 ohms for the 1st 6 tubes.

Assume that the audio tube takes 2.4 milliamperes (.0024 amp.) The required voltage drop is 130—90=40 volts.

R=40÷.0024=16670 ohms.

The preceding calculations have all been on the assumption that the resistance is placed in series in the circuit, the current following one continuous path with respect to the source. In the case of parallel circuits, where two or more resistances are connected between two points in a circuit, the joint resistance of the two or more is less than the resistance of any one of the branches, being numerically equal to their product divided by their sum.

Thus if the above 17,000 and 16,670 ohm resistances were connected in series their combined resistance would be 33,670 ohms. But if connected in parallel it would be 17,000× 16,670÷33,670 or 8,416 ohms.

Because of its relatively great conductivity, copper is not used in the construction of rheostats, some high resistance alloy generally being employed. Assuming copper as unity, the relative resistance of Nichrome wire is 58., of Climax wire 50.46, of Constantan, Advance or Eureka wire 28.43, and of German silver wire 19.14.

Thus if 10 ft. of No. 22 copper wire has a resistance of .1614 ohms, 10 ft. of Nichrome has 58x.1614=9.36 ohms.

The so-called potentiometer, or more correctly voltage divider, is a high resistance unit for conveniently delivering a lower voltage than is provided by the source. Thus with a 6 volt *A* battery as a source, the potentiometer can be set to deliver any desired *C* or grid biasing voltage or it may be used to boost the *B* battery voltage from an *A* battery supply.

Interesting Data on Reception

By E. T. Jones

YOUR first impression of radio was probably good, provided that you heard the announcer say that you had just listened to Vincent Lopez and his Pennsylvania orchestra, or some other notable organization. You hardly stopped a moment to recall whether you heard "music" or not, you were so bewildered and fascinated. The truth of the matter was that you may not have heard any real music, that is, the kind of music which would make you feel like owning the set. Probably the fault lay in the operator of the receiving set, and not in the set istelf. In his over-zealous attempt to bring it in loud enough for you, a great number of distracting noises were also brought in with the music and if you were not too absorbed in the mystery of the thing, you would have immediately condemned the performance and secretly resolved never to listen to that particular orchestra again.

There is a limit to the amount of amplification that should be employed and this limit is reached when the quality of the music is being impaired to produce quantity. But you insist on quality, to which you are entitled, when you pay several hundred dollars for a radio receiver, and happily the design of modern equipment is towards that end. It is well to bear in mind that the slightest noise in the radio receiver distracts from the beauty and quality of the music. You know quite well that if a phonograph dealer were to let you hear a popular record and you heard one scratch in the entire selection, you would say that you were pleased with the selection but would like a new record from stock. That is how keen your ear is for good music when you are paying for it. Therefore, why inject any more noise into the radio receiver than is picked up from external sources.

The proper procedure in the operation of a radio set, for loud speaker reception, is to adjust the volume to a point where the noise is in the background, and at no time becomes sufficiently severe to impair the quality of the music or speech. When the volume is increased beyond that point, the noise will increase in proportion, and will have a greater interfering effect as it becomes more audible. The moral is, adjust your receiver to the point where acceptable music is to be had, no matter how much volume you can obtain and are holding in reserve. The neighbors all know that you have a radio set, and it is not necessary to increase your volume until they have to close their windows due to the noise. The word volume is strictly a synonym of noise in radio reception and furthermore an antonym of quality.

Then there is the question of distance, a subject which is the cause of continuous argument between customer and dealer. The manufacturers of most of the 500-watt radiocasting stations will not guarantee more than 100 miles daylight communication. This bears out the fact that you ought not to hear the numerous 500 watters if you are more than 100 miles distant. At night the range of such stations is greatly increased, and from 500 to 1,000 miles is a consistent range. If you happen to hear such a station at a greater distance, then you may consider yourself lucky, for the station has exceeded its guaranteed range by many miles. If you fail to hear the station tomorrow night, don't throw up your hands and wish you had bought a phonograph, for your set is not to blame. Bear in mind that nearly all the stations you listen to at night are 500 watts output, or less, and that if the sun failed to set one evening, you would not hear any of the stations you were accustomed to hear after sundown.

If you are located 100 miles or less from a 500-watt station, you should have consistent communication 365 days in the year. At night the same station should be heard at a greater distance, and it has been found that this range varies from night to night, so that no guarantee can be given by the dealer as to the exact maximum possible distance obtainable, due to the variation in receiving conditions from night to night. If you read a published statement that such and such a station was received over a distance of 1,000 miles in the day time, you can bank on the fact that the reception took place after sunset, and that one of the two locations was probably in total darkness at the time. To obtain reliable service over distances up to 1,000 miles would require at least 100 times the power now in use, so beware of the receiver that has performed coast-to-coast reception in "broad daylight," for the "dark man in the woodpile" was probably the broad stretch of night that covered 90 per cent of the space between the two points.

The Australian Broadcasting Company's station (3L0) at Melbourne has altered its wavelength from 1,620 meters to 371 meters. This station had the longest wave of any broadcasting station in Australia. One Sydney station, 2BL, has altered its wavelength from 350 to 353 meters and has increased its plate input to 1,500 watts. The other station, 2FC, has intimated that changes are being considered, but no official announcement has been made.

HANDY HINTS

A good portable ground connection can often be made to a piece of wire netting, laid on the ground. This serves only as a counterpoise, unless laid on very wet soil.

The substance sold by druggists as "new-skin" makes a good binder for holding inductance coils together.

It is much better to keep a storage battery well charged at all times than to let it run down, and then give it a long charge.

When laying up a lead storage battery for a while, the simplest way is to give it a good charge and then continue this into an overcharge of about 10 or 12 hours at a reduced rate. Then replace the electrolyte with distilled water, and again charge it at a low rate. All that is necessary to lay up an Edison alkaline battery is to put it away, provided there is enough electrolyte to cover the plates. The state of charge does not matter with this type battery.

Electrolysis in water pipes under some conditions may set up enough trouble to cause sparks and thus interfere with radio reception.

One of the handiest tools around the radio shop bench can be made up by making a heavy chisel-like knife from an old file. This can be used to scrape wires, cut wood, or do any of a hundred things you'd not care to use a good tool on, and when its broken or worn out, a new one can be ground up again on any emery wheel.

Files can be resharpened, after the loose dirt has been removed with a stiff brush, by first boiling them for an hour in a solution consisting of ¼ lb. of saleratus to a quart of water so as to remove the grease. They are then washed in clear water and dried preparatory to being completely immersed, standing on end, in a solution of ¼ lb of sulphuric acid to a quart of water, where they should be left for 12 hours. They should again be washed and dried.

Copper may be cleaned and brightened in nitric acid, even if it is old and green. This often is much easier than scraping or sandpapering. Remove all traces of acid, before leaving the job, however, or things will corrode worse than they were before.

In working around lead storage batteries, celluloid sheeting can be used to protect the table or floor, and will prove to be as resistant to acid as the usual lead or rubber, also being cheaper and easier to handle.

A few sheets of blotting paper should always be kept in or near the storage battery cabinet to absorb any acid that may be spilled.

Loud Speaker Testing Methods

Suggestions Applicable to Home as Well as Shop Tests for Quality of Reproduction

By John P. Minton

THE editor of one of the technical magazines recently said that the quality of the sound from his radio set seemed to be poor. He had tried all the ideas he could think of to improve it, but had not succeeded in obtaining satisfactory results. He had concluded that the loud speaker was the source of his trouble, and with this particular part of his set he was not able to attempt an improvement He could tinker, so to speak, with coils, tubes, batteries, wires, etc., but he was at a loss as to how to tinker with the loud speaker itself.

This is true—none of the fans know how to tinker with a loud speaker. Certain types of loud speakers are well nigh hopeless for the amateur to apply his innate desire for "tinkering," and for this reason, care in the selection of a loud speaker at the beginning should be exercised. The present short discussion of the testing of the commercial loud speakers of today will, without doubt, be helpful to many in suggesting methods for doing their own testing.

The usual method employed is the listening test with actual radio signals. This is a good test and an important one, but the experimenter cannot make use of it satisfactorily unless he has at least a half a dozen loud speakers to compare with one another. The speakers must be tried on various sets and comparisons made with speech and music from a number of different stations at various times. Logical conclusions of a comparative nature can then be drawn with considerable degree of certainty by a person who has been well trained to make just such tests. Fig. 1 illustrates this method of test.

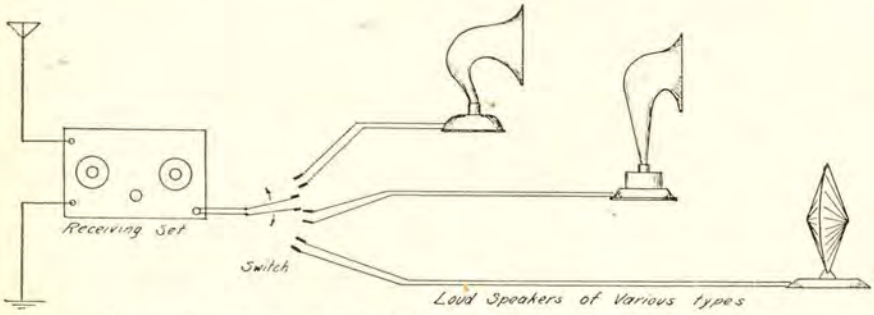


Fig. 1. Comparing Loud Speakers by Means of a Receiving Set.

Another method utilizes the voices of various people as they speak into a high quality microphone or, better still, the high quality condenser transmitter. The voice current generated by either one of these instruments is fed into a resistance coupled amplifier which is as free from distortion as is possible to make it. From this amplifier the speech current is led to the loud speakers to be tested. This scheme of testing loud speakers, as illustrated in Fig. 2, gives very valuable results. Any distortion due to a receiving set or to the radiocast station is eliminated. The final result, then, will be characteristic of the loud speaker itself in direct comparison with the speaker's voice at the microphone.

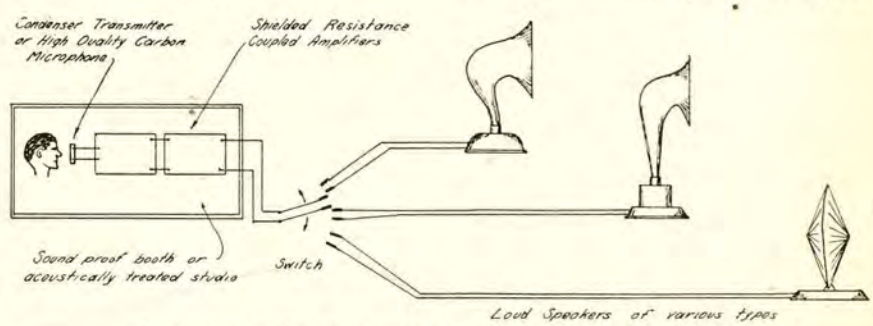


Fig. 2. Comparing Loud Speakers by Means of Actual Voice.

Usually the speaker is in a sound-proof booth and the listener is just outside. At any moment the doors can be opened as the speaker continues to talk without change in his voice or position, and we are then able to listen to his voice directly and thus are able to make the comparison between the original and the reproduction. A piano or other instrument may also be placed in the booth. In the Technical and Test Laboratory of the Radio Corporation of America is a studio whose acoustic characteristics are similar to those of their radiocast studios. Studio conditions can thus be obtained any time.

A third method used in loud speaker testing is electric phonograph reproduction. In place of the usual sound box into which the phonograph needle is placed, an electric sound box, as it may be called, is adapted so that the needle, actuated by the record, is connected to a loud speaker unit of either the usual bipolar or balanced armature type. The needle's motion in the groove of the record causes corresponding vibration in the unit, and these in turn make possible the generation of corresponding electric currents. These currents are fed through a suitable amplifier for amplification and then led to the loud speaker. In this scheme of testing we have perfect control over the testing conditions, but it has the disadvantage that any distortion which is in the records is reproduced in the loud speaker.

These three methods all employ the ear for observation. The ear can judge with great accuracy the human speech. We can tell instantly if a voice sounds natural, evenly balanced and whether or not it can be understood with perfect clearness. Such cannot be said so positively regarding music. Music will stand for a lot of abuse and distortion as far as the average listener is concerned; he will not be so conscious of these defects, particularly while listening to music over the loud speaker. Therefore, the second method is the most useful, the others being used for preliminary tests.

But the most important factor in making these tests is some permanent record of loud speaker performance as the basis for precise comparison and also as a legal means to substantiate claims. Fig. 3 shows the set-up employed, a loud speaker replacing the personal voice at the sending end and a highly sensitive current measuring system replacing the loud speaker at the receiving end.

By means of a vacuum tube oscillator electric currents can be produced whose frequencies cover a range from 10 cycles to as high as we desire to go—say 20,000 cycles. The human ear will perhaps include a range of frequency from 20 to 16,000 cycles. Above and below these

(*Continued on Page 66*)

An Inexpensive Chemical Rectifier

Constructional Details of an Outfit That Will Supply 550-600 Volts for an Amateur Transmitter

By C. A. Weidenhammer, 1 ZL

IN these days of ultra-short waves and resulting poor notes it is unusual to hear a "ham" who sports a note which has no A. C. component. Of course, if a good note becomes unsteady, it is as exasperating as the hoarse squawk of an unfiltered synchronous rectifier or "pure" A. C., but barring unsteadiness, nine times out of ten the owner of such a note will tell you he has accomplished a lot more DX and consistent work just through its readability and cleanness.

The average amateur, on starting in the power game, turns to chemically rectified A. C. as the solution of his plate supply problem. In the first place he shuns A. C. from sheer fear of ostracism from the rest of the gang. Secondly, motor generators are beyond the reach of the average pocketbook. Then, too, "sink" rectifiers are rather beyond construction by the amateur who hasn't mechanical ability to a pronounced degree. Thus, in utter desperation, he turns to electrolytic rectification as the only way out of the difficulty.

In a great many cases, the builder of a chemical rectifier obtains a lot of jars, throws in aluminum and lead strips that are not too pure and clean, mixes a solution with suspiciously pure water, and then wonders why good rectification doesn't occur. He would have spared himself no end of trouble and disappointment if he had built his rectifier according to a set standard of construction. The rectifier to be described was built by the writer from universally accepted electrical data on rectifying apparatus and partly from wrinkles encountered in past experience. At any rate this particular combination has worked exceptionally well, indeed better than the average, and that seems enough justification for its description.

The builder will need a list of material that can be purchased for the most part at very nominal cost, the only expensive items being the lead and aluminum. The list follows:

16 Blue Ribbon mayonnaise jars (half-pint size).
(Any other jars of this type will do).
16 pieces of the purest aluminum obtainable, 1½ by 5 in.
16 pieces of sheet lead, 1½ by 5 in. (⅛ in. thick in both cases).
16 round head, brass machine screws, 8/32, 3/8 in. long, with nuts.
A pound of sodium phosphate.
A pint of medium grade transil oil.
A half-gallon of distilled water.
Lye for cleaning the elements.
A wooden tray for the rectifier.

The position of the rectifier in the station will best determine the size of the tray and the arrangement of the jars. There are a few dealers at present who are selling aluminum and lead strips already bored. Although a little more expensive this way, the elements are bound to be truer and are really to be preferred to those cut by the builder from sheet aluminum and lead. There is a lot less work in store for the "ham" if he buys these, but if the sheet metal is decided upon, it is best to use a pair of tinner's shears for cutting up the lead and a hacksaw for the aluminum.

The drilling of the elements is a rather tedious job, but should be done carefully, nevertheless. An 8/32 hole is drilled in the center of each aluminum and lead strip, 5/8 in. from the end. Any metal drill of that size will do the job. Be careful not to wrap the lead pieces around the bit, a situation that will result if the strips aren't held firmly in the process of boring.

The elements now being ready for cleaning, it is absolutely necessary that they be rid of dirt and grime if the rectifier is to work. Foreign matter on the surface of the electrodes forms an efficient barrier against electrolytic action. A hot lye solution will solve the cleaning problem. Dissolve six or seven tablespoons of lye in a gallon of boiling water, in a pot or pail you have no use for. Do this in the open air, for lye is strong stuff and not especially recommended for inhalation. Stir the solution with an old stick and *don't* get any of the solution on the hands. Hooking a piece of wire in the hole at the end of each aluminum strip, suspend each one in the solution until the metal hisses and froths. As soon as this frothing has started, remove each strip from the solution and wash it in cold water. Don't let the strips lie around, for they will become streaked where the excess lye on the surface eats in. Wash them immediately. If the aluminum is streaked with black lines and covered with dark splotches, it should not be used in the rectifier, for this is the sign of impurity. Pure aluminum should present a silvery appearance upon cleansing and there lies one secret of efficiency in rectifier operation.

The lead strips are given the same treatment and if the solution has lost its power, make a new one. The lead will not froth like the aluminum, but should be given a reasonably long immersion. Keep the aluminum strips away from the lead when you take the latter from the solution, for if any of the solution left on the lead strips splashes on the aluminum, black spots will result that won't come off. Clean and dry the aluminum first; then tackle the lead strips.

This operation completed and the elements dried, the strips can be bolted together and bent to fit the jars, allowing for separation between jars and a half-inch at the bottom of each jar. Four single pieces will be left for the end connections.

The writer has found sodium phosphate to be a much better solution than borax. In the first place it does not eat up the aluminum strips as borax does and secondly, it is not so messy to work with and on the whole it's general performance is much superior. A pound of the sodium phosphate will be needed for the solution, and it may be bought at any drug store for a very small sum. Fill a stone crock with enough distilled water to fill the jars to within a half-inch of their mouths, heat the water slightly and pour in the phosphate, stirring the solution slowly. Keep adding the powder until

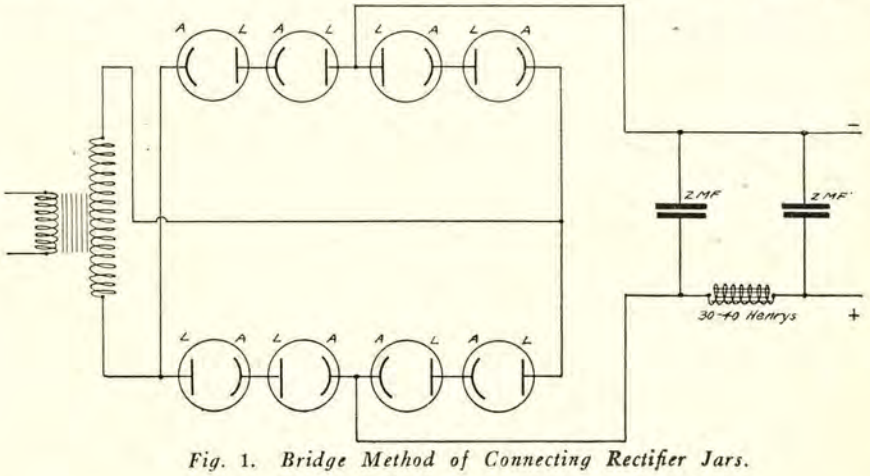


Fig. 1. Bridge Method of Connecting Rectifier Jars.

the solution has become saturated; that is, until the water will dissolve no more of the chemical. Let the mixture stand for a day or so until it has settled. The sediment will take crystal form in the bottom of the crock. The clear solution must be poured off and care should be taken not to pour any of the sediment along with it, for if this is done, the rectifier jars will be graced with a quantity of sediment after they have been standing a short time. Pour the solution into the jars and immerse the elements in their proper sequence, as shown in Fig. 1. Take care not to splash any of the solution on the aluminum and lead crosspieces and sides of the jars, for crystallization will result almost immediately and the rectifier will not be the thing of beauty that it should be with the proper precautions.

Placing a quarter-inch of medium grade transil oil, or medium auto lubricant if you haven't the other, in the top of each jar completes the job. This oil film is of real importance for not only does it prevent the solution from evaporating and creeping, but it also prevents arcing between the aluminum elements and the solution, a valuable feature in itself. It may seem superfluous to some, but it is worth its weight in gold in the end.

The rectifier is now ready for operation. The strips are connected according to Fig. 2 for a center tap connection, but a bridge connection can also be used as shown in Fig. 1, although it will require more jars which the builder can add as he sees fit. As soon as the connections have been made, throw on the juice and the aluminum will form almost immediately if pure, but the lead will take quite a little longer to coat. When the coating has been completed, a process that can be accomplished either by leaving the rectifier connected to the transformer for a few hours or by gradual formation through operation in conjunction with the transmitter, the aluminum will present a grayish appearance with little evidence of any great deposit on its surface, while the lead will be a chocolate brown. If the rectifier is working properly, all the aluminum strips will glow in the dark with a phosphorescent light without any pyrotechnic display. Fireworks, large arcs occurring on the surface of the aluminum, are a sure sign of overloading and too few jars. There will be star-like lights all over the surface of the aluminum during the forming process, but these are negligible and are to be expected. It is the arcs of greater magnitude that bode evil. Those jars that do not glow at all are "duds" and should be replaced. The rectifier at the writer's station has been in commission for six months and is still working merrily with the original solution and elements. Every aluminum strip glows without any evidence of excess current.

The rectifier that has been described was designed primarily for 550 to 600 volts. If the builder intends to use a higher voltage, it will be necessary to place more jars in the rectifier system. There is a simple formula regarding the number of jars to be used with a certain applied voltage that has often been quoted, but which will always stand requoting. It is:

$$\frac{\text{Volts to be applied}}{40} = \text{number of jars to be used.}$$

There must be a jar for every 40 volts input if efficient rectification is to result, and the rule if incorporated in the design of your rectifier, will keep your electric bill down low enough to insure domestic tranquility

The filter for this combination can best be the well known "brute force" type, made up of a 30 or 40 henry choke in the plus lead with 2 mfds. shunted across the supply on each side. The writer uses only a 1 mfd. condenser across his supply for a filter, the small value being necessary because the set is keyed in the primary of the plate transformer. There is no key thump to speak of and all report the note "D. C.," erroneously, of course.

There is one "kink" that has become very popular of late that improves the note greatly and that is the combination of filament by-pass condensers and a large rheostat in the primary of the filament transformer. A rheostat in the tube filament circuit proper throws the center tap off, thus throwing the circuit out of balance and giving the station a poorer note than would result if the center tap were unaffected. The filament by-pass condensers explain themselves.

In closing it should be noted that cleaning a rectifier frequently is a good plan for through continued use the lead strips become coated with a milky white substance that is better removed. Sediment in the bottoms of the jars should be poured out and distilled water added as evaporation takes place. With a little care the rectifier described will give the utmost satisfaction and should be a distinct asset to the station.

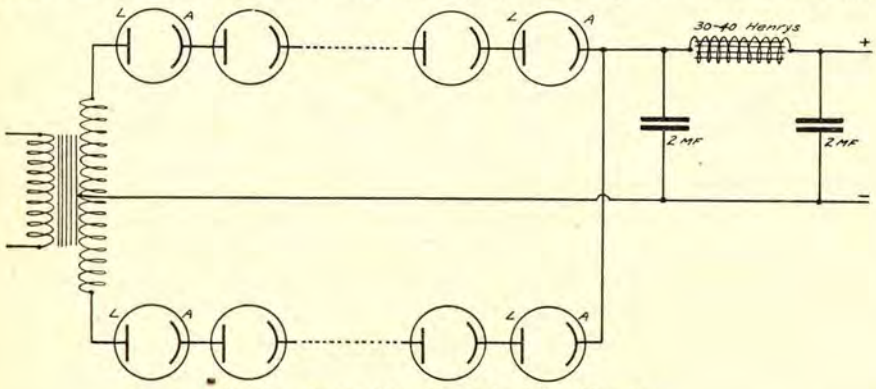


Fig. 2. Center Tap Method of Rectification.

NEW TUBES AND BASES

Vacuum tube manufacturers have adopted a new form of standard base which may be used interchangeably in the present form of Navy socket or in a new type of push socket. In the case of the Radio Corporation of America these will be known as the "UX" tubes and in the case of Cunningham they will be "CX," in each case using the present series of numbers to designate various types of storage and dry battery tubes.

The new base has longer contact pins and the filament pins are larger than the grid and plate pins so as to insure correct placement in the socket. The "push" type of socket gives better contact and takes less space and will be made in two diameters to receive the large and small tubes. The present dry cell tubes with their original bases will be continued in production as long as the demand exists.

Three new types of receiving tubes will be announced at an early date. The "112" is an audio amplifier for use in the last stage; it requires 135 volt *B* battery and storage *A*. The "120" is similar except that it may be used with dry cell *A*. The "210" takes 6 volts *A* and up to 350 volts *B*. They are all low impedance tubes which provide improved quality of loud speaker reproduction. Two new types of rectifier tubes for *B* battery eliminators are also to be introduced for either half wave or full wave rectification.

Two Japanese news agencies, Toho and Teikoko, are using a 2000 watt radio station to send out news daily to Europe, America and the Far East.

The U. S. Forest service requests the co-operation of radiocast and amateur operators in sending out slogans and warnings about the prevention of forest fires.

Permalloy, the new magnetic material used in loading submarine cables so as to greatly increase their traffic carrying capacity, has great possibilities for improving the characteristics of the audio frequency transformers used in radio receivers. It is an alloy consisting primarily of nickel and iron and has a permeability about twenty times that of soft iron wire. For an alloy consisting of 78½ per cent nickel and 21½ per cent iron the permeability is about 2300 as compared with 115 for the best soft iron. Various other elements may be added to impart other desirable properties, chromium thus being added to secure high resistivity.

The Push-Pull Radio Frequency Oscillator

Constructional Details for an Easily Made Short Wave Transmitter Having no Harmonics

By D. B. McGown

THE General Electric Company has recently developed a circuit for use in their high powered short wave transmitters, which is deserving of consideration by all amateurs interested in transmission. This system uses two or more tubes, in groups of two, in such a way that each tube operates in "push-pull" fashion similar to the performance of the audio frequency amplifier system of the same name. The transmitters employed by the General Electric Co. are of comparatively high power, but the principle of the circuit is the same for any type of tube, and for the amateur with two tubes of identical type, provided they are not in excess of the power restrictions placed on the amateur, this circuit possesses many interesting features.

The chief advantage of the circuit is that it eliminates radiation of harmonics, which is ordinarily the most troublesome and objectionable cause of interference with reception of stations on other wavelengths, and is the cause of difficulties in the transmitting set such as heating of the small wires inside the vacuum tubes leading to the grid and plate elements. These currents are of extremely high frequency and have high power contents, so that in many cases the small connecting wires melt and open the circuit, thus ruining the tube. Inserting small chokes in series with the grid or plate leads where heating appears does no good, as these oscillations are apparently due to other causes than inter-tube coupling.

The "push-pull" transmitter also allows very easy control of the tubes at waves as low as 20 meters, thus being a good all around system for amateur use. In Fig. 1 is shown a schematic diagram of connections for the circuit, from which it is noted that the antenna circuit is coupled to the plate circuits of the respective tubes by coupling inductances L_1 and L_2 respectively. The antenna circuit may be the same as that used for any ordinary oscillating system and may be tuned to the fundamental wavelength to be used, or to one of its harmonics, whichever is desired.

The plate circuit is made up of two symmetrical coils of exactly equal size, indicated in the diagram by L_3 and L_4. These coils are connected together at one end as shown and the plate supply fed through the mid point X. These coils should not be placed in inductive relation to each other, their normal position being about a foot apart and with their axes parallel.

The closed oscillatory circuit is formed by these inductances, L_3 and L_4 and the two variable condensers C_1 and C_2, which are connected in series. The latter are of the double spaced, low loss type, of .00025 mfd. each. L_3 and L_4 were made up of 4 turns of 1/16 in. by 1/4 in. edgewise wound copper strip on a 4 in. diameter, with clips provided for any variation that might be needed. Condensers C_1 and C_2 were connected in series to give symmetry to the circuit and the grid of each tube was connected to the plate circuit inductance of the opposite tube through condensers C_3 and C_4, which are similar to C_1 and C_2. The grids were kept at the proper potential by the gridleaks marked GL, the proper value depending upon the size of tube used. For the UV-203-A 50 watt tube the leaks should be around 5000 ohms, and for lower powered tubes this value will be considerably higher. Inductively wound leaks were used, so that they choked back the radio frequency currents impressed upon them. If non-inductive type leaks are used, small radio frequency choke coils will be required in series with the leaks.

The filaments were supplied with low voltage a. c. from a step-down transformer, the actual balance between the tube filaments being obtained by variation of the rheostats in series with the transformer secondary. No mid-tap is shown in the diagram, but it is possible that slightly better tube life might be obtained should one be provided. The plate current is fed through the tuned choke L_5, C_5, which is augmented by a larger untuned choke, L_6. The antenna coupling coils were made of 3 turns each of 1/16 in. x 1/4 in, edgewise wound copper strip on a 3 in. diameter and were so arranged that they could be moved right into the plate inductances L_3 *and* L_4, or coupled as loosely to them as was desired. Clips are provided to allow a variation of the inductance.

Standard vacuum tube sockets were employed, since the ultra-high frequencies were not to be used. The preliminary adjustments and set-up of this circuit are not critical, provided that reasonable care is given to symmetry. The adjustment and operation of the circuit depends entirely upon this symmetry and without it, the usual circuits might just as well be used.

In setting up the apparatus, it is a good plan to cut all the connecting wires in pairs, first having arranged the two tubes and their respective inductances and condensers in such a manner that they are symmetrically placed. A suggested set-up is shown in Fig. 2, which

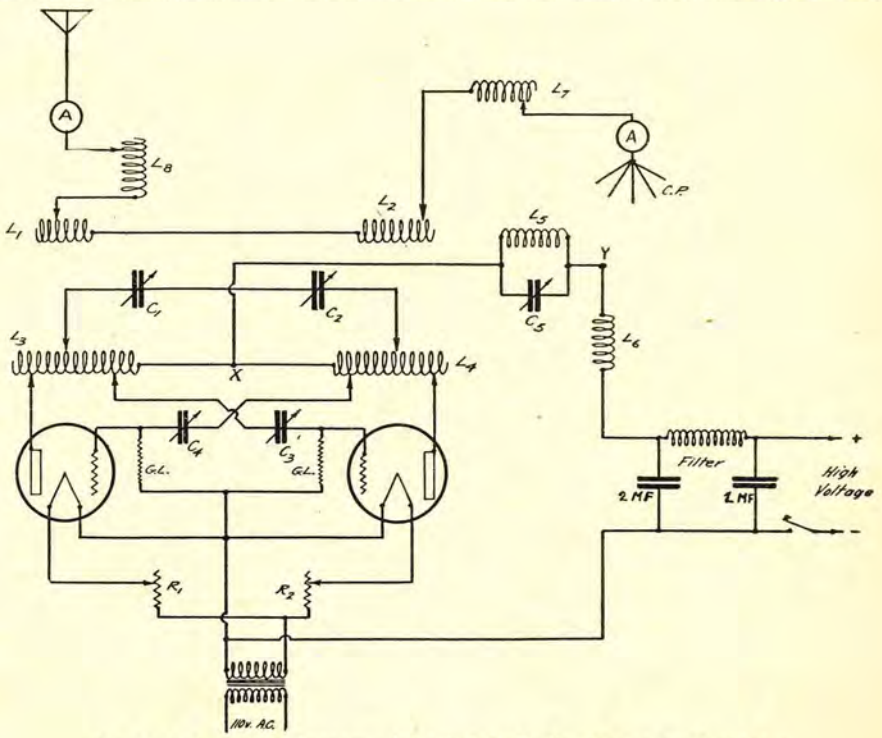


Fig. 1. Schematic Diagram of Push-Pull Radio Frequency Oscillator.

shows the layout of the various parts mentioned in Fig. 1. The grid taps of coils L_3 and L_4 should be set so as to include the same amount of inductance in each coil, and the plate taps should be likewise adjusted to symmetrical positions. The variable condensers and closed circuit taps should be adjusted to symmetry as far as can be observed with the eye, the coupling condensers in the grid circuits being set to about half their maximum capacity.

between L_1 and L_3, and between L_2 and L_4 will be found to be very critical, so that resonance is often passed over if the wavelength variations are not made slowly and carefully.

With the circuit adjusted to its best operating condition, the plate choke should now be adjusted by varying condenser C_5 and inductance L_5 until the plate current drops slightly and the antenna ammeters indicate slight increases. This will indicate resonance and shows

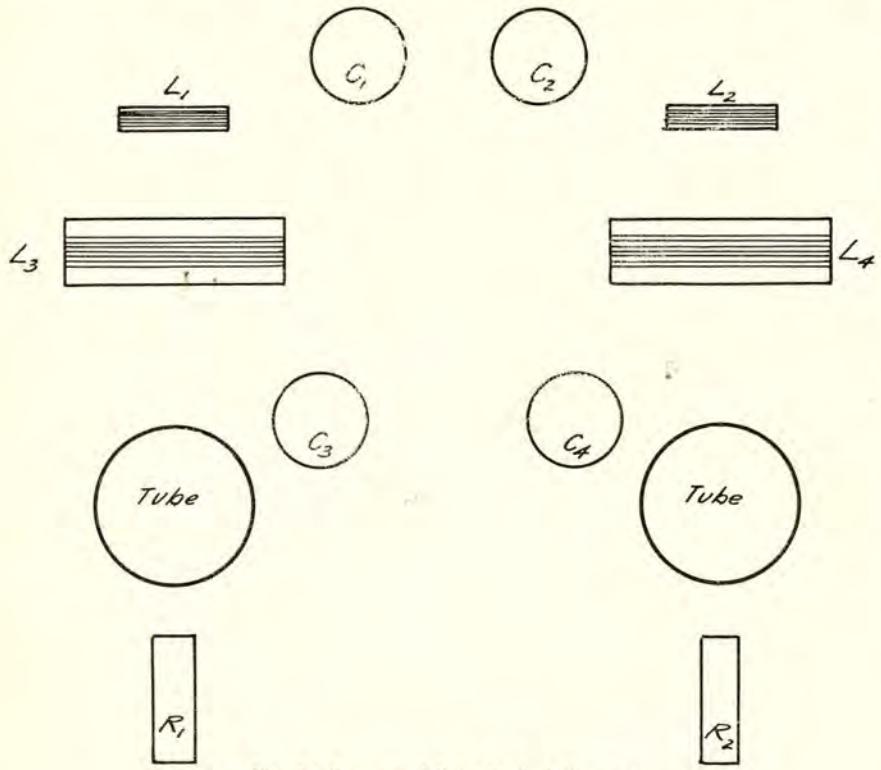


Fig. 2. Suggested Set-up of Apparatus.

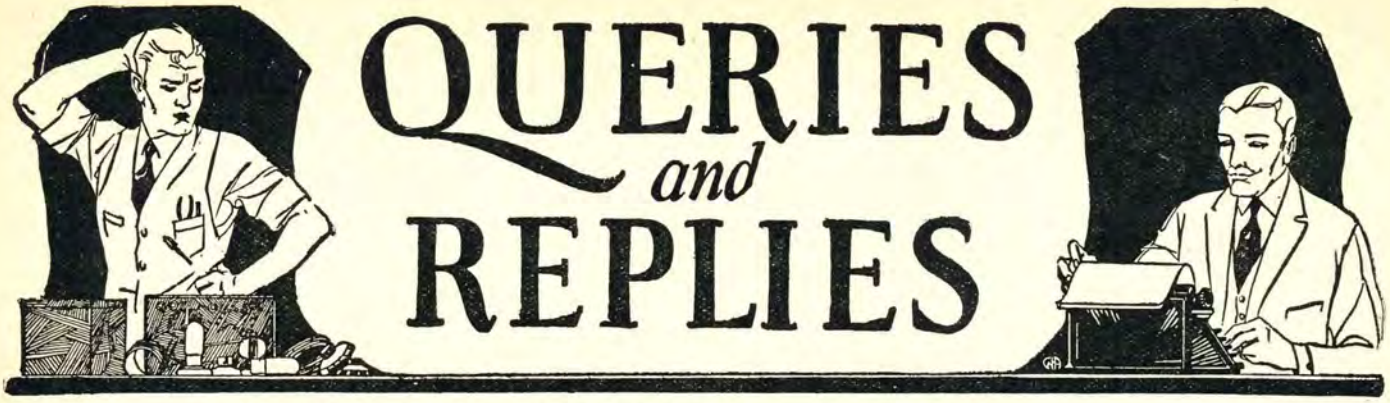
The antenna circuit should either be loosely coupled, or else entirely disconnected during the preliminary tests. Next light the filaments of the tubes and apply a low plate voltage, so that if the adjustments have been made properly, oscillation should take place at once and with sufficient power to be detected with a wavemeter. If the wavelength is too high, reduce condensers C_1 and C_2, or if it is way too high, reduce the amount of inductance in L_3 and L_4 as well as the capacity of the condensers in shunt. Now couple the antenna circuit to the oscillator and tune to resonance. This may be done either by varying inductance L_7 or by the use of a series air condenser, if the inductance is not desired. It has been found good practice to provide two inductances, L_7 and L_8, one in the antenna and the other in the counterpoise lead, two radiation ammeters being used to obtain the optimum adjustment. A slight re-tuning of condensers C_1 and C_2 may be necessary to obtain maximum resonance, and it will probably be found desirable to vary the two grid condensers C_3 and C_4, as well as their inductance taps. The coupling

that the tuned choke system is effectually rejecting any energy that reaches it. The untuned choke L_6 may then be removed, but generally this is not advisable, as if anything happens to throw the circuit off resonance, there will be a feedback of high frequency to the plate supply with resultant trouble. L_5 may be made up of 25 turns of No. 22 D. C. C. wire wound on a 3 in. tube, and L_6 may be a 50 turn coil of the same dimensions.

Keying is accomplished in the usual way, in the negative plate lead to the mid-tap of the transformer, on the supply side of the filter. Another method of keying could be employed by inserting the key between the two grid leaks and the point where they are connected to the filament circuit and in many cases may provide better control than breaking the negative plate supply lead.

While the adjustments are somewhat critical, especially the coupling coils, the circuit will be found to be very satisfactory over a band of wavelengths from 10 meters up, the oscillations being very uniform and easily controlled, without overheating of the vacuum tubes. In the transmitter constructed by the writer, a band of waves from 20 to 50 meters was ordinarily employed, and it was found that the steadiest note was obtained by adjusting the coupling between the antenna and oscillatory circuits to a point a trifle below maximum radiation, as at maximum there is likelihood of a shifting of energy due to mutual coupling.

An interesting feature of the circuit is the ease with which the load may be shifted from one tube to the other, for the increase in capacity of either C_3 or C_4 by a small amount beyond the condition of symmetry will unbalance the system so that the entire load will be shifted to one tube, with resultant heating of the plate of whichever tube is carrying the full load.



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

In the February issue of RADIO a combination transmitting and receiving set was described. Please publish the circuit showing the transmitting tube only, without receiving attachment.

—T. McD., Hamilton, Ohio.

In Fig. 1 is shown the circuit for the receiving tube when used as a transmitter. A separate antenna inductance is shown, to permit looser coupling. With a C-301-A tube or its equivalent, the plate voltage can be as high as 150, when used for C. W. telegraph only. The spark coil shown in the original circuit can be used if desired, but the arrangement shown in the sketch will produce a better unmodulated wave.

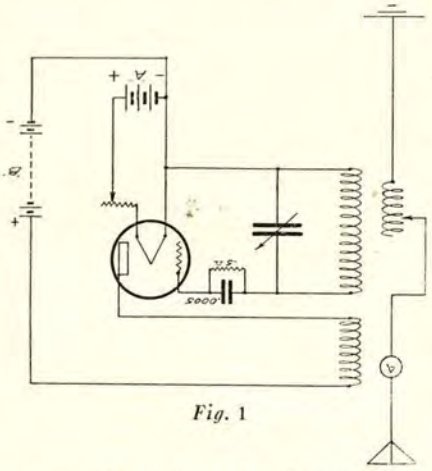


Fig. 1

What is the simplest form of superheterodyne I can build, for portable purposes? I have in mind using crystal detectors in place of vacuum tubes and reflexing one or more of the intermediate frequency stages.

—P. W. D., Erie, Pa.

A satisfactory superheterodyne embodying the features you mention can be constructed according to the diagram shown in Fig. 2. The set consists essentially of an oscillator tube, crystal frequency changer, two intermediate frequency stages, crystal detector, one stage of reflexed audio frequency and a second stage of non-reflexed audio frequency amplification. This requires a total of four tubes, which is the minimum permissible number for best results. The oscillator coil is a standard coupler such as is used in many superheterodynes described in RADIO, with the grid coupling coil connected to the crystal frequency changer, D_1. The two intermediate frequency transformers T_1 and T_2 are of the standard high ratio shielded type, using an intermediate frequency above 50,000 cycles if possible. Tuned transformer T_3 should be selected to match the intermediate frequency transformers, and the tuning condenser marked .00025 mfd. in the diagram should be of the value specified by the manufacturer. The output of the crystal detector D_2 is fed through a low ratio shielded audio frequency transformer, T_4, and into the 1st intermediate frequency amplifier tube, the output of which is connected to the primaries of transformers T_2 and T_3 in series, the latter being similar to T_4. The by-pass condensers in the grid and plate circuits of the 1st intermediate frequency tube are very necessary and should not be omitted under any circumstances. It would be better, theoretically, to have them of larger size, but this cannot be permitted due to the fact that the audio frequency transformers would be tuned to some audio frequency well within the voice range and would destroy the quality of output into the loud speaker. Crystal detectors of the adjustable variety are preferable, as considerable experimenting may be necessary before finding the proper adjustment of each crystal. The oscillator requires only 22½ volts plate, and the grid is connected directly to the filament, thus simplifying the wiring. It would be a good idea to shield the intermediate frequency stages from the rest of the circuit, with partitions of sheet brass or copper, connecting the shields to the negative *A* battery. Using a loop antenna at least 15 in. square, having 18 turns of wire, this set will receive stations with loud speaker volume over a distance of at least 750 miles at night, in the favorable months of the year.

Kindly publish information on nickel plating by means of the the electroplating method.

—G. T. G., Superior, Wis.

A complete story on the electroplating process, by D. B. McGown was published in

(*Continued on Page* 46)

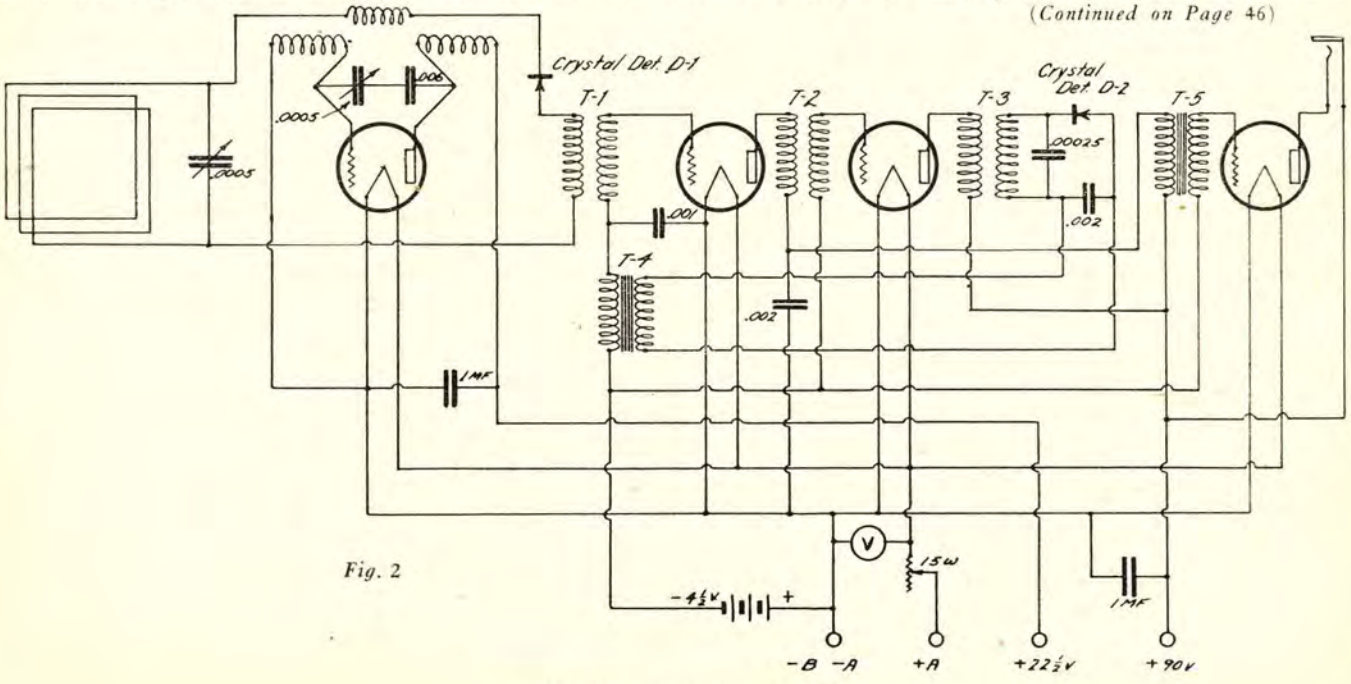


Fig. 2

Short Wave Experiments While With the Fleet

By F. L. Ulrich

FOR several months prior to the departure of the Pacific Fleet for the war maneuvers off Hawaii, experiments with short wave reception were conducted at station 6DBC, San Diego, Calif., and were continued aboard the U. S. S. *Langley*, Naval Aircraft Carrier, enroute to the islands. The experiments conducted on the vessel are of particular interest due to the excellent results obtained under difficult conditions of reception.

The short wave receiver with which these experiments were conducted was constructed from a tuning coil of the conventional low loss, three circuit type, which was stripped of its windings, leaving a substantial frame of the right size for the work. The coil frame was rewound with No. 12 copper wire, the primary consisting of 5 turns on a 4 in. diameter, the secondary 12 turns, and the tickler was wound with 20 turns of No. 20 D. C. C. wire, on the rotor, which was 2½ in. diameter.

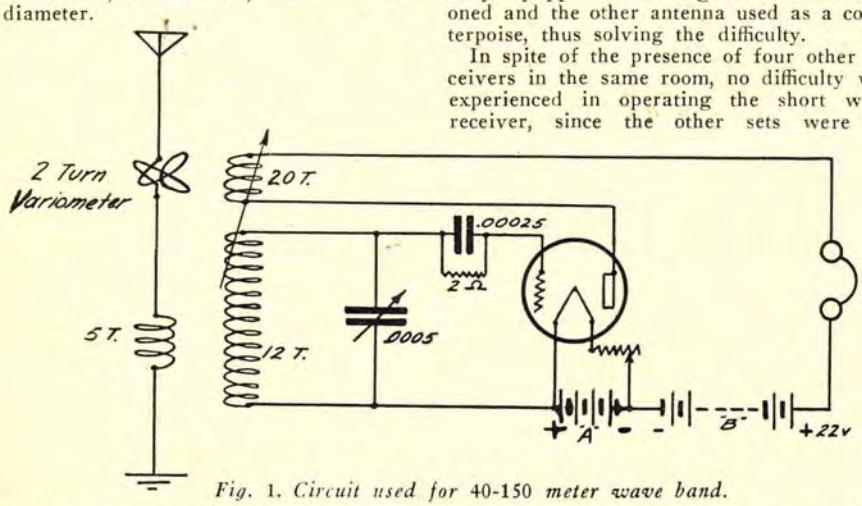


Fig. 1. Circuit used for 40-150 meter wave band.

As shown in Fig. 1, the secondary was tuned with a high grade condenser of .0005 mfd., the primary being aperiodic. The usual two step audio frequency amplifier was added, and the entire assembly can be

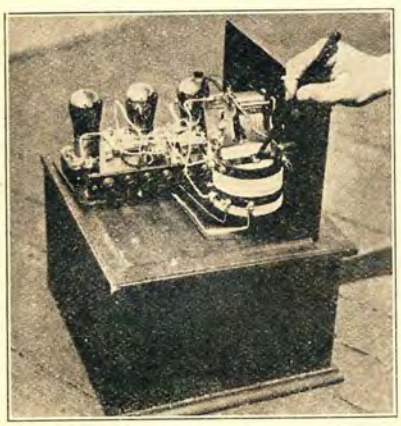


Fig. 2. Internal construction of 40-150 meter receiver.

seen in Fig. 2, particular attention being called to the fact that the tickler winding is split in the center, a total of 10 turns being wound on each side of the shaft which turns the coil. Any good low-loss coil form may be used for the coil mounting, an Uncle Sam tuning coil being used in the set illustrated. Before sailing, the receiver was calibrated according to the different frequencies transmitted from NKF, Bellevue Radio Laboratory at Washington, D. C., in order to have a reliable check on the various wavelengths.

The conditions for installing antennas on the *Langley* were difficult, since everything on the flying deck which covers most of the superstructure must be kept clear, so as not to interfere with the landing of planes. Two small cage type antennas were erected, being extended out on 15 ft. booms in a horizontal position, at the most forward position of the ship's bow, one antenna being on the starboard side and the other on the port side. The antennas consisted of 5 wires on a 6 in. hoop, with a total length of 25 ft. each, plus a 25 ft. lead-in made from a copper tube ¼ in. thick. At first one of the antennas was used with the regular ship's ground, but it was found that most of the energy was absorbed by the large masses of iron girders, stacks, winches, guys, etc., with which the ship was plentifully equipped. So the ground was abandoned and the other antenna used as a counterpoise, thus solving the difficulty.

In spite of the presence of four other receivers in the same room, no difficulty was experienced in operating the short wave receiver, since the other sets were all coupled to one antenna by means of the Taylor coupling system. Schedules had been arranged with 6CGC at San Diego, before sailing, so we were able to copy him on 80.1 meters regularly every night on the way to Honolulu. During the voyage we passed through a dead spot during which the long wave receivers experienced violent fading of signals from San Francisco, the fading lasting over a period of two hours, during which time no fading was noticed on the very short waves. This dead spot is a familiar one to operators and is probably due to large deposits of ore at the bottom of the sea.

Great trouble from induction was caused by the ventilating motors, aircraft engines and the like, so that coupling with antenna system was made as loose as possible. This sharpened the tuning to such an extent that a two turn variometer made of No. 12 cotton covered wire was necesary in series with the antenna, for vernier control. This variometer is shown in Fig. 1, in the antenna circuit.

While at sea we learned that experimental transmission from station NXN at Chicago was to be conducted on waves from 20 to 40 meters, so another receiver for these waves was constructed and is pictured in Fig. 3. An inductance consisting of 12 turns of No. 14 D. C. C. copper wire was wound.

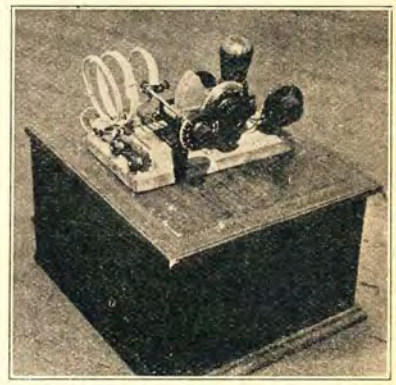


Fig. 3. Receiver for 20-50 meter wavelengths.

with a tap at the 9th turn, the nine turns being the secondary coil and the other three turns the tickler winding, which was coupled to the former. The antenna was coupled to the grid lead with four turns of heavy wire, thus acting as a condenser, as can be seen from the diagram in Fig. 4. A small choke made of 280 turns of No. 28 insulated wire was placed in the plate lead as shown, and the feedback from the plate was through a .00025 mfd. fixed condenser, making the circuit a more or less standard Reinartz.

With this receiver, especially between 4 and 9 A. M. Pacific time, signals from NXN were easily copied, although they were unsteady at times and subject to bad fading. Among the many stations copied at Honolulu were Z4AA, Canadian 3AP, 3XI, 9BM, 5GO, Porto Rico 4SA, Mexican 1XBX and hams from every U. S. district were too numerous to mention. Suffice it to say that our labor was well repaid in the results obtained, and as soon as a shore license in Hawaii can be obtained, the work will be continued.

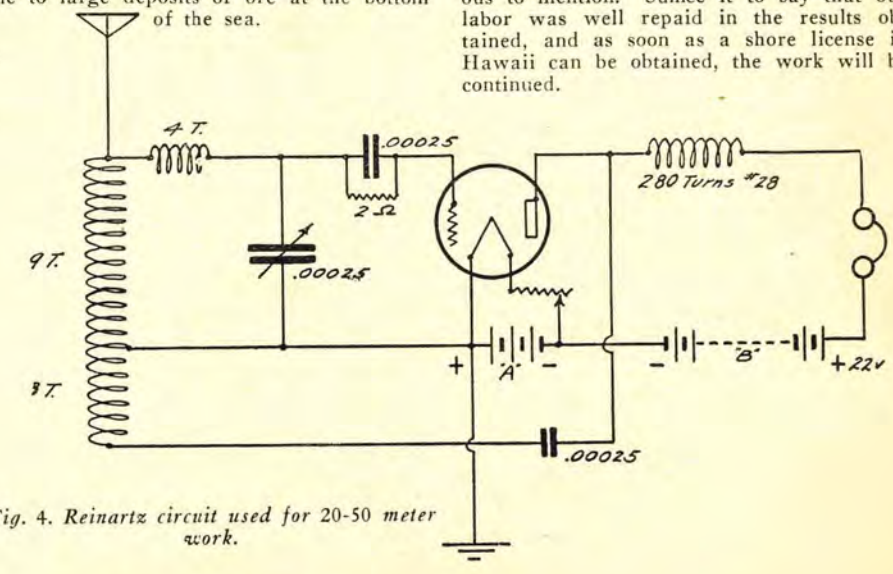


Fig. 4. Reinartz circuit used for 20-50 meter work.

With the Amateur Operators

SHORT WAVE TRANSMITTER AT 6XAD

Major Lawrence Mott, owner of Station 6XAD-6ZW, at Avalon, Catalina Island, California, is the proud possessor of a new short wave transmitter, which contains so many interesting features, and involves so great an amount of unusual short wave theory that a detailed description of the set will undoubtedly be of interest to all amateurs.

At the time of this writing the set has been in operation only two weeks and during that time, Major Mott has worked four European countries, the Antipodes, China, WNP at Labrador, and U. S. districts too numerous to mention, all on a wavelength of 40 meters. This success is principally due to the extraordinarily steady wave transmitted, together with the fine antenna ground system which has been designed especially for the new transmitter.

In the picture can be seen the transmitter proper, at the extreme left, in the center the 5 to 100 meter Townsend receiver and at the right the power panel. The transmitter is similar in principle to the one installed on the yacht ELOISE, a description of which is given elsewhere in this issue, except that two 250 watt tubes operated from 60 cycle a. c. supply are used instead of one 50 watt tube.

Referring to the circuit diagram in Fig. 1, the two Western Electric tubes are coupled in a reversed feedback circuit, to an antenna-ground system, the tuned circuit being mounted on the wall above the transmitter. The filaments are excited by a separate filament lighting transformer, which supplies 13 volts A. C. to the two filaments in parallel. The plate supply is obtained from a standard 4000 volt pole transformer, which is center tapped.

The grid and plate inductances, as well as the antenna inductance, are made of heavy copper tubing, silver plated, and arranged so that coils of different values of inductance can be substituted if desired. The antenna is tuned with two General Radio lab standard air condensers, and radiation meters are placed in both the antenna and ground leads.

The arrangement of the oscillator system is somewhat different from that ordinarily used, a theoretical diagram being shown in Fig. 2. Steadiness of frequency is of extreme importance in transmission, and for this reason, Mr. Ralph Heintz, who designed and built the station, made the inductances

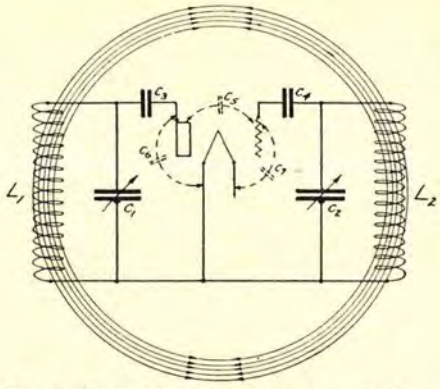


Fig. 2. Theoretical Circuit of Oscillation.

relatively small and the capacities correspondingly large, so that parasitic capacities have practically no effect on the closed circuits.

For instance, circuit L_1C_1 practically determines the frequency at which the set will oscillate and is hardly affected by the grid or antenna circuits. Likewise, the grid circuit L_2C_2 is not appreciably affected by the plate circuit so that the former becomes a controlling factor as regards the output of the set, depending upon its approach to resonance with L_1C_1. This is contrary to what takes place when the same circuit is used on long waves, in which case the grid circuit becomes more of a factor as regards frequency and the plate circuit as regards output.

This is easily explained when it is considered that in this circuit, or its modifications, the internal capacity of the tube itself becomes the medium for transferring energy from the plate circuit to the grid circuit, to effect grid excitation in the right proportion for efficient oscillation. This internal capacity is fixed and when used on the lower frequencies is not capable of transferring as much energy as when used on the higher frequency now used by amateurs. As a matter of fact, at these high frequencies, the feedback through the tube is too great and must be partially neutralized, accomplished by coupling L_1 with L_2 so that the fields are opposing and the inductive feedback is in the reverse direction, as shown in Fig. 2.

Now as we are concerned with a fairly narrow band of frequencies corresponding

(*Continued on Page* 64)

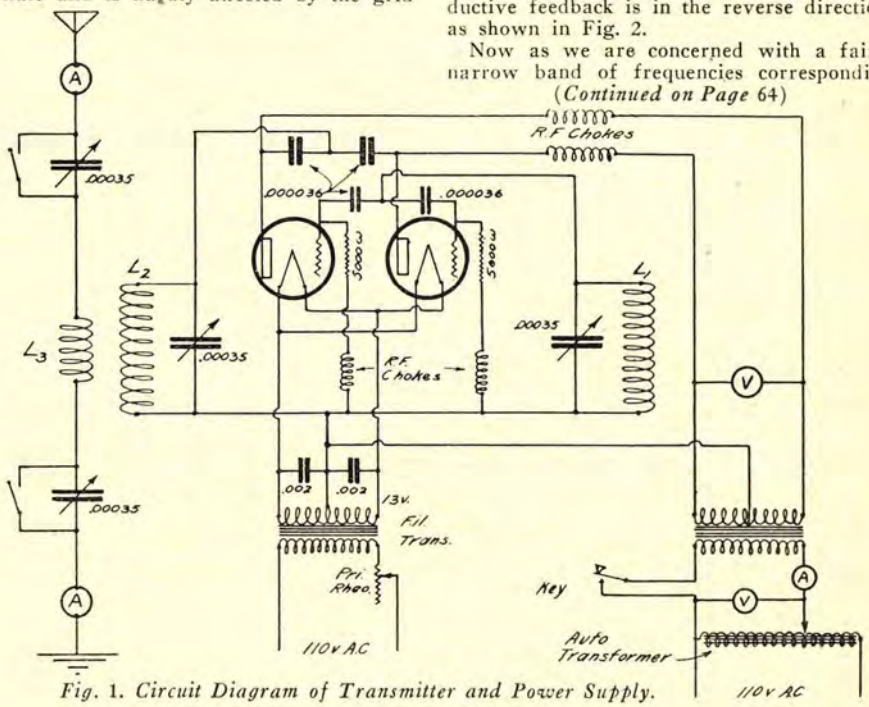


Fig. 1. Circuit Diagram of Transmitter and Power Supply.

New 500 watt, 5-80 meter Installation at 6XAD-6ZW

STATION 8ASE, 8AXG, ELM GROVE, W. VA.

This station was designed and constructed by S. Edward Pence, and from the picture it can be seen that an elaborate layout of apparatus is employed. Two transmitters are now in operation and a third will soon be added, the transmittter shown in the upper right hand corner of the picture operating on 155 meters, the antenna current being 6½ amperes. The 500 watt tube operates on a wave of 79 meters, and is of Telefunken manufacture. Both transmitters use the loose coupled Hartley circuit, the plate voltage being supplied from either a kentron rectifier system or a motor generator set.

Four receiving sets of various makes furnish efficient reception on all wavelengths, a Hartley circuit receiver being used for the waves from 40 to 100, and a 1BGF tuner being employed on the waves from 80 to 200 meters. By means of a wavemeter, which is shown at the right end of the table, a careful check of the transmitter wave is to be had.

The antenna is a three wire fan, with a four wire fan type counterpoise placed directly underneath the antenna. The fundamental wavelength is 155 meters. This station has been heard in many foreign countries and it can be seen from the cards that all American districts have been worked. Any foreign amateurs desiring an 8x10 photo of this station, for wall paper, can have same by sending a report of the stations signals.

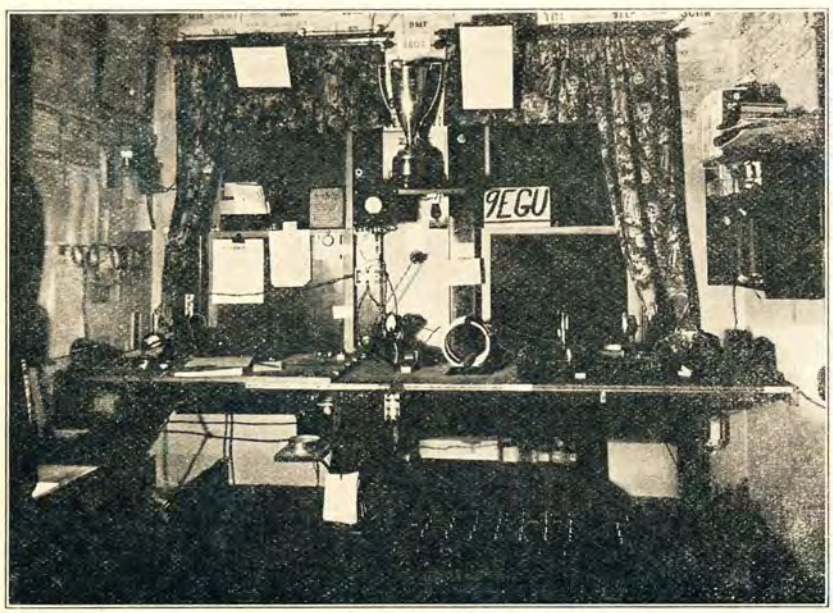
Radio Station 8ASE, 8AXG

RADIO STATION 9EGU

Station 9EGU is owned and operated by Cy L. Barker at Henning, Minnesota. The transmitter uses one UV203-A, 50 watt tube, operating on the lower wave bands of 20, 40 and 80 meters. The well-known inductively coupled Hartley circuit is used and performs very efficiently at this station. A borax chemical rectifier of 50 jars is used to furnish power to the plate of the tube, in connection with a 50 henry-4 mike "brute force" filter which gives a fine pure d. c. note when desired.

The tuner is built on the order of Schnell's set, and uses 2 tubes—detector and 1 step a. f. All U. S. States have been worked, and all Districts in the U. S. and Canada. Signals from this station have been copied in Cook Inlet, Alaska, and such points as Mexico City, Mexico; San Jose, Costa Rica; and Sydney, Australia have been communicated with.

9EGU holds appointments as official relay station, broadcast station, railroad emergency station, official wavelength station and city correspondent, as well as being a member of the ARRL Experimenter's Section. This station is now the office of assistant division manager for Minnesota, of the Dakota Division, ARRL. 9EGU's main working wave is 38 meters, and he will be found on that wave the greatest part of the time.



Radio Station 9EGU

NEWS OF THE AMATEUR OPERATORS

Call 6BWS has been re-issued to Russ Shortman, 1617 E. Van Buren St., Phoenix, Ariz.

7DE, Leo H. Machlin, Cordova, Alaska, will handle Alaskan traffic. Glad QSO anybody any time on 40 and 80 meters.

6 BUR, 340 No. Painter Ave., Whittier, Calif., will QSR traffic to pi 1 HR in the Philippines. He recently worked NUQG on 40 meters off Shanghai.

2AHK, Nelson Parker, has moved from Poughkeepsie, N. Y., to 554 So. Clinton St., East Orange, N. J., using 50 watter on 40 and 80 meters; all cards QSL'd.

D. Cordray, 1st operator at 8ATX will be on the job early in September after visiting many stations around Los Angeles. A 50 watter on 20 and 40 meters is contemplated.

3PY has been re-assigned to Francis Richardson, 507 South Orange Street, Media, Pa., who will appreciate reports of his signals on 175 and 41 meters.

U-6EA, H. C. Seefred, 343 South Fremont Avenue, Los Angeles, Calif., has been reported on 40 meters by 0-A4M, S. C. Pleass of Johannesburg, South Africa while U-6EA was working A-3BD of Melbourne, Australia. His signals were heard in Africa at 3:53 p. m. while he was working from 5:20 to 6:25 PST in California. Going west, the distance is 14,130 miles from Los Angeles to Johannesburg, most of the intervening space being in darkness. Going east, the distance is 9,010 miles, with daylight at both ends. During the same period 6EA was also heard by J. Watson of Perth, West Australia.

NEW RADIO CATALOGS

Burgess Battery Co. has published two new engineering circulars. No. 6, by W. B. Schulte, discussess the use of dry cell batteries for plate voltage of radio transmitting sets. No. 7, by W. H. Hoffman, illustrates and describes the No. III short wave radio receiver of 9XH-9EK.

Marshall-Gerken Co. have discontinued the manufacture of "Read 'em" binding posts because of the recognized validity of the patent recently granted the H. H. Eby Mfg. Co., who will hereafter take care of their orders.

Pittsburgh, Penna

"SJQ," 2711 Espy Avenue, Dormont.

6aak, 6aam, 6aao, 6ab, 6abe, 6abs, 6ac, (6adt), (6afa), (6afg), 6age, (6agk), 6agw, 6ahp, 6ahq, 6aib, 6aji, 6ajq, (6ajr), 6akw, (6alf), 6alw, 6ame, 6amf, 6amm, 6amo, (6ano), (6anq), 6aoe, (6apw), 6aqg, 6ary, 6ase, 6asv, 6atn, (6auf), 6aut, 6avj, (6awt), 6bab, 6bas, (6bbq), 6bcn, (6bcs), 6bdv, 6bez, (6bfw), 6bgc), (6bge), (6bgl), (6bgv), (6bh), 6bho, (6bhz), (6bik), 6bil, (6bir), (6bis), (6bjd), (6bjj), 6bjx, 6blw, (6bmo), 6bmw, 6bnu, (6bol), 6bpf, 6bql, 6bqr, (6bsn), (6btl), (6btm), (6btx), (6bui), 6bur, 6buw, 6bve, 6bwy, (6cae), (6caq), (6cct), (6ccv), 6ccy, (6cdg), 6cdn, 6cdy, 6cej, 6cfe, (6cge), 6cgo, 6cgv, 6cgw, 6chl, (6chs), 6chx, 6chz, 6cig, 6cix, 6cjj, (6cka), 6cku, 6ckw, 6clp, (6clv), (6cmd), (6cmg), 6cmq, 6cms, 6cmt, (6cmu), 6cnc, (6cnk), (6cnl), 6cnm, 6cnn,6cpf, 6cqd, (6cqe), (6crr), 6crs, 6crx, 6csl, 6cso, (6css), 6cte, 6ctn, (6cto), 6ctx, (6cty), (6cub), 6cuc, 6cuq, 6cvf, (6cvk), 6cvm, 6cwi, (6dah), 6dai, 6dan, 6dao, 6dax, (6dbh), 6cv, 6cw, 6dh, 6ea, 6eb, (6ew), 6ex, 6fa, (6fh), 6fy, 6gg, (6gt), 6hm, 6ih, 6il, 6im, 6ir, (6iv), 6ja, 6ji, 6jp, 6jy, 6kb, 6kr, 6lj, 6lv, 6mg, 6mw, 6no, 6now, 6oe, 6pl, 6py, 6qd, (6qi), 6rf, (6rn), 6rv, 6sb, 6ti, (6ts), 6ua, 6uc, 6uf, 6uo, (6ut), 6vs, (6vd), 6vf, 6vt, (6vw), 6wp, (6ws), 6xad), 6xg, 6xo, 6yb, 6zap, 6zbn, 6zh.

(7abb), 7adm, (7afo), 7agi, 7agz, 7ahs, (7aib), 7aif, 7aip, 7ajv, (7ao), 7ay, 7bj, (7cy), 7dd, 7df, 7dj, 7dx, (7ec), 7fj, 7fq, 7fr, (7fv), (7gb), (7gj), 7gm), (7ih), 7ij, 7jh, 7ku, (7lh), (7lr), (7ls), 7mf, (7mi), (7mp), 7mx, 7nh, (7nq), 7nt, 7nx, (7ob), 7qd, 7qu, 7rl, 7sb, (7si), 7sl, 7sy, (7uj), 7uq, (7uz), 7vn, 7wm, (7wu), 7ya, 7zz).

Mexico—1a, 1aa, 1af, (1b), 1j, 1k, 1n, 1x, (bx), 9a. British—2cc, 2dx, 2fu, (2jf), 2kf, 2kz, 2nb, (2nm), 2od, 2rb, 2sz, 2wj, 5dh, 5lf, 5nn, 5ma, (5pu), 5rz, 5uq, 5xn, (6lj), 6nf, 6td, (6tm). French—8ab, 8ba, 8bo, 8ctp, 8di, (8go), 8gp, 8fq, 8gm, 8sm, 8ssc, 8tk. Holland—Pc-1, o-nl, o-bq, o-ba, o-ll. Denmark—7bn, 7ec. Spain—E-ar6, e-ar2. South America—Cb8, wjs. Belgian—3ad. Australia—2ay, 2bk, 2cm, 2ds, 2ij, 2yg. New Zealand—(2ac), 2cp, 2xa, 4ak, (4ar).

At 2BRB, Brooklyn, N. Y., during June on 40 meters

U. S. A.—4cu, (4km), 4pz, (4rl), 4sa. (5aec), 5afd, 5agl, 5apu, 5ati, 5atv, 5ce, 5dx, 5er (5hy), 5lg, 5ov, 5sa, 5wi, 5zai, 5zas, 5sw. (6afg), (6agk), 6ahp, (6ajm), (6avj), (6bgz), 6bhg, 6bjj, 6bny, (6bqr), 6cc, 6cej, 6cgo, (6cgw), 6chh, 6cig, 6cmu, 6cpf, 6cto, (6css), 6cub, 6eb, 6dah, 6dat, 6fa, 6hu, (6jp), 6lj, (6qi), 6ts, 6vc, 6xg. 9adr, 9ajo, 9apm, (9bca), 9bek, (9beq), 9bhl, 9bnd, (9bpb), 8buj, (9bzg), (9chu), 9cuo, 9cxc, 9dbz, 9dfj, 9diq, 9dng, 9dqu, 9egg, 9fj, 9hn, 9hp, 9ka, 9kb, 9mm, 9nm, 9oo, (9zk). Australian—(2ay), (2bb), (2bk), 2cm, (2ds), (2ij), 2rj, (2yi), 3bd, 3bq. Bermuda—ber. Canada—2au, (3fc), (3tv), 4gt. French—(8qq). Mexican—1aa, 1b, 9a. New Zealand—(2ac), 2ae, (2xa), 3ad, 4ag, 4ak. Porto Rico—(4rl), 4sa. Others—nrrl.

By 6CWP-BUX, 1485 E. Fifth Ave., Pomona, California, for June 40 meters

1asf, 1yb, 1xz, 2bbx, 2brb, 2cnk, 2qs, 3jw, 4cu, 4gy, 5ac, 5amb, 5afd, 5aec, 5ail, 5apu, (5ame), 5atk, 5aiu, (5lg), (5vl), 5nj, 5amw, 6zac, 7cw, (7pz), (7ya), 7uz, 7fb, 7dd, 7uj, 7ku, (7yk), (7nx), (7nt), 7pp, 7wu, (8jj), 8do, 8bu, 8pl, 8nx, 8chk, 8buk, 8apw, 8dtr, 8xc, 8eq, 8qz, 8eb, 9dfh, 9cxx, 9ell, 9dbz, 9mn, 9bml, 9oo, 9bdr, 9apm, 9eak, 9dcg, 9ek, 9cfi, 9bkr, 9dfj, (9cld), 9arf, 9bht, 9wo, 9duc, 9ayp, 9bof, 9adr, 9caa, 9dac, 9bkb, 9bsz. C5eu, c9ck, miaa, nkf, (nrrl). 20 meters 1pl, 7sf, 9ape, nrrl, (6bil). Qrk my 5 watter.

By H. C. C. McCabe, 71 Holloway Rd, Wellington, New Zealand, May 1-31st, 1925

1yb, 1xu, 1xav, 1cmp, 1pl, 1oj, 1aao, 1zn, 2cv, 1cxw, 2agw, 2wc, 2rm, 3ll, 5agl, 5ox, 5aah, 6baq, 6cms, 6dah, 6bsn, 6cls, 6cqe, 6cnl, 6hm, 6zac, 6bmw, 6awt, 6chl, 6avj, 6vw, 6cmu, 6qi, 6cig, 6cto, 6bjj, 6cix, 6agk, 6ji, 6bbv, 6dh, 6rn, 6ur, 6cqz, 6cc, 6aoi, 6cgo, 6bgo, 6zbn, 6bsc, 6ac, 6xh, 6vc, 6aws, 6clp, 6cub, 6cej, 6ahp, 6ea, 6csw, 6aji, 6ts, 6km, 6com, 6wd, 6xg, 6age, 6cst, 6alf, 6uf, 6no, 6xag, 6bhz, 6cgw, 6bh, 6opu, 6qd, 6cvm, 6buc, 6chz, 6css, 6bur, 7df, 7ym, 7dc, 7kk, 7rl, 7ay, 7gj, 7pz, 7gb, 7ya, 7nh, 7ku, 7adm, 8aly, 8gu, 8bwb, 8bf, 8jj, 8bu, 8brc, 8er, 8rv, 8dgp, 8zu, 8avl, 8nx, 9og, 9bvh, 9eas, 9dum, 9cld, 9ig, 9ado, 9dps, 9edb, 9bdu, 9cfi, 9dqu, 9xi, 9bht, 9dct, 9dat, 9clj, 9bkr, 9sr, 9ded, 9cdw, 9oo, 9cul, 9dge, 9abc, 9dps. Canadian—5ba. Argentine—Cb8. Others—Nrrl, nkf. Will gladly confirm by card any of above.

By 6CIX, 317 N. Friends Ave. Whittier, Calif.

1aao, 1ahl, 1cmx, 1fx, (1ka), 1wr, (1yb), 2bbx, 2brb, 2cdu, 1cty, 4cu, (4fw), 4mw, 4sa, (4ux), (8ahm), 8afs, 8ayy, 8bau, 8biq, 8chk, (8cyi), (8do), (8djf), (8dsc), (8eq), 8gz, 8uk, 8ze, 6asr, 6cst, (6dcf), ytq, (6zac), nrrl. Argentina—ah2. Australia—2bc, (2bk), 2cm, 2ds, 2ij, 2rj, 2tm, 2yi. Japan—(1aa). Mexico—1b, 9a. New Zealand—(1ao), 2ac, 2ae, 2ak, 2xa, 3dt, 4ak. Miscellaneous—1hvt, zhc.

By Albert E. Scarlett, Jr., 23 Cooley Place, Mount Vernon, New York

U. S.—6aak, 6afg, 6agk, 6ahp, 6aji, 6ajq, 6alf, 6awt, 6bmw, 6bur, 6ccv, 6cej, 6cgw, 6chs, 6cls, 6cpf, 6cto, 6cub, 6dah, 6ji, 6mc, 6no, 6qi, 6rw, 6ts, 6ut, 6vc, 6xag, 6xg, 7ay, 7gb, 7uz, kel, npq. Mexico—1af, 1k. Cuba—2lc. England—2kf. Italy—1ev. France—8do. Bermuda—ber. Brazil—1ab, 2sp. Off Newfoundland—wnp. Hawaii—nrrl. Porto Rico—4je, 4kt, 4rl, 4sa. Samoa—6zac. New Zealand—2ac, 2ae, 2xa, 4ar. Australia—2 bk, 2cm, 2ds, 2yg, 3bd. All heard on 1 audio and 80-foot indoor antenna.

At SATX, Canton, Ohio

(6chl), 6cmu, 6cix, 6crx, (6xad), 6xat, (6zz)?, 6zh? Seventh District—7abb, 7afo, 7afp, (7df), 7fq, 7gr, (7cu), (7ls), 7qr, 7gj, 7mf, 7zu, 7zo. English—(2cc), 2kf, 2kz, 2mk, (2od), (5gf), 5nn, 5xx, 6gh, 6nf, (6lj). French—8df, (8dq), 8soc?. Canadian 1dd, 1dr, (2ju), 2bn, (2ku), (3gl), (3gg), (3ka), (3xx), (3acf), (3fs), (3nm), (4hh), (4xx), (5ba), (5gi). Australian—3bq, 2yi, 2ay, 2bk. New Zealand—1ao, *4aa, *4ak. Spanish—(ear 2), ear6. Italy—(1ler), acd. S. A. wjs, cb-8-ch9tc. Cuban—ber, 2mk. Special—Nrrl, qsa, vy, wnp, nkf, wgh, wir. wiz, kdka, nat. For cards qsl to Donald Cordray ex-8atx, box 1226, station C, Los Angeles, Calif., these stations wkd and hrd fm Canton, Ohio, where 8atx was located—73's.

By 2-BUY, Bradley Park, N. J.

(4af), 4ask, 4bl, 4cu, 4du, 4jr, 4oa, 4pz, 4rm, 4rr, 4sh, 4tv, 4ua, (5ac), 5amw, 5aom, 5atx, (5hi), 5lg, (5nq), 5ph), 5sz, 5ty, (5wi). 6agk, 6bmw, 6chz, 6crs,6 csa, (6css), 6li, 6lj, 6xg, 7uj, (8adm), (8aub), (8bbl), (8bhj), (8bkm), (8ccw), (8dal), (8qj), (8rv), 9ado, 9aij, 9aud, 9bdw, 9bht, 9bmx, (9buj), 9bxq, 9caa, 9cdv, 9cvr, 9cxx, 9dcg, 9dka, (9dwz), 9eas, (9db), 9es, 9ff, (qra), 9qi, (9sn), 9uq, (9wo). Canada (1am), (1ar), 2be, (3ael), (3en), 3tf, 3tv, p. r., 4kt, (4of), 4rl, 4sa. Bermuda—B. e. r. Mexico—1ag. Brit.—5dh???. Misc.—Pox, wnp, (nkf), npg, qra? Would appreciate cards from station worked es station hearing my sigs on 39 meters. All cards answered!!!!

By 6EB, Lyndon F. Seefred, 343 So. Fremont Ave., Los Angeles, Calif. 70 to 100 meters

1aao, 1abf, 1acb, 1ad, 1af, 1ajx, 1all, 1ary, 1ban, (1bbe), 1bei, (1bes), 1bhv, 1blb, 1bv, (1cab), 1cmp, 1cpc, 1er, (1fb), 1fd, 1gs, (1hn), 1id, 1kc, 1ow, 1qm, 1rd, 1se, 2aay, (2adk), (2ag), 2agh, 2agi, (2ana), 2azy, 2bck, 2bkr, 2bqa, 2br, (2brb), (2bsc), 2by, 2cee, 2cg, (2cgj), 2clg, (2con), (2cpa), 2cpd, 2cqz, 2cty, 2cvw, 2cxw, 2cxy, 2czr, 2dd, 2gk, 2ke, 2kf, 2kx, 2le, 2mu, 2pd, 2rk, 2wd, 2wl, 2wr, 3ab, 3ach, 3aew, 3aky, 3ash, 3bdo, 3bg, (3bnu), (3bpp), 3bta, 3btq, (3bva), (3bwj), 3cc, (3chc), 3chg, 3cjn, 3cjt, 3dh, 3gb, 3hg, 3hh, 3hj, 3kg, 3kq, 3lg, 3ll, 3lw, 3nf, 3oe, 3sf, (3te), 3ue, 3ws, 4bq, 4dm, 4do, (4dv), 4eb, 4eh, 4fg, 4fm, 4fz, 4gw, (4io), 4jr, 4ku, 4my, 4oa, 4pn, 4sb, 4tj, 4ua, (5aaq), (5ab), 5acl, 5acz, 5ado, 5adz, 5aec, 5aex, 5afd, 5afn, 5afu, 5agq, 5ahd, 5ahw, 5aij, 5ail, 5aiu, 5aja, 5ajb, 5ajh, 5ajj, 5akf, 5akn, 5akw, (5aky), 5akz, 5am, 5ame, 5amh, 5amu, 5amw, 5aph, 5apm, 5apt, 5aqw, 5aqy, 5as, 5asv, 5asz, 5atp, 5atu, 5atx, 5aul, 5aur, 5ayw, 5bg, 5bp, 5bx, 5bz, 5ca, 5ce, (5ck), 5cn, 5cp, 5cv, 5dm, 5dw, 5ew, 5gk, 5hd, 5hi, 5hl, 5hp, 5hs, 5im, 5in, 5jf, 5ka, 5kc, 5kk, 5kq, 5lg, 5lh, 5li, 5lj, 5lr, 5ls, 5lu, 5mf, 5mi, 5mp, 5nj, 5nw, 5oq, 5ot, (5ov), (5ox), 5ph, 5py, 5qs, 5qw, 5qx, 5qy, 5rg, 5 sd, 5se, 5ty, 5uj, 5uk, 5un, 5wg, 5wo, 5wy, (7abb), 7ac, 7acm, (7acy), 7adf, (7adm), (7afn), 7afo, 7agi, 7agn, 7agz, (7aif), 7aip, 7ajl, 7ajv, 7ajy, 7akk, 7ald, 7ali, (7ao), 7av, 7bj, 7bm, 7cw, 7dc, 7dd, (7df), 7di, (7dj), 7dx, 7ec, 7eo, 7ex, 7fd, 7fj, 7fm, 7fq, (7fr), 7gb, 7gc, 7gj, 7gq, (7gr), 7gs, 7gv, 7gy, 7ij, 7iu, 7jm, 7jq, 7js, 7jv, 7jw, 7kc, 7kf, 7kq, 7kr, 7ku, 7lh, 7lj, 7lq, (7lr), 7ls, 7ly, 7mf, 7nh, 7nx, 7ok, 7ot, 7oy, (7pm), 7qc, (7qd), 7rh, 7rl, 7ry, 7sb, 7se, 7sf, (7sp), 7sy, 7to, 7ub, (7uj), 7un, (7uq), 7us, 7vg, 7vn, 7vu, 7vw, 7wm, 7wz, 8aa, 8abm, 8abs, 8aci, (8acm), 8acy, (8ada), (8aes), 8agp, 8ah, 8aly, 8ame, 8apr, 8aro, 8aub, 8avd, 8avl, (8awa), 8ban, (8bau), 8bbf, 8bch, 8ben, 8bf, (8bit), (8bk), 8bkh, 8blr, 8bnh, 8bpa, 8bpm, 8bpr, 8bqa, 8btf, 8bxh, 8byf, 8byn, 8cbp, 8cc, 8cdt, (8ced), 8cei, 8cjp, (8cko), 8coy, 8cp, 8cpy, (8cud), 8cva, 8cwu, 8cyi, 8czy, 8dae, 8dal, 8dgo, (8dgp), 8dgv, 8do, 8doo, 8dpq, 8dse, 8dwz, 8dzg, 8eb, (8gz), 8jj, 8kc, 8ln, 8pl, 8qy, 8rv, 8ry, 8tc, 8uf, 8up, 8vq, 8wa, 9aaw, 9abf, 9aby, 9ach, 9acq, 9adg, 9ado, 9adq, 9afr, 9afz, 9agil 9aim, (9aki), 9alt, 9amb, 9amj, 9amm, 9amq, 9amx, 9and, 9aob, (9aod), 9aoi, 9ape, 9apm, 9asw, 9ato, 9auy, (9avv), 9awa, 9axs, 9axx, 9ays, 9azp, 9bbw, 9bcd, 9bch, 9bcj, 9bcy, 9bdf, 9bdh, 9bdu, 9bdw, 9beo, 9beu, 9bff, 9bfi, 9bfp, 9bfr, 9bfx, 9bgh, 9bhh, 9bht, 9bhy, 9bib, 9bji, 9bjk, 9bjl, 9bkb, 9bkk, 9blk, 9blz, 9bm, 9bmk, 9bml, 9bmv, 9bmx, 9bnk, 9bnt, 9bof, 9bol, 9bpy, 9bsz, 9btz, 9buo, 9bvo, 9bvz, 9bwb, 9byg, 9byv, 9bzk, 9ca, 9cbf, 9ccm, 9cdo, 9cdq, 9cdv, (9cea), 9ced, 9cee, 9cfg, 9cfi, 9cfs, 9cfy, 9cga, 9cgh, 9che, 9cii, (9cip), 9cjc, 9cju, 9ck, 9clb, 9cld, 9clq, 9co, 9coc, 9cou, 9cov, 9cpm, (9csg), 9ctd, 9ctr, 9cur, 9cuv, 9cvl, 9cvo, 9cvs, 9cy, 9dac, 9dbf, 9dbz, 9ddp, 9ded, 9deo, 9dev, 9dfh, 9dfz, 9dga, 9dgv, 9dhb, 9dhq, 9dhs, 9dkv, 9dme, (9dmj), 9dmz, 9dng, 9dps, 9dpx, 9dqu, 9dtk, 9dtl, 9dun, 9dvi, 9dwx, 9dwz, 9dxn, (9dxy), 9dyi, 9eae, 9eam, 9eas, 9ee, 9eeb, 9eep, 9efh, 9efy, 9efz, 9egh, 9eht, 9ei, 9eib, 9eih, 9eky, 9elb, 9eli, 9ell, 9em, 9en, (9er), 9es, 9ev, 9hn, 9hp, 9ig, 9ih, 9iw, 9lz, 9mi, 9mm, 9na, 9nm, 9on, 9pb, 9qy, 9rt, 9sb, 9sr, 9vc, 9vd; (1xam), 1xj, 1xm, 1xz, 1yb, 1zt. (2xbf), 2xq, 2za, 2zb, 3xm, 3yo, 4xe, 5xa, 5xau. (5za), (5zai), 5zas, 5zav, 5zh, 7zf, 7zn, 7zq, 7zz, 8xaf, 8xe, 8xv, 8yj, (8ze), 8zz, 9xbg, 9xbp, 9xe, 9xi, 9xt, 9za, 9zak, 9zb, 9zd, 9zk, (9zt), 9zy;—Canadian: (3ni), 3acu, (4cr), 4io, (4dq), 4fn, (4gt), 4eo, 4fv, 5go, (5an), 5bz, 5ba, (5gf), 5ef, 5ct, (5ak), 5hs, 5bo, (5hc), 5hh, 5af, 5bl. United States—2xd, wgh, nkf, (nqg), nfv, (npg), ket, kgi, kel, nerk-1. Mexico—1b, (bx), 9a. (1aa). Porto Rico—4sa. French-Indo-China—hva. New Zealand—4ag. France—uft (2 step and loud speaker on lamp cord antenna). Brazil—ux8, (wjs). 2 step and loudspeaker on lamp cord antenna.

All of the above, except the last two, were copied on a low loss tuner with 1 or 2 steps of amplification and a cage antenna hanging from a 101 ft. pole, and no ground. Have printed cards for any of the calls mentioned if they will write and give me their correct address.

By J. G. Tinney, 74, Kainni Rd., Hataitai, N. Z.

U. S.: 1ax, 1pl, 1te, 1aao, 1anq, 1bcc, 1cki, 1cmp, 1xua, 1alw, 2ha, 2lu, 2qh, 2rm, 2zv, 2bee, 2brb, 2xaf, 3hg, 3ll, 3bva, 3dck, 4dm, 4tv, 5iw, 5mi, 5nj, 5oq, 5ov, 5uk, 5acl, 5ajh, 5apu, 5atv, 6cc, 6eb, 6fa, 6ji, 6jp, 6km, 6nb, 6ns, 6nx, 6ts, 6xg, 6no, 6ahq, 6aji, 6aoi, 6awt, 6bhl, 6bhz, 6bjx, 6blz, 6bmw, 6buc, 6bur, 6cck, 6ccy, 6cgw, 6chs, 6cnc, 6cso, 6css, 6cto, 6cvm, 6dcf, 6xad, 6zac, 7gb, 7gj, 7mf, 7ya, 7nt, 8dø, 8eb, 8gz, 8lp, 8pl, 8ry, 8zf, 8apw, 8bfw, 8ced, 8chk, 8cht, 9ek, 9og, 9uq, 9wo, 9xw, 9zt, 9aao, 9akf, 9apm, 9baj, 9bht, 9cvr, 9ddf, 9dct, 9ded, 9dfh, 9fw, 9dpx. Argentina: cb8. Canada: 5ba, 5gt. England: 2lz, 2nm, 2od. France: 8bv, 8co, 8ct, 8qq. 8yor. Italy: 1er, 1rg. Mexico: 1aa, 1b, 9a, xda. Sweden: smyy. Porto Rico: 4sa. Brazil: wjs. Hawaii: fxl, 3ze, 6asr. Misc: 1ab, (bz), 2sp, (bz), lpz, nkf, npm, nrrl, wiz. Australia: 2at, 2bb, 2cm, 2bd, 2bk, 2ds, 2hm, 2hs, 2ij, 2me, 2rj, 2js, 2yi, 2zn, 1an, 3bm, 3bp, 3bq, 3ef, 3fm, 3lp, 3ze, 4an, 4wb, 5bd, 5kc, 5wj, 7aa, 7cs, 7gd, 7om, 7pf, 7rb.

By R. W. Mintrom, 62 Barton Street, Woolston, Ch, Ch, New Zealand.

1aao, 1py, 1te, 1xz, 1yb, 2brb, 2cgj, 2cxw, 2xaf, 3ll, 3oe, 4cu, 5ew, 5nj, 5ov, 5uk, 5wi, 5zai, 6ahy, 6ahp, 6awt, 6age, 6agk, 6ajm, 6afg, 6ac, 6bhz, 6buc, 6bmw, 6cct, 6cmu, 6cej, 6cgw, 6ccy, 6ccw, 6cst, 6chs, 6cub, 6cso, 6eb, 6ew, 6jp, 6ji, 6km, 6no, 6rw, 6ts, 6xg, 6zbn, 7gj, 7ls, 7ya, 8apw, 8ayy, 9afu, 9aey, 9bpb, 9ccs, 9eky, 9eli. Canada: 1ar, 4gt. Mexico: 1aa. England: 2lz, 2nm, 2kf, 2od. France: 8bv, 8ct, 8fq, 8qq. Italy: 1er, 1rg. Chile: 9tc, Brazil: wjs. Argentina: 1pz. Tutuila, Samoa: npu, 6zac. Special: nkf, nrrl, wgh, wiz, kel, kio, kdka (music), icx (eritrea). All crds Q.S. led.

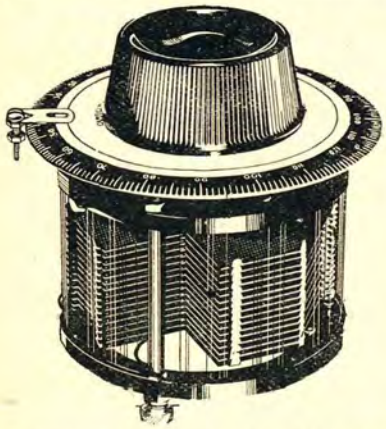
(*Continued on Page* 48)

FROM THE RADIO MANUFACTURERS

The B. M. S. verni-juster dial is a new unit which can be attached to any standard condenser or other tuning shaft without the

use of tools. It is merely necessary to unscrew and fasten a knurled cap. The entire device is of metal, insulated from the shaft by ingenious bushings.

The Camfield condenser is a low-loss instrument of the straight-line-wavelength type. It is distinguished by an ingenious and effective plate movement, a very low minimum capacity, and a gear ratio sufficient to permit its use in any radio circuit with-



out the necessity of a vernier. It has a 360-degree dial and is enclosed in a transparent dust-proof cover. Extra paper logging dials are provided with each instrument.

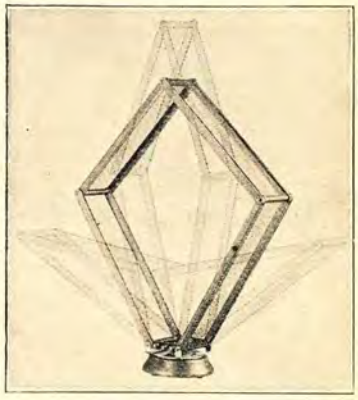
The No-Dial Receiver is a compact set which is tuned by turning the cover of the instrument, its surface sufficing as a station register. The several variable con-

densers are adjusted by one shaft, all other adjustments either being automatic or made once for all at the factory. It is made in a five tube and in a four tube model.

The Tower Meistersinger speaker is one model of a new line of low priced loudspeakers giving an excellent quality of reproduction. It has a cast-iron base and a duraluminum horn with a goose-neck, standing 20½ inches high. Another type has a straight fibre horn with 10 in. bell, another has a 17 in. straight horn with 8½ in. and

a fourth midget model has a 5½ in. celluloid horn. All models employ an adjustable phone unit which is claimed to give great volume without distortion, this unit also being available as a phonograph attachment.

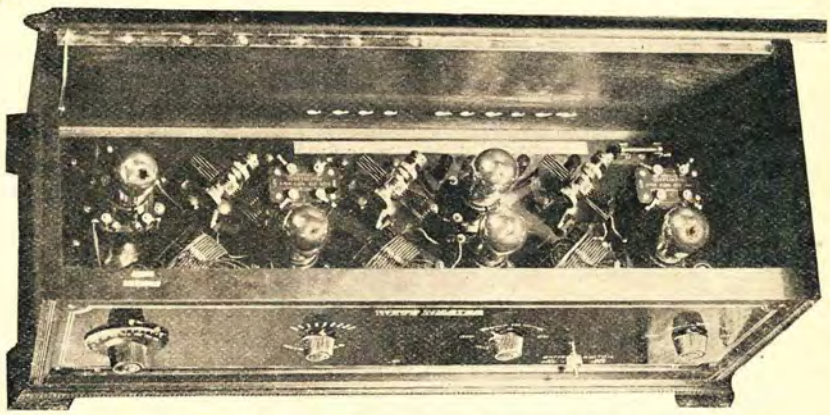
The Aalco collapsible loop is made of litz wire wound on hard rubber insulation. The wires are taut when collapsed as well



as when extended. It has three taps and a revolving base. The frame is of walnut and all metal parts are nickel-plated.

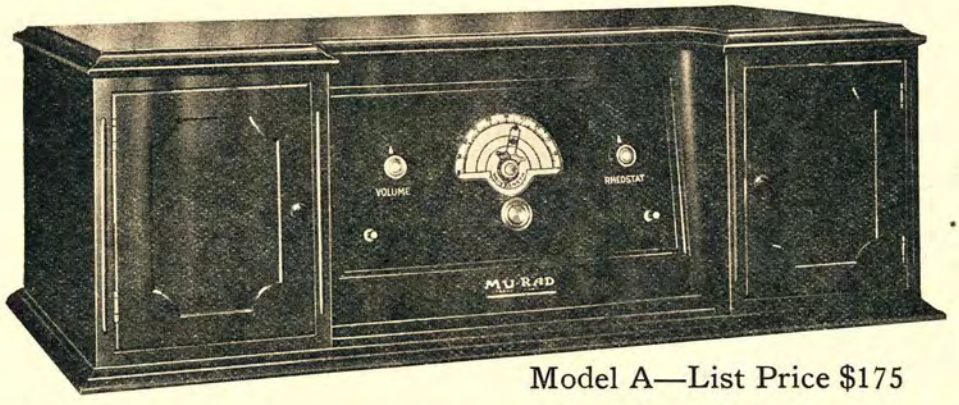
The Aerovox Grid Condenser is made in the convenient size of .00025 mfd. with spring clips for the grid leak and handy

terminals for mounting the condenser in the set. The best grade of mica is used for the dielectric and the condenser has a low internal resistance.



The Kellogg Wave Master is a five tube tuned radio frequency receiver with but one selector dial. This simplicity in tuning is secured without impairment of selectivity by using tapped stators for the two radio frequency transformers and the detector tuner, all the tap switches being controlled by a single knob, which selects any one of the nine 40-meter zones. The fine tuning for any station within a desired zone is done with a single dial which operates three rotors within the above stators. All condenser settings are made at the factory and like the detector and audio rheostats need not be changed after once adjusted. The volume is controlled by the first rheostat and the oscillations by the second. Every technical effort has been made to reduce losses and to give maximum operating ability. It is designed to give best results with about an 80 ft. aerial.

Radio's Greatest Achievement



Model A—List Price $175

THOSE persons who have delayed buying a Radio Receiver in the belief that "something newer and better" would appear, as well as those who have Radios but are not satisfied with results hitherto obtainable, will find the New Mu-Rad a revelation in the art of radio reception.

This remarkable receiver is the culmination of 8 years of study and laboratory experimentation of the Mu-Rad engineers, plus the knowledge gained by the mistakes and the progress of the entire radio industry.

The Mu-Rad
Transcontinental Receiver

is a distinct advance in radio—a year or two ahead of the times. Its ideal circuit embodies two stages of **tuned** Radio Frequency, a Detector and two stages of Audio Frequency.

Great progress has been made by Mu-Rad engineers in eliminating lost energy in the circuit and in balancing the circuit so as to secure a degree of selectivity hitherto unknown in a Radio Receiver.

Coast-to-Coast reception **all year round** is made possible with this receiver and the quality of reception is extraordinary.

Ask Your Nearest Dealer for Demonstration

ONE DIAL CONTROL

A revolutionary feature of the New Mu-Rad is its one dial control. There is only one dial to tune. A slight movement of this beautiful Gold Finish Dial brings in one station after another—clear across the continent—without interference from local stations. The dial can be accurately "logged." Stations will always come in at the same dial setting. It's as simple as turning a doorknob.

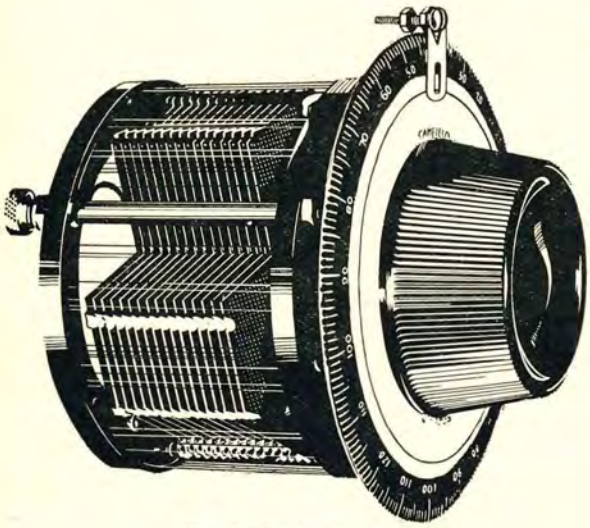
A Child Can Operate It

MU-RAD RADIO CORPORATION

Sales Office:
Newark, N. J.

Factory:
Asbury Park, N. J.

these 15 features



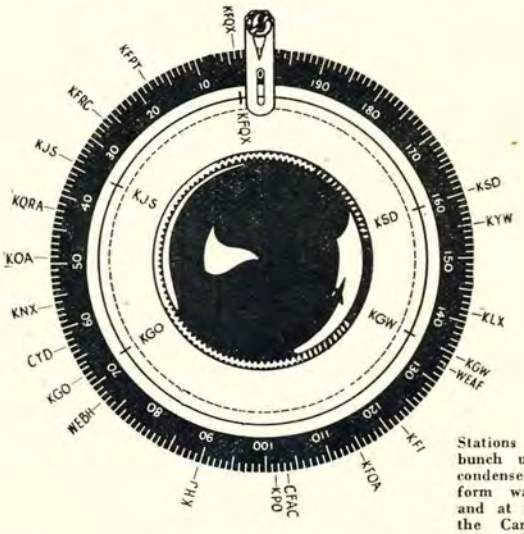
The Camfield Condenser is the result of years of effort to perfect a condenser that would be permanently low loss in construction and that would combine every feature necessary to insure perfect operation and simplicity of tuning.

1. *Low Loss Construction.* The elimination of bakelite from the dielectric field at one end, and the use of two metal strips at the other end of the condenser plates, reduce the loss to a point seldom, if ever, obtained in previous condenser designs.
2. *Transparent Dust Proof Case.* This case entirely eliminates the accumulation of dust between the condenser plates, which is known to be the greatest single factor in causing condenser losses—preserves permanently the straight-line feature.
3. *Straight-line Wave Length.* Dial reading is directly proportional to station wave length in meters. This makes tuning simple.
4. *Full 360° Dial* tuning from maximum to minimum gives vernier action and prevents crowding of stations.
5. *Perfect Balance.* Exclusive plate action gives perfect balance eliminating tendency of dial to turn or creep after station has been tuned in.
6. *Soldering* of brass plates gives perfect connection and low resistance.
7. *Pig-tail Connections* to both sections of plates eliminate noise in operation and give low resistance.
8. *Embossed Plates* insure perfect alignment.
9. *Black and Gold Finish Dial* gives the finest appearance obtainable.
10. *Large Bakelite Knob* makes manipulation of the dial easy.
11. *Adjustable Spring* for regulating dial tension.
12. *Two Paper Sub-dials* provided for logging stations.
13. *Celluloid Marker makes* station logging simple.
14. *Body Capacity Eliminated* by the complete insulation of shaft and dial from both sections of plates.
15. *Careful Inspection and Test* at our factory insure that each condenser has the correct capacity reading throughout the entire scale.

Sold in Three Sizes:

Type 886, .00025 mfd.	$6.00
Type 887, .00035 mfd.	6.00
Type 888, .0005 mfd.	6.50

The brass plates on the Camfield Condenser are of an exclusive design that makes the straight-line wave length performance possible. They are embossed to keep their surface uniform and in perfect alignment.



Stations that ordinarily bunch up on the average condenser come in with uniform wave length spacing and at greater intervals on the Camfield. Notice the full 360° dial. The paper sub-dials and the convenient pointer for a marker are standard equipment on Camfield Condensers.

make the new

CAMFIELD
STRAIGHT LINE LOW LOSS CONDENSER

"In the transparent dust-proof case"

one of the most important radio developments of the year!

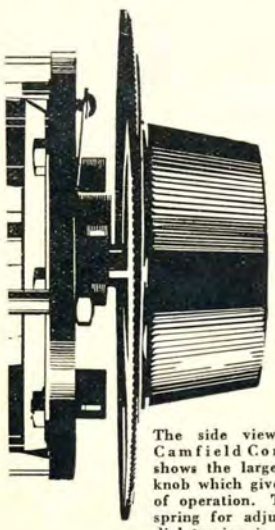
Here is a condenser that combines all the most advanced and proven principles of condenser construction with exclusive features of its own—such as the transparent dust-proof case, which keeps dust and dirt from the plates and makes the low-loss feature permanent.

The Camfield Condenser will add to the performance of your set and improve its looks. Ask your radio store to show you the Camfield Condenser, or write to us for name of nearest dealer.

$6.00
Complete
WITH DIAL
Sub-Dial and Marker

CAMFIELD RADIO MFG. CO.
807 Harrison St. **Oakland, Calif.**

See Our Exhibits at San Francisco and Los Angeles RADIO SHOWS



The side view of the Camfield Condenser shows the large bakelite knob which gives it ease of operation. The shaft spring for adjusting the dial tension is shown at the upper side of the condenser end plate.

dealers

Dealers: This Camfield display on your counter and the Camfield box on your shelf will identify you as a dealer in only the highest quality radio parts.

This remarkable condenser will be backed by an aggressive merchandising and advertising campaign. You will find it profitable. See your jobber about it immediately.

West Coast Representative:
A. S. LINDSTROM COMPANY
San Francisco, Los Angeles, Portland, Seattle, Salt Lake City

QUERIES AND REPLIES

(*Continued from Page* 37)

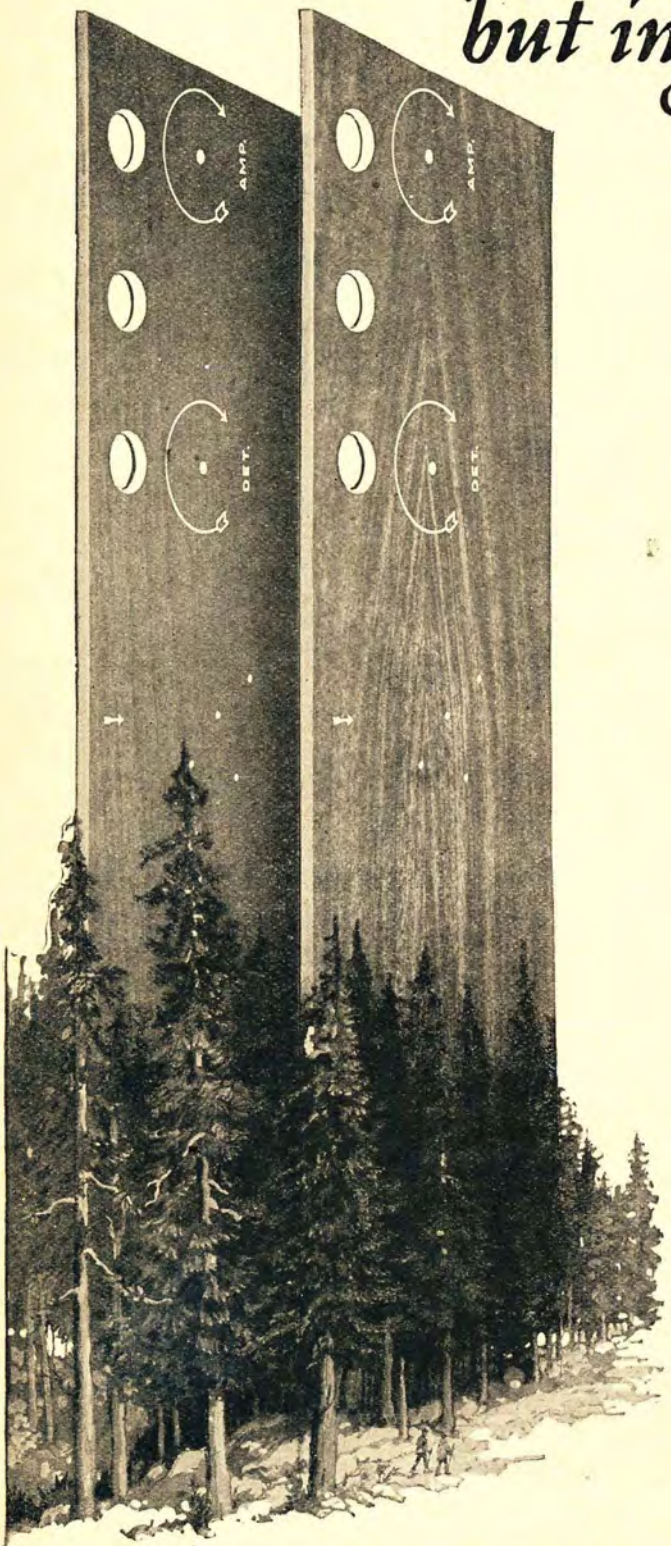
March, 1924 Radio. A few of the interesting points in Mr. McGown's article are given here for your information. Polish the articles to be plated on a buffing wheel or other suitable polishing medium. Clean first in gasoline and then immerse in a bath of boiling lye, removing quickly and washing in running water until all trace of lye is gone. Fasten the article to a small copper wire and suspend in the plating bath, which is made up as follows; mix in a stone or glass jar 12 oz. nickel-ammonium sulphate with 1 gallon of distilled water, adding about .125 oz. benzoic acid. If a larger amount of solution is desired, increase the ingredients in proportion. Obtain several nickel anodes, or solid nickel bars, which may be obtained from any large chemical supply house. Suspend these anodes in the solution on one side of the tank or jar, used to hold the solution and the work to be plated at the other side. The current supply for small work may be a 6 volt storage battery, the amount of current required being about .1 ampere per sq. in. surface of the article to be plated. Connect the positive of the battery to the nickel anode and the negative to the apparatus to be plated, and allow the current to flow for from 10 to 20 minutes, depending upon the amount of plating desired. The current can be controlled by a series rheostat and ammeter without difficulty. After the plating is complete, wash the article in running water and dry in sawdust or warm air blast. For small work, the crock in which the solution is mixed will be O. K., but where a large amount of work is to be handled, the tank had best be made of wood. If articles made of metal other than copper or brass are to be plated, it will be necessary to copper plate them first, using a separate solution. Copies of the March 1924 issue of Radio are available if a detailed description of electroplating is desired.

Strips of thin leather make very fair supports for the sockets of vacuum tubes, and help reduce the shocks and jars to which tubes are subject.

Thumb tacks of some varieties make very fair substitutes for switch points, provided they are used on thin panels.

It's mahogany to the eye-

but in fact it's Bakelite



So perfectly is the grain and color of mahogany and walnut reproduced in these Bakelite Radio Panels, that the eye cannot distinguish them from the natural woods.

By using a Bakelite Panel that matches the wood in the cabinet, your finished set will be far more handsome than if a plain panel is used.

Rigid and strong, Bakelite Panels support the weight of heavy instruments without sagging. They will not compress, or cold-flow, under pressure of binding screws. Because of their resistance to extremes of heat, cold and moisture, they will not warp nor split. These properties and their insulation value, color and finish are permanent.

Be sure to ask your dealer to show you these wood finish Bakelite Panels—obtainable under any of the following trade-names:

FORMICA CELORON **Dilecto**
Spaulding Fibroc **Micarta**

A Bakelite Panel on a set is an indication that the manufacturer has used the best.

Write for Booklet 30

BAKELITE CORPORATION
247 Park Avenue, New York, N. Y.
Chicago Office: 636 West 22nd St.
Visit Our Booth at the Chicago and New York Radio Shows.

Bakelite is an exclusive trade mark and can be used only on products made from materials manufactured by the Bakelite Corporation. It is the only material which may bear this famous mark of excellence.

BAKELITE

REG. U.S. PAT. OFF.

BAKELITE is the registered trade mark for the phenol resin product manufactured under patents owned by the Bakelite Corporation.

THE MATERIAL OF A THOUSAND USES

CALLS HEARD

(*Continued from Page* 41)

By 6EB, Lyndon F. Seefred, 343 S. Fremont Ave., Los Angeles, Cal.
(40 meters)

(1ow), 1xav, 1pm, 1yb, 1cmx, 1za, 1pl, 1gu, 1gv, (1aao), 1anq, (2aay worked on 5 watts), 2brb, 2bg1, 2ctq, 2gk, 2agw, 2rm, (2bbx), 2buy, 3hg, (4bl), (4si), (4eo), (5aec), (5atv), (5asv), 6est (Hawaii), (7gp), (7dc), (7ya), 8byn, 8dal, (8gz), 8bac, 8cbp, 8do, (8chk), 8apw, 8cyi, 8bgq, (8pl), 8bgn, 8dcb, (9dat), (9bht). Canadian: c4by, c4gt, c4cr, c4dq, c4oa, 45bf, (c5ba), c5ef. Porto Rico: 4sa. kfuh, kfvt, wiz, kel, npg, napg, nps, nve, naj, nqw, nfv, (nrrl), (nkf), (npm), (fx1). Mexico: (m9a), (m1b), mbx, m1aa, m1k, m1n, m1x. New Zealand: (z1ao), z4ag. Australia: a2yi, (a3yx), (a3bd), a2bk, a2yg. Japan: j1aa. Philippine Islands: (pilhr). Buenos Aires, Argentina: (raf2).

One 50 watt tube (uv203a) on 38.7, 39.8, 40, 41.9 meters, respectively, with 1000-1500 v. ac and 400 milliamperes on plate, 8.5-10 v. filament, was used. The old 80 meter antenna 97 feet long, 4 wire cage, old corroded stranded wire was used for 40 meters with no counterpoise. Antenna current was .7 to 1.3 T.C. amperes.

Am on 19.9 meters now with .8-.9 T.C. amperes antenna current, using 15 ft. single wire counterpoise in basement of house and single wire antenna 35 ft. long and 30 ft. high. All wire is No. 12 enamel and glass insulators. All reports of 6eb answered.

By 7pz, W. R. Farquaharson, 1115 James Street Chehalis, Wash.

1cmp, 1cmx, 1ow, 1pl, 1te, (1xu), 1yb, 2agw, 2bee, 2br, 2cv, 2il 2te, 2wb, 3apv, 3oe, (4rm), 4sa, (5aij), 5ail, 5fv, (5ox), 8aa, 8aks, 8aly, 8avl, 8bcv, 8bro, (8buk), 8chk, 8cjp, 8cyi, 8eq, 8er, 8ex, 8gz, 8jj, 8jp, 8nx, 8ry, (8xaf), 9amq, 9ado, 9bbv, 9bdu, 9bdw, 9beq, 9bht, 9bht, 9bjp, 9bkr, 9caa, 9cap, 9ccs, 9cfi, 9cld, (9cpm), 9cpo, 9cul, 9bdz, 9dez, 9dpx, 9dxr, 9ee, 9efy, 9elb, 9fj, 9hk, 9oo, 9sr, 9wn. Canadian: 2bg, 4cr, 4ed, (9al). Australian: 2cm, 2ay, 2yi. New Zealand: 4aa. NKF, NPG, (NRRL). Would appreciate any reports on my signals. Glad to answer all qsl's.

6clz-6cow, 1045 Peralta Avenue, Berkeley, California

U. S.: 1aac, 1aac, 1abf, 1aci, 1aff, 1aid, 1ajg, 1ajt, 1ajx, 1alw, 1amd, 1azc, 1aqm, 1are, 1ary, 1asy, 1aur, 1avf, 1awe, 1axa, 1axn, 1axz, 1bbe, 1ban, 1bcc, 1bdx, 1bep, 1bkq, 1bpb, 1ckp, 1cln, 1cmp, 1cmx, 1af, 1by, 1er, 1gk, 1gt, 1gv, 1hn, 1il, 1ka, 1kx, 1oj, 1ow, 1pl, 1pm, 1py, 1ql, 1rd, 1rr, 1sl, 1te, 1vd, 1ve, 1wy, 1xai, 1xam, 1xao, 1xay, 1xu, 1xz, 1yb, 1yd, 1za, 2aaj, 2aan, 2aay, 2abt, 2acp, 2adk, 2adm, 2aey, 2agw, 2ahk, 2aim, 2ale, 2als, 2ana, 2anm, 2avg, 2axf, 2bck, 2bee, 2bgi, 2bjx, 8blm, 2bmi, 2bqa, 2brb, 2bsc, 2cee, 1cgi, 2chk, 2cla, 2lg, 2cnk; 2cpd, 2cpo, 1ctf, 2ctq, 2cty, 2cub, 2cvf, 2cwj, 2cxw, 2cyx, 2ag, 2bm, 2bo, 2br, 2bw, 2by, 2cm, 2cv, 2fb, 2gk, 2gx, 2ke, 2le, 2mm, 2mu, 2pd, 2ph, 2qh, 2rk, 2rm, 2wb, 2wi, 2xaf, 2xam, 2xbf, 2xi, 2zu, 2zv, 3adp, 3aec, 3ajd, 3apv, 3ash, 3ava, 3bfe, 3bjp, 3bmn, 8bnu, 3bpm, 3bss, 3bta, 3buy, 3bva, 3bwj, 3ccv, 3cdv, 3chg, 3chh, 2cjn, 3ab, 3bx, 3ck, 3cs, 3hg, 3hj, 3jw, 3kz, 3lg, 3ll, 3mf, 3mu, 3qt, 3tp, 3xan, 3yo, 3zo, 4au, 4bl, 4bq, 4cu, 4du, 4dv, 4er, 4gw, 4gy, 4jh, 4jr, 4ku, 4ll, 4pu, 3rm, 4te, 4tj, 4tv, 4tw, 4uc, 4uk, 4xe. Australia: 2bc, 2bk, 2cm, 2ds, 2ij, 2yi, 3bd, 3bq. Brazil: 3ad. Canada: 1ar, 1ei, 2az, 2cg, 2fo, 3co, 3gb, 3kq, 3mv, 3ni, 3ws, 3xi, 3xx, 9al. Hawaii: 6asr, 6cst, 6xo. Holland: orz. Mexico: 1aa, 1af, 1b, 1j, 1k, 1n, 9a. New Zealand: 2ac, 2ae, 2xa, 4aa, 4ak. Porto Rico: 4sa. Samoa: 6zac. qra????, 86a, (hp). All crds promptly and gladly answered. qrk, 6clz-6cow on 20 and 40 meters?

At 8ze-8gx, E. W. Thatcher, Oberlin College, Ohio
(On 40 meters)

U. S.: 6age, 6agk, 6ahq, 6alj, (6aji), 6ahp, 6awt, (6bhz), 6bik), (6bkx), 6bjd, 6bmu, (6bsc), 6buj, 6bur, 6cgo, (6cgw), 6cej, 6chz, (6cig), (6cix), (6clr), 6clp, 6cnc, 6cpf, 6css, 6csw, 6cto, 6dah, 6cc, (6ji), (6im), (6hw), (6lj), 6kb, (6km), (6no), (6oi), 6ui, (6ur), (6ut), (6ts), (6vc), 6xag, 6xap, 7abb, 7ay, (7gb), (7nx), 7mf, 7pz, 7ya. Foreign and special: a2bk, (a2ds), (a2cm), a2ay, a2ij, a2yi, a3bq, c4gt, c5gt, g2kf, g6ym, P. R. (4sa), (4je), (m1-k), m1aa, z2ac, (z2xa), z4aa, z4ag, z4ak, z4ar. Hawaii: (nrrl), 6zac, 6xap. Naval: (nrrl), ?5gos, (qra?).

8ze-8gx is maintaining a relay transmitter which is at present located on 14.5 meters. Tests are being conducted on the lower wave bands, particularly on five meters. Communications from men interested in taking part in these tests and reports on the character of the signals will be greatly appreciated. All cards will be answered.

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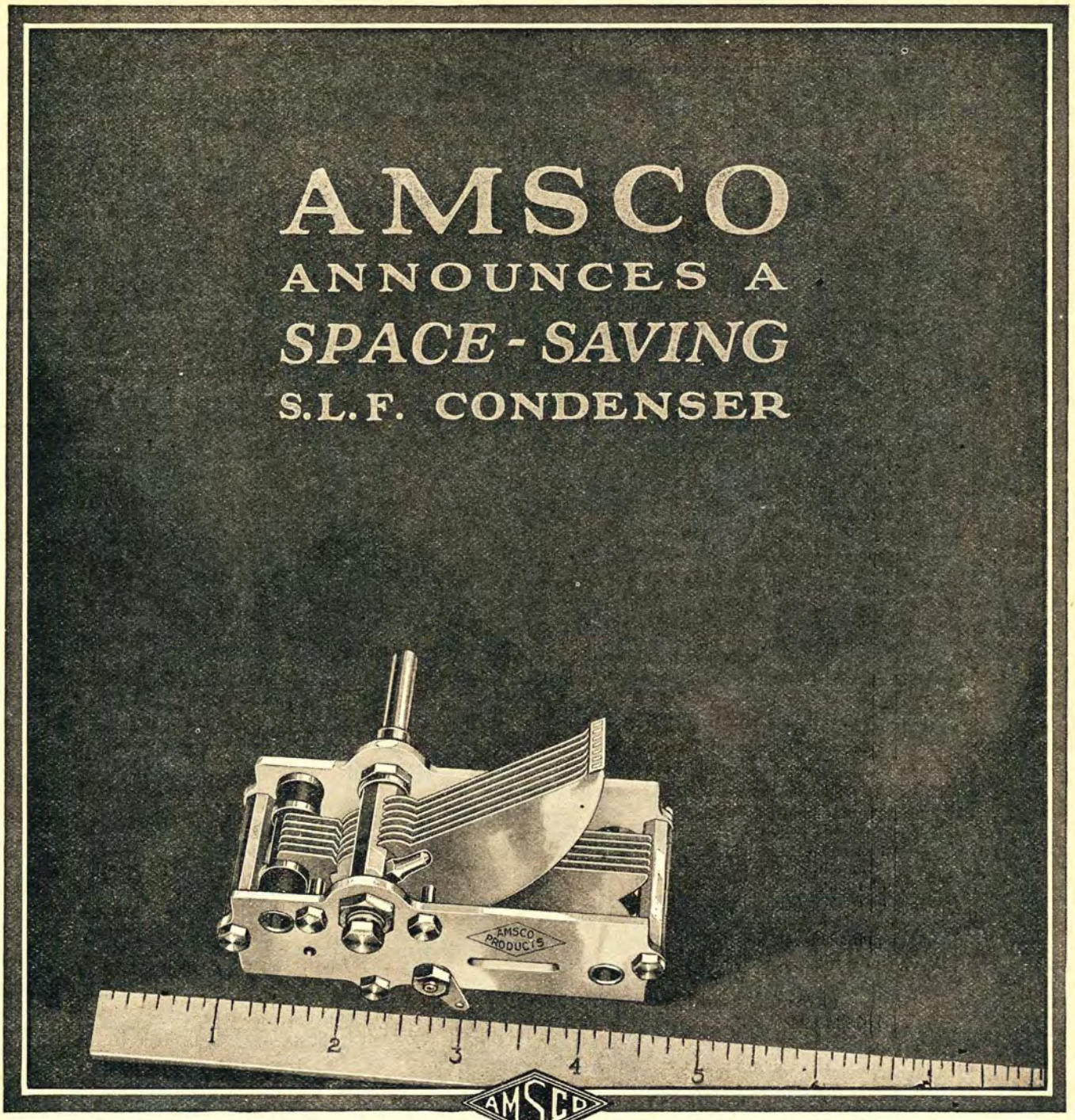

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—is the secret.

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—is the shape of the rotor plates.

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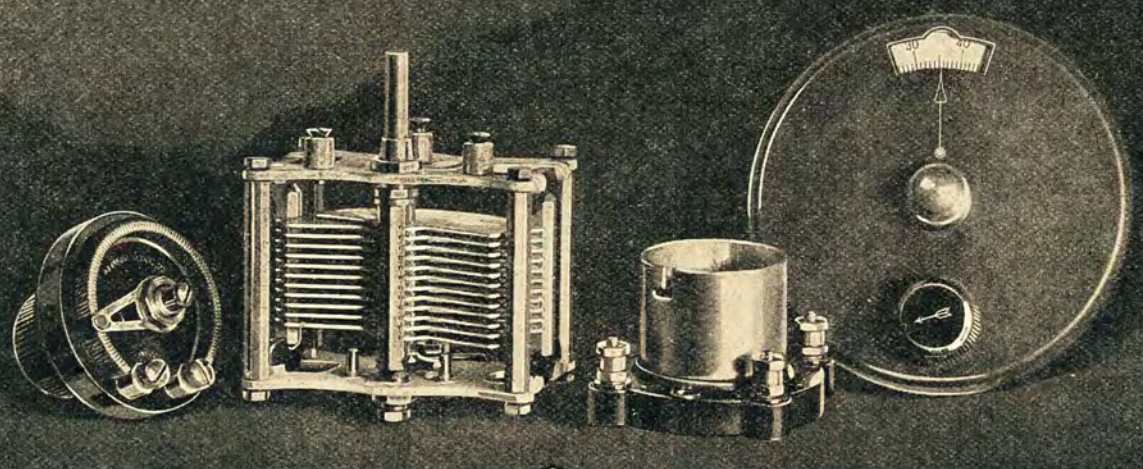

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NEW—The Amsco Vernier Dial—at a popular price. The right ratio for precision tuning.

13 to 1

RESCUING UNCLE MARMADUKE

(*Continued from page* 24)

make amends before I pass on; and the time of my passing is not far off—no, it is not far off."

"Oh, you haven't been so bad," I said, comfortingly, "Of course, that affair you had with the chorus girl was a bit of a mess; but by and large, I'd say you would stack up just about par. There's been lots of chaps much worse than you: Jessie James or Gyp the Blood, for instance. Besides, who has been giving you all the inside dope about your passing?"

"The spirits!" He said it with a soft, sliding sound, biting the word off quickly at the end; and then continuing with a hollow-voiced, sing-song effect. "The spirits, Reggie. They come to me in the quiet of the night. Rapping—rapping—gently rapping. Revealing what is to be. Guiding and advising me. And always—always they say, 'Purify yourself of all wealth. Remove the taint of earthly gain. The time of your passing approaches.' They say it over and over again—over and over again."

I say, you know, that sort of thing in a dimly lighted room is likely to make a chap's nerves crawl; but I managed to keep myself bucked up.

"Rot! You've got a plain case of heebie-jeebies. Get out the old golf clubs, play eighteen holes with me tomorrow, and you'll feel better. This spirit business is the . . . ."

I was about to say, "the bunk." But just then something happened that positively made my spine curl. In the center of the room stood a small table. All of a sudden, there came from it three distinct raps. For a moment, I just sat there with my mouth open, and the little shivers frolicking up and down my back.

"The spirits," Uncle Marmaduke whispered, "The spirits, signaling a message."

It was all quiet for an interval, so quiet that I could hear Uncle Marmaduke breathing through his nose like an acrobat getting ready to do a stiff trick. Then the table began rapping again, very slowly—rat-tat tat-tat-tat. I saw Uncle Marmaduke writing something in a notebook which he took out of his dressing robe pocket. The table kept up the rapping for a minute or two; then stopped.

"The spirit message," Uncle Marmaduke said, handing me his note book. He had written on one of the pages:—"Beware of evil influences. Free yourself from the taint of earthly gain. The time of your passing cometh soon."

I'VE read that chaps, whom Fate has given the old K.O., have a habit of picking themselves up and piecing themselves together again, so to speak. There's a lot to it. I know, because that's just what I did—or, at least, tried to do.

(*Continued on page* 54)

THOMPSON

Announces Same Good Policy for Fall Business

No less than 116 different types of Thompson Radio instruments preceded the creation of Thompson Radio Broadcast Receivers in that long climb through the past of wireless and radio development which culminated in the perfection of broadcasting and reception. In the history of radio development for ships, airplanes, submarines and the other forms of radio communication, the Thompson organization has contributed an unusually high percentage of the better equipments.

Armies and navies of the world use its apparatus and this organization now puts into its broadcast receivers all the experience and skill so gained by years of working with radio communication problems. Where the many newcomers have to guess, the Thompson organization knows by experience. Therein lies the greatest factor of safety for the dealer and distributor.

Today there are in use millions of radio receivers sponsored by manufacturers or assemblers who are as new to this difficult industry as broadcasting itself. Many of these sets will be unsponsored when inexperience has taken its toll. Between theory and practice there is a vast gap that no manufacturer can cross save over the bridge of experience.

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The platform on which we will join with you in doing a profitable business this Fall is in your distributor's hands. It is known, it is definite---it is fair. We believe you can build a permanent radio business on it.

THOMPSON
RADIO
NEUTRODYNE

R. E. THOMPSON MFG. CO., 30 CHURCH ST., NEW YORK CITY

(*Continued from page* 52)

After the seance in Uncle Marmaduke's room, I felt pretty shaky. I mean to say that the full horror of the thing rolled over me. A fellow can put up a scrap against another fellow; but I ask you, what can he do against a ghost? Absolutely nothing. Right!

But the next morning with the merry sunshine pouring through the windows, I began to feel different about it, sort of got myself together. Here, says I, is a chance to exercise the old bean. Solve the mystery of the rapping table, and win a fortune. It was worth trying.

So when I heard Uncle Marmaduke go down to breakfast, I gum shoed into his room for a bit of sleuthing. Naturally, my first hunch was that the knocking was produced by strings or wires attached to the table. But there weren't any. I studied the table, moved it about, went over every inch of it with an eagle eye for clues. All minus. The table looked just about like maybe a million other tables I had seen. The thing had me fairly stymied.

Worse than that, it meant I was doomed to be thrust out into the cruel world without even a crust upon which to rest my weary head. I mean to say that the future looked pretty black for the younger generation of the Rockford-Peebles family. No question that Uncle Marmaduke was thoroughly sold on the spirit messages; and it was only a matter of time until he re-vamped his will as per the spirits' directions. I could close my eyes and see Mrs. Hoagworth, grim and cruel, clutching the deed to the property in one hand while she ordered Ruth and I out of the house with the other.

Feeling pretty low, I dragged myself downstairs, and went out in the garden to puzzle the thing out. There was a Ford car parked in front of the house; and coming up the walk was Bill Curtiss. He looked as fresh and fit as a dew-covered violet. Somehow, the very sight of him seemed to steady the old nerve centers, gave me new born confidence, as it were.

"I say, Bill," I shouted, rushing at him pell mell and grasping his hand like a drowning man grasps the well known straw, "how in blazes did you happen to drop in?"

"Why," he said, looking a bit ruffled, "I seem to have the impression that you invited me down for the week-end to give you some advice on radio sets."

"So I did! So I did!" I chortled, dragging him up to the porch, "But sit down; I've got something else on my mind. What do you know about these people who put you in touch with spirits?"

"You mean bootleggers?"

"No, no; spiritualists, mediums."

"Not very much; why?"

(*Continued on page* 56)

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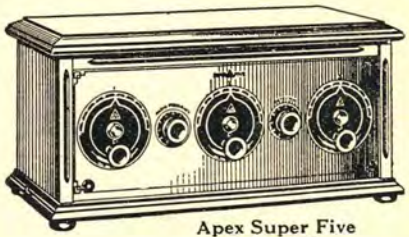

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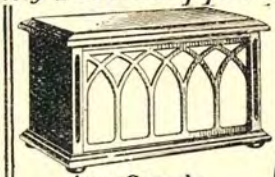

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(*Continued from page 54*)

I told him, unburdened my bruised and bleeding soul to him, so to speak. He listened attentively until I had finished the whole harrowing tale.

"Is your uncle's housekeeper present when these spirit manifestations take place?" he asked.

"No. I mean she wasn't around last night, anyway. Not a sign of her."

"You say you examined the table carefully?"

"Righto! It's just an ordinary table; been in the family for years."

"Does your uncle, when he is communicating with the spirits, ask questions which the table answers?"

"No, the table seems to do all the talking. I mean to say it raps out messages like—like . . . ."

"Like a telegraph instrument?"

"Yes, by Jove, that's it exactly; just like a telegraph instrument. Unc takes the messages down in a little book."

"H'm, I wonder if there's any chance of my sitting in on a seance; I'd like to see the table perform. Perhaps you can palm me off as being somewhat of a medium myself."

"What, Ho! There's a brainy thought," I said, jumping up, "we can't get ruled out for trying, anyway. Come along, I'll speak to the old boy about it."

"Wait a minute," he answered, "I want to get something out of my bag. And by the way, Reggie, you wear a wrist watch; let me borrow it for a while."

"What for?" I asked, unstrapping the watch and handing it to him.

"Never mind; tell you later."

He ran out to his car, fussed around for a moment getting something out of his bag, and was back on the porch in a jiffy.

"All right, Reggie, my boy, lead the way."

We found Uncle Marmaduke in the library with Mrs. Hoagworth. She was talking to him in low tones, but cut her conversation off sharply as we entered.

"Here's good news, Unc," I said, "Meet Professor Bill Curtiss, world-famous medium, the man whose remarkable psychic powers have baffled the scientists of two continents."

Uncle Marmaduke smiled weakly and bowed; but the Hoagworth woman sat bolt upright in her chair and gave me another hard look. I pretended not to notice it, however, and babbled on. "I was just telling the prof about your table rapping stunt, and he says that's kindergarten stuff. He can make it do a song and dance. Eh, professor?"

"I'm afraid your nephew overestimates my ability," Curtiss said, smiling, "I'm merely a student of the occult, and would appreciate attending one of your seances."

(*Continued on page 58*)

NO-DIAL (Patented)

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The "NO-DIAL" so simple in operation, so positive in performance, is just what you want

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The NO-DIAL brings in stations far and near by merely rotating the cover. Each station comes in at a certain point. As stations are received they are recorded right on the cover (fig. 1) and thereafter they will always come in at the same point. Thus you have a *permanent* and *visible* station record which is positive and unfailing.

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The Ohio Stamping and Engineering Company **Dayton, Ohio, U. S. A.**

(*Continued from page* 56)

"He doesn't hold seances," the Hoagworth woman interrupted.

"Oh, I beg your pardon," Curtiss said smoothly, "No doubt, I misunderstood the facts. If Reggie, here, were simply boasting, why . . . ."

Sunken into the depths as he was, Uncle Marmaduke had still retained a few drops of the old Rockford-Peebles sporting blood. I mean to say that what Curtiss said rather cut him. His face went red, and he completely disregarded the warning glance which Mrs. Hoagworth shot at him.

"I make no claim at being a medium," he said testily, "but if the spirits see fit to communicate with me, I see no reason why you shouldn't witness the phenonenon."

I started to shout, "bravo"; but changed it into a cough when I caught the expression on Mrs. Hoagworth's face. I've seen the same look on some of the wild animals at the zoo; a sort of oh-if-I-could-only-get-at-you-for-about-a-minute effect.

"The spirits seldom manifest themselves at this time of day," she said.

"Indeed?" Curtiss replied, giving it the rising inflection, "Then perhaps we'd better not disturb them. Frankly, I had my doubts regarding the matter, anyway."

This was too much for Uncle Marmaduke.

"See here, young man," he fumed, "I'll have you to understand that my nephew told you the truth. Come up to my room; and I'll prove it." He turned to Mrs. Hoagworth, and went on in a wheedling voice. "There can't be any harm in it. Why don't you join us?"

"I'll have nothing to do with it," she said frostily.

She arose, swept out of the library and up the stairs, with the rest of us following along behind to Uncle Marmaduke's room. In the light of day, it wasn't so dashed spooky. In fact, I was beginning to get quite a kick out of the affair. We waited for about five minutes, and then the table signalled a message. Rat-tat-tat. It was followed by a pause, and, at length, a prolonged rapping. When the knocking finally stopped, Curtiss roused himself from his seat near the table.

"A remarkable psychic demonstration," he said, "Did I understand you to say that you had no control over these spirit manifestations?"

Uncle Marmaduke nodded. "I haven't anything to do with it. Whenever the spirits have a message for me, they knock on the table. Mrs. Hoagworth taught me how to translate the rappings. You see, the various knocks stand for different letters of the alphabet. For instance, one short knock followed by one long one stand for the letter A."

(*Continued on page* 60)

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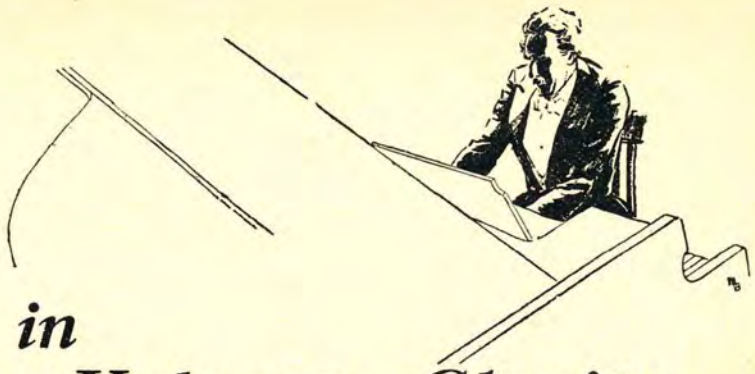

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OUT SEPTEMBER 10th

The Fall issue of the CITIZENS RADIO CALL BOOK will be ready about the tenth of September.

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It will contain many new features in the form of articles showing how to build a 45 kilocycle Superheterodyne, Browning-Drake, 6 Tube Tuned Radio Frequency Receiver, Counterflex 8 Tube Superheterodyne, Roberts and many others.

Also a very complete directory showing pictures of radio announcers and artists. Calls and schedules of Broadcasting stations all over the world, maps, log sheets, etc. Price 50 cents.

ATTENTION AMATEURS:

COMPLETE REVISED AMATEUR SECTION

OUT SAME DATE

BE SURE TO WAIT FOR IT

(*Continued from page 58*)

"Yes, I understand that," Curtiss answered, "In fact, I was able to translate the message. It was, 'Put not your faith in false prophets; for they shall vanish away!' I've had considerable experience with these kind of spirit messages myself."

"You don't tell me?" he said, perking up in his chair.

"Yes, indeed," Curtiss went on, "and what's more, I can usually control the spirits, make them give me messages whenever I'm in the mood. If you'll excuse me for a moment while I run down to my car, I'll be glad to conduct a seance right now."

By this time, Uncle Marmaduke was so tickled that he was twisting about like an electric fan.

"Oh, by all means! I would be delighted, positively delighted. And so will Mrs. Hoagworth, I'm sure. I'll send for her."

But he didn't have to send. Curtiss had hardly left the room when in popped Mrs. Hoagworth, her face the color of a bottle of ketchup.

"See here," she shouted, "What's the idea of letting this bum put on a seance? Let this bunk artist pull any of his tricks around here, and I warn you, you'll regret it."

"I can't see why the seance should have any serious consequences. What is there to warn me about?"

"There's this," she hissed, "The minute this smart Alec starts his tomfoolerie in this room, it means that the hour of your passing is at hand. Just think that over."

With that, she turned and bounced out of the room, slamming the door behind her.

Uncle Marmaduke turned a bit pale; but there's no denying that the old boy was game. He didn't even flicker an eyelash when Curtiss returned, bringing with him a couple of dry cells, a coil of wire, a push button and a little oblong box, all of which he placed on the bureau.

"Before we start the seance," he began, "I want to explain my interest in this table of yours. It is the only spirit table I know of which transmits messages in Morse code. When Reggie told me about it, I was so fascinated that I decided to try a little experiment. I borrowed Reggie's wrist strap, took out the watch, and inserted a compass in its place." He took off the wrist strap, handed it to Uncle Marmaduke, and went on, "Ordinarily, the hand of the compass points north and south. But when the compass is brought into an electro-magnetic field, the hand points in the direction of the electro-magnet. I noticed that it did that very thing during the time you were receiving the spirit message; that is, instead of pointing north and south, it pointed toward the table." (*Continued on page 62*)

FADA Radio

If it's in the air *Fada gets it*

PUT Fada *into* your home today.

It will prove its right to *stay* there.

Simply ask your dealer to install a Fada Neutrola-Grand, let him set the dials for you, and then leave the operation in your hands.

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Manufacturers of TUNED RADIO FREQUENCY *receivers using the highly efficient* NEUTRODYNE *principle.*

Fada Neutrola-Grand $225. Adapted for dry cell or storage battery

(*Continued frome page* 60)

"But—but what has all that to do with the spirits?" Uncle Marmaduke inquired, fidgeting about like a small boy waiting for dessert.

"I'm coming to that," Curtiss resumed, "just have patience. Now there's another little device which is also affected by electro-magnetic waves. It is called a coherer; and it consists of a glass tube filled with particles of iron between two solid electrodes. These particles of iron offer resistance to an electric current under normal conditions. but when they are brought into the presence of electro-magnetic waves, they cohere, and allow the current to pass through. The result is that you can transmit signals between two points without the aid of connecting wires. In fact, the coherer is one of the earliest radio receiving devices. To demonstrate . . . ."

He had been hooking up the dry cells to the oblong box as he spoke. Now he did something to the push button. There was a series of shrill buzzes and the snapping of electric sparks. But what bowled me over, so to speak, was that the table was rapping with every buzz coming from the oblong box. Uncle Marmaduke fairly bounded from his chair.

"What's that?" he gargled, "What does this mean, sir?"

"It means," Curtiss said calmly, "that if you search Mrs. Hoagworth's room, you'll probably find just about the same equipment which I have here—a spark coil, a battery, and a push button or telegraph key. Moreover, if you'll remove the top of the table, you'll find a coherer arranged so that the hammer of the bell strikes against a hollow wooden block. I'll pay for the table just for the satisfaction of proving that I'm right."

He snatched up a poker which stood by the fireplace, and whacked it across the table, splitting the top. Sure enough, concealed in a little partition just underneath the broken top, was a couple of dry cells and the apparatus he had described.

"Why, sir," Uncle Marmaduke roared, "Mrs. Hoagworth has been sending me all these messages herself! I see it all now! It's a fake! I've been deceived!"

"It's a fake, all right," Curtiss said with a grin, "but you haven't exactly been deceived. I'd say that the table gave you some rather reliable advice. Didn't it warn you against false prophets, and didn't it tell you they would vanish away? Well, if you'll just glance out of the window, you'll see Mrs. Hoagworth vanishing down the road."

Deucedly clever chap, this fellow Curtiss. What!

YANKEE TUBES

Types 201-A and 199

"A Yankee Yields To None"

Trade Mark
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THE Manufacturers of **Yankee Tubes** have only one aim—to make the best tubes it is possible to build. To judge by the enthusiasm with which dealers and set manufacturers have received the latest types, this is to be a **Yankee** year.

In order to make sure of your quota of **Yankees** for the rapidly approaching season, write today for our special proposition to dealers.

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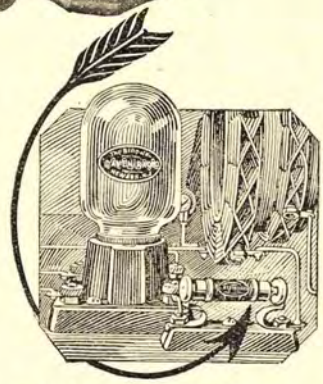
"Simplify Radio" says Daven

Daven Engineers Blaze Another Trail



The New Daven Tube

Type MU-20 increases the amplification of the Daven Super-Amplifier to equal or exceed that obtainable with transformer coupling. A one-purpose, three-element tube, 6 volt, ¼ ampere—$4.00 each. Daven Power Tube Type MU-6 is recommended for last or output stage—$5.00.

THE biggest of all the little things in radio is the grid leak. The Daven Grid Leak is known the world over as the grid leak of permanent, constant value. It is standard.

Almost as important is the condenser. But grid condensers change with temperature and humidity. The mica in condensers lacks uniformity or is impure. The tin foil plates melt or change their capacity.

In their constant efforts always to simplify and to improve, Daven engineers have made a remarkably effective combination of grid leak and condenser. Two-in-one!

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IT is so simple, so effective and so sturdy that you will wonder why it was not thought of before.

Similar in size to the Daven Grid Leak, it takes the place of the usual grid condenser which has shunted around it the usual grid leak. Made with five different values of grid leak resistance, 2, 3, 4, 5 and 7 megohms. The grid condenser capacity is fixed and correct for all makes of detector tubes.

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For Dealers: Send your letterhead or card, or this coupon and we will have our nearest distributor communicate with you.

THE BIG LITTLE THINGS OF RADIO

TRANSMITTER OF 6XAD

(*Continued from page* 39)

to waves between 10 and 80 meters, we can so proportion the set that the inductive coupling can also be fixed, so that as the frequency is increased, and the coupling effect of the tube increases with it, this coupling becomes more of a controlling factor and the inductive coupling between L_1 and L_2 becomes more of an erasing factor, keeping the capacity coupling in a more or less constant excess.

In this manner the circuit is not easily affected by changes in the antenna circuit, and most of the feedback energy is effected within the tube, thereby relieving the grid lead-in wire and the grid itself of practically all strain.

Circuit L_1C_1 should be coupled as loosely to the plate as possible, and yet transfer the necessary amount of energy, so that the coupling condenser C_3 need only be slightly greater than the plate-filament capacity of the tube. This condenser functions not only as a plate blocking condenser but as a grid coupling condenser, for it is clear from the diagram that the grid circuit receives its energy from L_1C_1 by virtue of three capacities in series (C_3,C_4,C_5). If C_3 and C_4 are small, the possible effect of L_2 on L_1 is very slight, and the effect of L_1C_1 on L_2C_2 is limited by the weak capacity coupling through C_3C_4 and C_5. The series capacities C_3 and C_6 are parasitic capacities in parallel with C_1 but are so small that where they changed in value, the effect on the constancy of frequency of L_1C_1 would be very slight. The same is true of the two series capacities C_4 and C_7 and their consequent effect on L_2C_2.

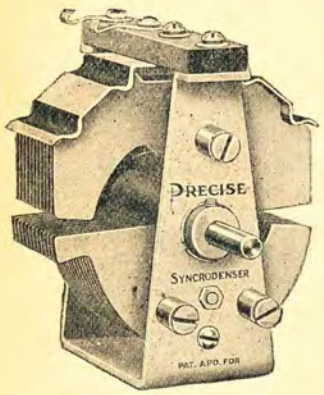
The circuit, therefore, is very stable and can be relied upon to deliver oscillations of a steadiness rivalling that of the master oscillator-power amplifier system controlled by an oscillating crystal, such as is used at NKF.

The antenna used with this transmitter is a single wire 75 ft. high and is worked on the 3rd harmonic of 120 meters, being connected to a buried ground system which covers nearly ¼ acre. The special house in which the transmitter is placed is entirely encased in chicken wire, which is bonded and grounded at various points.

EVERY PRECISE INSTRUMENT IS A LABORATORY PRODUCT

Announcing
Two New Precise Instruments

The Syncrodenser



PRICES:
.00035 Cap. $4.00
.0005 Cap. $4.50

Like a pure straight-line frequency condenser, the Syncrodenser spaces the lower wavelength stations evenly over the first half of the dial from 0 to 50. It does not, however, start at that point to crowd the higher wavelength stations together over the last half of the dial, from 50 to 100.

This is because the Syncrodenser is a scientific combination of straight-line frequency, where it is vital, with straight-line capacity where that is superior.

The practical manner in which the Syncrodenser actually separates stations over this entire broadcast waveband marks a new era in condenser design.

Unusual design and great strength permit the Syncrodenser to be mounted on panel or subpanel in any conceivable position.

Made in two styles. The 750 type has extremely high minimum to maximum capacity ratio for use where a great frequency range is desired. The 750L is designed to cover the same frequency range as the average condenser of approximate capacity using the same coil.

No. 480 Super-size Audio Transformer

The need for faithful reproduction of all forms of broadcasting caused this Precise super-size audio transformer to be designed. It reproduces with absolute fidelity the true richness of the original creation as broadcasted, with magnificent amplification. The core and windings are unusually large and designed to withstand great overload. Compactly housed to permit subpanel mounting.

The other audio transformers in the complete Precise line are the original No. 285 (4½ to 1) at $5. Eclipse (2½ to 1) at $4. Comet (3½ to 1) $3.25. Push Pull No. 800-801 $11 per pair. The Precise Super-Multiformer is four matched radio frequency transformers in one unit, $20. Precise Filtoformer radio frequency choke coil and bypass condenser with inductance of 200 millihenries and .006 m.f.d. is $4.50.

Made in two ratios, 5 to 1 and 2½ to 1. Price for either ratio, $7.50.

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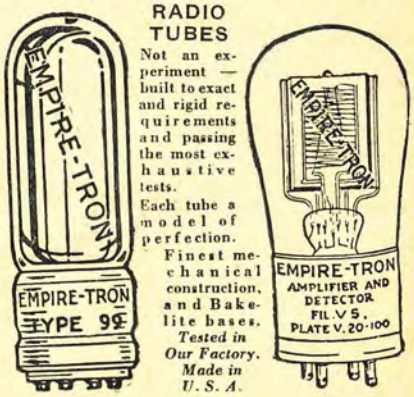
RADIO TUBES



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Those desiring the best always consider quality before price. Brightson True Blue Radio Tubes were designed to meet the needs of those seeking the best in radio.

No other tubes are comparable to True Blue Radio Tubes. You do not have to switch True Blue Tubes to get the best results. They are absolutely uniform and interchangeable. Every True Blue Tube is as good as every other True Blue Tube. Equipped with silver contact points and non-conductive bakelite bases to avoid electrical losses and disturbing tube noises. True Blue Tubes are also the clearest toned because of their rigid non-microphonic construction and high degree of vacuum. Their special filament material lasts two or three times longer than the standard.

Brightson True Blue Radio Tubes are sold with a 60-day written guarantee against defects. "The Squarest Selling Policy in Radio" permits users to return True Blue Tubes in 10 days if they don't think they are the best money can buy.

True Blue Tubes are 6 volt ¼ amp. storage battery tubes, made with standard base and small base. Ask your dealer to show them to you.

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Northwest Corner Waldorf-Astoria Hotel
16 WEST 34th STREET, NEW YORK, N. Y.

The Finest Radio Tube in the World!

LOUD SPEAKER TESTING METHODS

(*Continued from page 22*)

limits the tones will be inaudible. The currents from this vacuum tube oscillator are fed into the loud speaker to produce a single constant intensity tone whose frequency or pitch can be varied at will. These tones are air pressure variations due to a corresponding frequency. They are referred to as sound pressure and correspond to the pressure variations produced in speech and music. The condenser transmitter responds to these changes in pressure just as it does to the voice and musical sounds and these pressures are very small, being in the neighborhood of one-five hundred thousandth of a pound.

By means of elaborate tests the whole testing system, including the condenser transmitter and the amplifier, has been calibrated in such a way as to enable us to determine the sound pressure merely by observing the current output from the amplifier as measured by the sensitive current-measuring device. Readings or observations are made at definite frequencies in order to cover the whole pitch range that a loud speaker is called upon to cover. The results are recorded in a note book for a permanent record.

From these data we plot a curve such as that illustrated in Fig. 4. This curve shows the intensity or magnitude of the sound pressure given or produced by the loud speaker at the various frequencies in which we are interested for both speech and musical sounds. The height of the curve at the various frequencies indicates the intensity with which the tones of these various frequencies will be reproduced. The average height indicates in a general way the efficiency or loudness of the loud speaker when used on radio sets. This is true because the intensity of the tones as indicated by the sound pressure at the various frequencies is related directly with loudness, which is a psychological effect or phenomenon. We thus have a means of telling precisely what the performance of a loud speaker will be on radio signals, and furthermore we shall have a permanent record for reference at any time. In a succeeding article we shall give a number of curves and show how these curves tell us the story of what the loud speaker does to the radio signals.

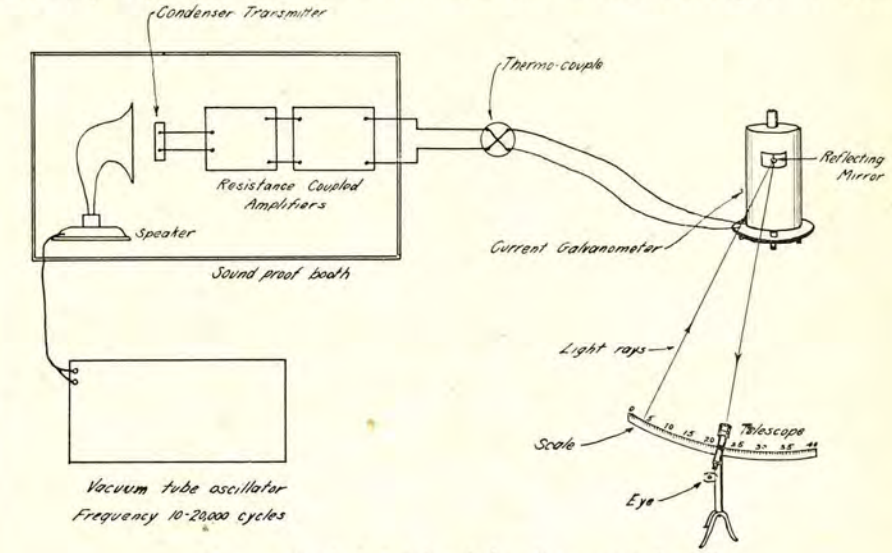


Fig. 3. Method Employed for Permanent Record.

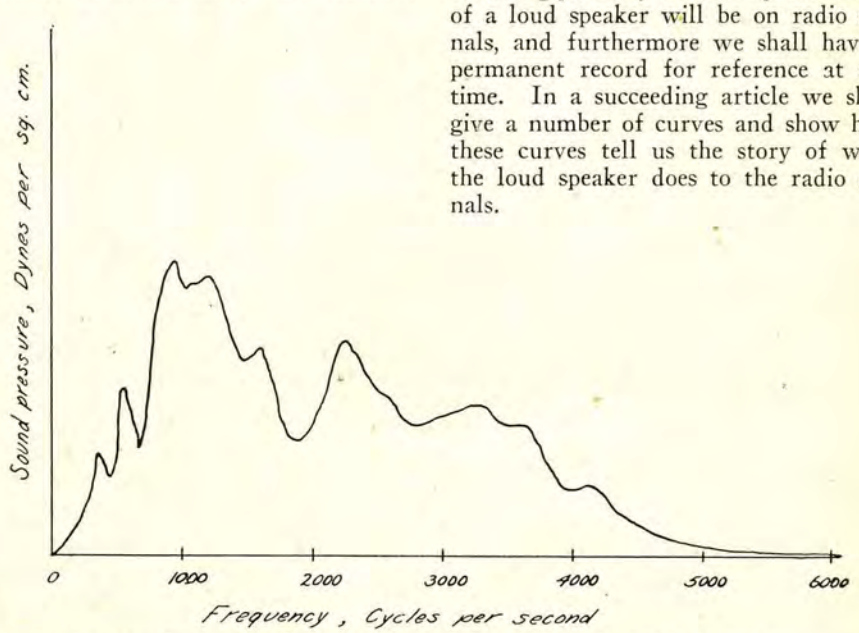
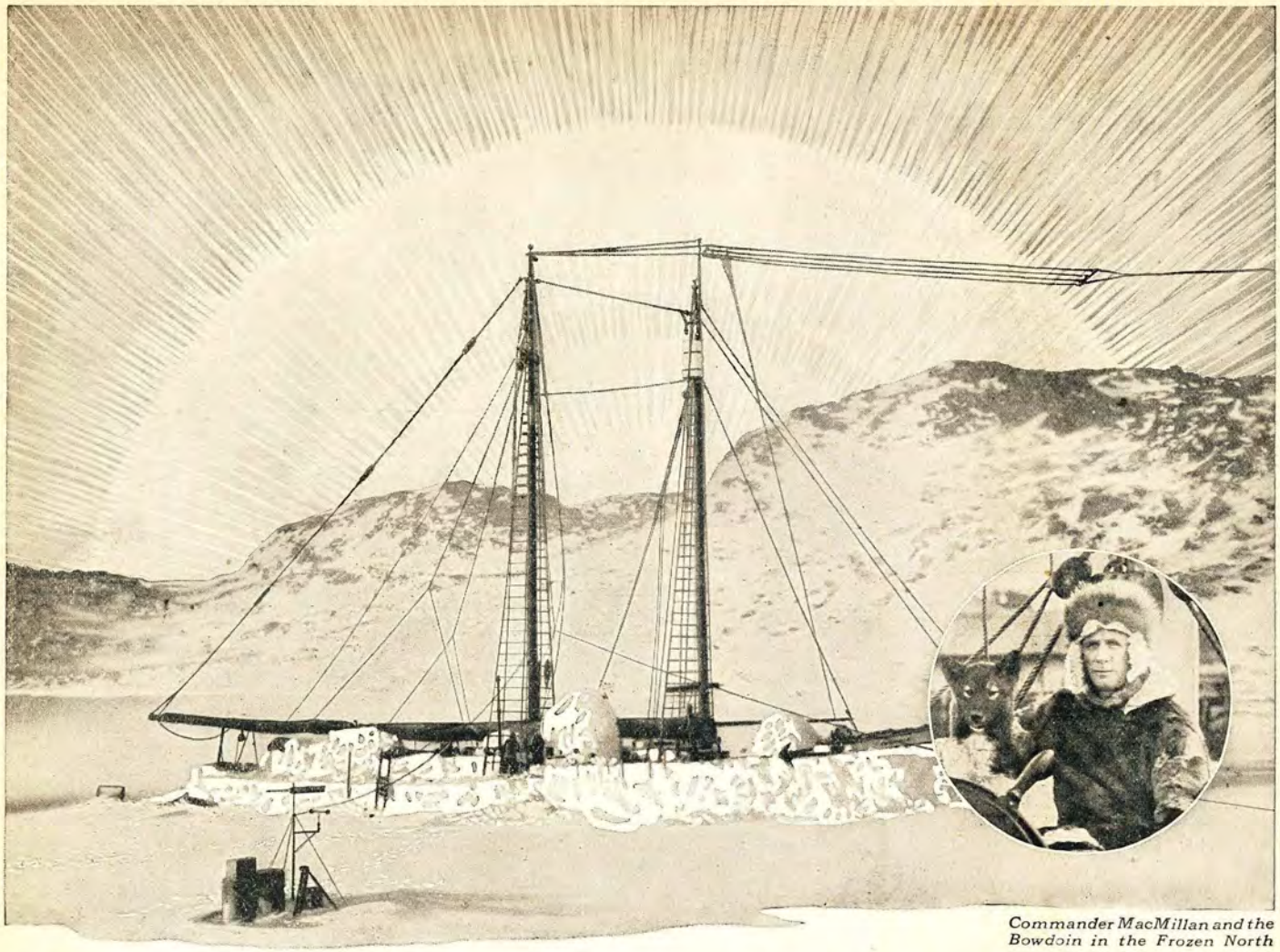


Fig. 4. Curve Showing Variation of Sound Intensity with Frequency.



Commander MacMillan and the Bowdoin in the Frozen North

With MACMILLAN *in the* ARCTIC

ONCE again that intrepid explorer, Donald MacMillan, has gone into the Frozen North. And once again—for the fourth time—he relied on Exide Batteries to serve him, without flinching, through the extreme rigors of the Polar region.

Each item of equipment on such an expedition is chosen with utmost care, for life or death hangs in the balance. On previous voyages to the Arctic with MacMillan, Exide Batteries have been through shipwreck, blizzard and incredible cold and never once have failed.

On this latest adventure all the storage batteries are Exide—for radio sending and receiving, for electric light aboard ship and on shore, for operating the sensitive scientific instruments. The three U. S. Navy airplanes that accompanied MacMillan's two vessels are equipped with Exide Batteries. Wherever radio must not fail, you will almost always find Exide Batteries have been installed—in government and commercial plants—on the giant ship Leviathan, on the Navy dirigible Shenandoah, on the new British airship R33; on every continent and the seven seas speeding up communication throughout the modern world.

Exide 6-volt "A" battery in one-piece case

There are also Exide "A" batteries for 2-volt and 4-volt tubes and "B" batteries, 24 and 48 volts, of 6000 milliampere capacity. The Exide line includes a most economical "B" battery rectifier.

The same qualities that make Exide the choice where lives are at stake are built into the Exide Batteries that you can have with your own receiving set. Staunch and dependable, the Exide gives uniform current through a long period of discharge and assures the clearest reception of which your set is capable. There is a type for every tube and a size for every set, obtainable at radio dealers and all Exide dealers.

THE ELECTRIC STORAGE BATTERY COMPANY
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Exide
RADIO BATTERIES

FOR BETTER RADIO RECEPTION USE STORAGE BATTERIES

RADIO IN YACHT RACE

(*Continued from page* 11)

ter, the IDALIA is also equipped with a Telefunken spark set, tuned to 600, 706 and 800 meters, for communication with other ships and commercial shore stations. It consists of a 32 volt spark coil connected to an inductively coupled quenched spark equipment, and is controlled from the same operating table used for the tube set.

The equipment on the ELOISE, call KFVT, is not as elaborate as that of the IDALIA, as it consists of only one 50 watt tube, UV 203-A with associated apparatus. The transmitter was built by Heintz & Kohlmoos, of San Francisco, and employs the "tuned grid and plate" circuit as shown in Fig. 2, which resolves itself into the old reliable Armstrong circuit, where the plate and grid are tuned to resonance with each other and are fed through the inter-electrode capacities when resonance is reached.

Power is taken from the plate circuit by coupling the antenna and plate coils together, the coils being shown in the picture at the extreme ends of the set. Tuning condensers are mounted below these inductances, and the filament and plate meters on the panel below the condensers, adjacent to the rheostat and filament switch. The antenna condenser and ammeter are shown above the transmitter proper and the power panel and dynamotor are shown at the right, near the porthole. This circuit is of the coupled type and hence can be used ashore if desired.

For working amateurs, the transmitter of the ELOISE is tuned to 40 meters, but a special wave of 110 meters is also used, as is provided for small craft when necessary. The short wave receivers used on both ships are practically identical, and were built specially by Heintz & Kohlmoos from a design by Mr. P. J. Townsend.

The circuit is shown in Fig. 3, the antenna being connected to the small fixed coupling coil, which is permanently adjusted with respect to the secondary. The latter circuit is tuned with a shunt condenser, with fixed tickler coil coupled to allow the necessary feedback. Regeneration and oscillation are controlled by the variable shunt condenser across the output, which is in turn connected to an audio frequency amplifier. The wavelength range normally covered by the receiver is from 15 to 125 meters, and oscillation is obtained over the entire range. Slow motion dials were used to permit a small variation of the tuning controls.

The antenna system on both vessels is identical, consisting of a single vertical wire from one of the "yards" on the mast, to a lead-in insultator on the deck. The total length of the wire is 40 feet, and has a natural period, when grounded, of 50 meters. Connection is made to

the metal sheathing of the hull, which is connected to the keel, deep down in the water, thus providing a practically perfect ground. For operation above 80 meters, the antenna system is loaded with inductance, and on wavelengths of 40 or 20 meters, the antenna system oscillates on one of its harmonics. Ordinarily the antenna of each vessel is worked on the 2nd harmonic, which, although theoretically not as desirable as one of the odd harmonics, gives satisfactory results. The radiation at the antenna lead is but a few tenths of an ampere, but this does not indicate the carrying ability of the signals emitted.

The operator of the ELOISE is F. E. Clark of San Francisco, and both he and Mr. Newby are keeping watch on the amateur wavelengths, especially on 40 meters. During the voyage to Papeete, both ships were in steady communication with various amateurs throughout the U. S., and the only limitation to the number of stations worked was the necessity of conserving gasoline, and the requirement that all hands must take their turn at the wheel every 24 hours. As it will be several months before the yachts return to San Francisco, ample opportunity will be afforded many amateurs to work these vessels, and the results obtained will no doubt be of lasting benefit to short wave communication.

MODIFIED BEST SUPER

(*Continued from page* 18)

nections to one of the windings of the coil, in case this trouble develops.

For covering the entire wavelength band from 50 to 600 meters, three oscillator coils are necessary, instructions for winding being given in August RADIO. They may also be purchased ready wound, if it is not desired to make them.

For the wavelengths between 50 and 200 meters, it is often a good idea to employ an outdoor antenna in place of the loop, as the loop would require taps for the short waves, and is not particularly efficient when used in that fashion. Hence, a simple antenna tuned circuit may be mounted on the back of the cabinet as shown in Fig. 6, and flexible connections may be brought inside the cabinet to the loop terminals on the binding post strip. The antenna coil for 50 to 125 meters should consist of 15 turns of No. 22 wire wound on a 2¾ in. tube, connected in place of the loop antenna, with a small aperiodic primary made up of 4 turns of No. 22 wire wound over the secondary at one end of the coil. For 100 to 300 meters, the antenna coil should be 30 turns of No. 22 wire on a 2¾ in. tube, with a primary of 8 turns, and for 200 to 600 meters the secondary should be 60 turns and the primary 10 turns. In using the antenna adapter for the radiocast range from 200 to 600 meters, employ a small indoor antenna, for the aperiodic primary is not sufficiently selective for use with a large outdoor antenna at these waves, and the loop antenna is preferable, or an arrangement having a tuned primary such as was described for the shielded model. When the antenna coils are in use, it should be noted that condenser C_{10} is not used, as no particular advantage is to be gained by regeneration and the coil connections will be too complicated for ease in mounting on the back of the cabinet.

A number of well made loop antennas are now available on the market,

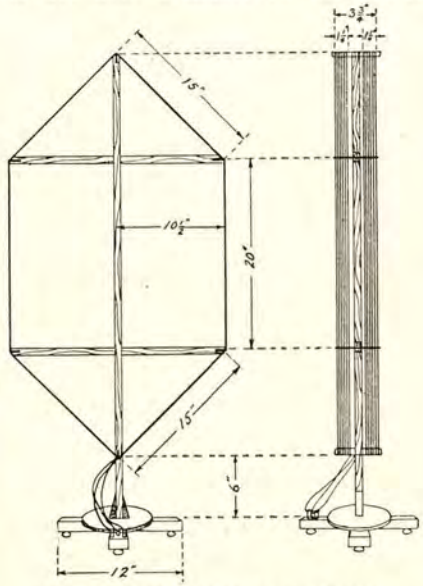

Fig. 7. Center Tap Loop Antenna.

and most of them are equipped with a center tap. The purpose of the center tap is to provide a means for reducing the resistance of the loop, by the use of capacitive feedback from the frequency changer tube. Energy from the plate circuit of the frequency changer is fed through the variable condenser C_{10} to one side of the loop, which is divided into two sections by the center tap. The feedback reduces the high frequency resistance of the loop practically to zero when adjusted properly, and enables reception over much greater distances than would otherwise be possible. Those wishing to construct their own loop will find the dimensions shown in Fig. 7 useful, the loop being wound with 12 turns of No. 18 single fixture wire, or other stranded wire of equivalent size, the total amount required being about 105 feet, including flexible leads. The center tap should be taken off at the end of the 6th turn, at the bottom of the loop.

If the receiver is to be used for amateur C. W. reception on the shorter waves, a separate beating oscillator should be mounted adjacent to the set and operated from the same *A* and *B* batteries. This oscillator should be arranged to work at approximately the same frequency as that used for the intermediate frequency amplifier, and should have an adjustable range at least 3000 cycles above and below the critical frequency, so that an audible beat note can be produced. In order to prevent too much of the beating oscillator energy from entering the intermediate circuit, a by-pass condenser of 2 mfd. should be shunted across the *B* battery terminals at the beating oscillator, and another condenser of like value should be bridged across the filament leads at the same point.

TRANSMITTER TUNING

(*Continued from page* 32)

find a point where oscillation is stopped within the receiver. This stopping point ought to be fairly sharp, unless the transmitter and receiver are too close to each other. Once the dead-spot is located it ought to be sharp enough so that the starting and stopping points are within a scale division on the series condenser dial. If this is not true the receiver and transmitter must be separated farther from each other and one of the coupling methods of Fig. 2 used if necessary, to get the proper adjustments.

After the above adjustments have been completed, the two transmitting circuits, primary and secondary, should then be in tune with each other, this because they were adjusted to the same tune on the receiving set. The only thing remaining to be done is to couple the transmitting helices together and start the set going.

Listen on the receiver as the key is worked and go through the alphabet once or twice to see if any break in the note of the transmitter can be noticed on any of the letters. Make certain that the break is not due to your receiver tube being overloaded, by inserting an extra low resistance grid-leak temporarily. After making sure that such a change in the note can not be due to the receiver you are ready to go ahead. If the note break occurs anyhow, then the coupling between the primary and secondary of the transmitter is too close and the separation between the two helices should be increased. Loosening of the coupling should be continued until the note is definitely constant and no change or "missing" is noticed on any of the letters of the alphabet. It is better to have plenty of coupling and be certain than to have tight coupling and be uncertain of a smoothly operating transmitting set. A coupling of less than 1½ or 2 in. between the coils should be avoided, for to have closer coupling will very likely mean that only parts of the characters sent will get on the air, because the transmitter will be "missing fire." That will result in your signals being unreadable although everything is apparently O.K., and thus it will be impossible to raise a soul.

The one remaining adjustment is the tuning of the antenna circuit with inductance and series condenser until the antenna ammeter reads maximum.

If the transmitter is a five watter, or of similar low power output, the ideal ammeter to use is one of agile needle and nearly full scale deflection, with the current obtained, because often the meter used does not deflect sufficiently nor move rapidly enough. A good ammeter for a low-power set is one with a ½ ampere full-scale reading. It can be of the hot-wire type although they are supposed to hold their accuracy more by luck than attention. We have long got-

ten past the delusion that we need accurate readings of antenna current, and we only require something that will indicate the fact that we are getting antenna current, so that resonance can be found by the maximum indication. Values of current mean little regarding the actual power the transmitter will radiate and probably we will have meters some day with arbitrarily divided scales, with no attempt at accuracy so far as current readings are concerned. Our antenna meters will be rated instead as being capable of carrying so many amperes and from that we will know which one to purchase for a given transmitter. Furthermore, since accuracy is unimportant, when the meter won't stand the load but runs off the scale, a handy length of wire can be used to shunt it, and hold it down.

If a d.c. milliameter is available, it can be used to tune the transmitter instead of employing the antenna ammeter. Follow the directions previously given for tuning the primary transmitting circuit to the desired wave, using the receiver. Then tune the antenna circuit and when it comes to resonance with the primary the plate milliameter will jump either up or down, the direction depending upon the way in which the set is adjusted. That it jumps at all is sufficient indication of resonance.

The shunt condenser in the primary transmitting circuit is not mandatory. It is merely a convenience for it simplifies tuning adjustments. If the primary inductance alone is too small to reach the wavelength desired a condenser so connected across all or part of it often solves the difficulty. If the primary helix is large enough it will tune to the wave desired just as effectively alone. If the helix is too large, the wave will be over-reached and the unused portion will very likely absorb otherwise useful energy. If there is necessarily an unused portion of one or both of the transmitting helices that is as great as the used portion it is best to play safe and amputate it.

If the transmitting tube overheats, movement of the inductance centertap toward the grid end of the primary, which increases the number of turns included by the plate circuit, will result in a reduction of the power going into the tube and will help, therefore, to keep it cool. Movement of the centertap toward the plate end will decrease the number of plate turns and increase the input to the tube. If the tube is running too cool and could in your opinion, stand a greater amount of heating, it is only necessary to move the centertap plateward to increase the input to it and therefore the heating. This is partly limited by the plate-voltage. If it is very low it may be impossible to make the tube heat although poor adjustment, such as movement of the centertap to the inductance excessively in either direction, will stop oscillation.

AUDIO FREQUENCY

(*Continued from page* 19)

sible to have 100 times the present primary impedance with the present number of turns. The frequency characteristic would therefore be almost perfect except as affected by winding capacities, or we might obtain 100 times the present voltage ratio with the present primary impedance by reducing the number of primary turns to 1/100th of the present value. Better still, the number of turns on both primary and secondary could be so chosen that one stage of amplification would not only do the work of two present day stages but do a better job of it as well.

Going back to present day transformers, there are at present some very good ones on the market along with many almost worthless ones. For those who purchase transformers in the future, the data given in this series will be of assistance. For those already in possession of poor transformers but who wish to improve their sets, three avenues are open. They may purchase improved transformers; re-arrange the circuit using the poor transformers as choke coils in an impedance coupled amplifier; or they may correct to some degree the resonant humps by means of shunt resistances and the rising frequency characteristic by means of secondary series resistances, as already described. If the extra vacuum tubes and battery drain are no object, then resistance coupled amplifiers are available, and the old transformers can be junked.

MANY of our readers have expressed interest in the methods of testing the various transformers and other coupling devices, and while detailed directions cannot be given here, a description of the apparatus and methods employed will serve to show the care necessary to obtain reliable measurements even at audio frequencies. In undertaking the problem of measuring audio frequency amplification, great care was taken to design the measuring equipment so that no errors localized in the equipment would be introduced, and yet the apparatus would be rapidly adjusted and flexible, permitting the measurement of amplification under all the conditions of actual operation.

The two equipments used consisted of a vacuum tube oscillator having a range of 90 to 5000 cycles, with an output control which would not affect the frequency of the oscillator and giving an output relatively free from harmonics, and a gain set. The latter consists essentially of a switching device by means of which the apparatus to be measured may be cut in or out of the circuit, a vacuum tube amplifier, and a vacuum tube voltmeter, or detector, sometimes called a Moullin Voltmeter.

The circuit used is shown in Fig. 1, the output of the oscillator being con-

nected to the calibrating potentiometer *Pc*, so that voltages appearing between terminals *2* and *3* of *Pc* are applied to the double measuring potentiometer *Pm*. This potentiometer consists of a high resistance section *1-3* (1800 ohms) and a low resistance section *3-5* (400 ohms), each wound uniformly and similarly with relatively few turns of high resistance wire, with a sliding contact. The 3 pole double throw key K_1 serves to switch the circuit from the calibrating to the measuring condition. When thrown to the right it connects the total drop across P_M to the grid circuit of the 1st amplifier-dectector tube *A*. At the same time it connects the grid of the tube *T* under test direct to its own *C* battery to keep its plate current normal and to prevent any disturbance through this tube and the coupling circuit under test connected as shown. When thrown to the left K_1 connects the drop across the portion of P_M selected by K_2 and the sliding contacts, into the grid circuit of the tube under test. It also connects the output of the coupling device to the grid circuit of the first amplifier detector tube *A*. Thus when the switch is thrown to the right the total voltage across P_M reaches tube *A* direct and when thrown to the left some definite fraction of this voltage is applied to tube *A* after first being amplified in the tube and coupling device whose amplification-frequency characteristic we wish to determine. The second tube *D* of the amplifier-detector is made a rectifier by the use of a large negative *C* potential. A milliammeter *M*, having *a* range of 0-1.5 milliamperes, in the rectifier plate circuit then indicates the relative amounts of A. C. voltage applied to its grid.

The testing method is then as follows: The coupling device to be tested is connected in the circuit as indicated and after adjusting the potentials of the batteries B_1 and C_1 and the filament current of the test vacuum tube to the desired values, K_1 is thrown to the right and P_C is adjusted until a convenient scale reading on the milliammeter *M* is obtained. K_1 is then operated to the left and P_M is adjusted until the *same* reading is again obtained on *M*. Since a single frequency sine wave current is used, the equality of the readings on *M* means equal input voltages on tube *A*. That is, the total vol age across P_M is equal to the voltage across a fraction of P_M multiplied by the amplification through the test circuit. Since the grid currents drawn are zero or negligible while P_M is of low resistance, the ratio of the total voltage to the fraction selected is the ratio of the total resistance of P_M to the resistance between the sliding contact and terminal *5*. Making use of this fact, a scale of ratios was laid off under each potentiometer pointer by adjusting to the appropriate resistances.

WAVEMETERS

(*Continued from page* 28)

course this particular curve will be of no use whatsoever on any other wavemeter.

There are other ways in which the wavemeter may be calibrated; one of which is to compare it with another wavemeter which has already been calibrated. A receiver is set to a given wave by the calibrated meter, the calibrated

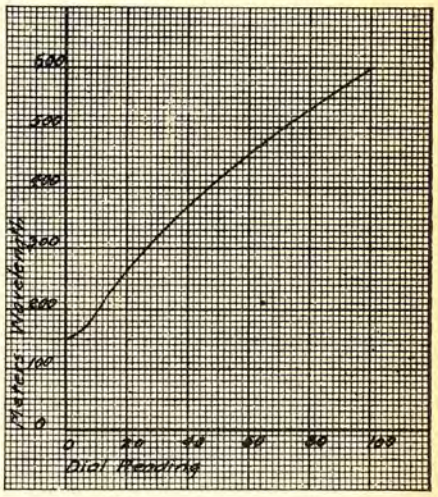

Fig. 5. Typical Calibration Curve of Wavemeter.

meter is taken away, the new meter is tuned to the receiver, and the setting read; so on until enough points are had with which to draw the curve.

WWV, the station of the Bureau of Standards, sends out standard wavelengths twice a month, on definite schedules. One wave band is covered at some ten points, at each schedule, the procedure being that one wavelength is sent for about ten minutes, then another after a few minutes intermission, and so on till the band is covered, the schedule lasting about two hours and a half. The transmissions and announcements are made by telegraph.

Another of the several advantages of the heterodyne wavemeter is that it can be used to measure wavelengths other than those for which it was calibrated. Any vacuum tube oscillator—which includes transmitters, regenerative sets, and the heterodyne wavemeter—sends out what are known as harmonics. These are waves whose lengths are 1/2, 1/3, 1/4, etc., that of the main wave, and which are known as the 2nd, 3rd, 4th, etc., harmonics. They are usually weak compared to the main wave, but may be used in measurements. Suppose a regenerative receiver to be oscillating at 250 meters. The beat note with the heterodyne wavemeter can be obtained at 250 meters; and if the wavemeter be turned up to 500 meters, another fainter beat will be heard. This is the 2nd harmonic of the meter beating with the receiver. Using this method, the range of the wavemeter can be extended to several times that which shows on the dial.

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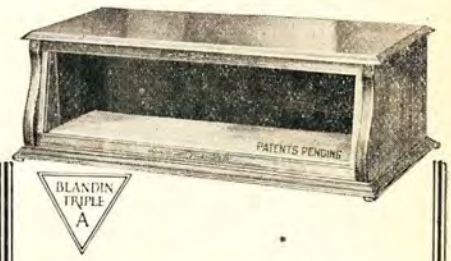

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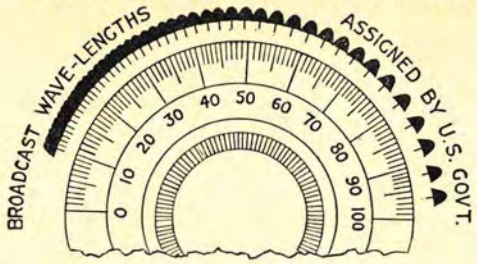

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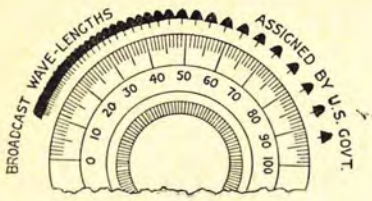

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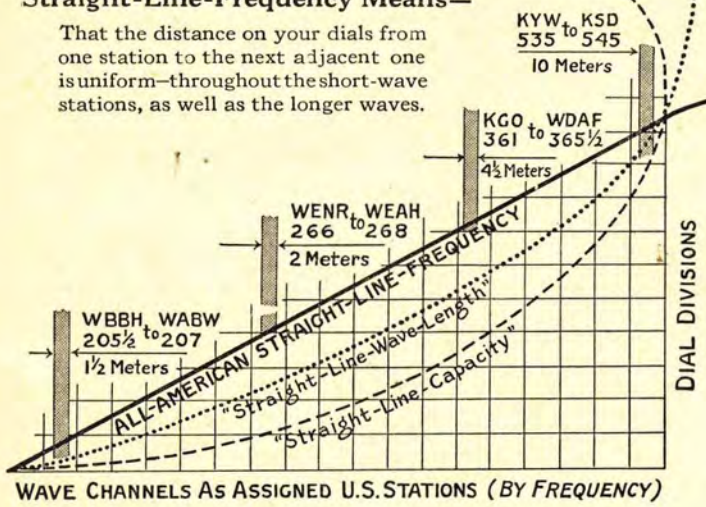

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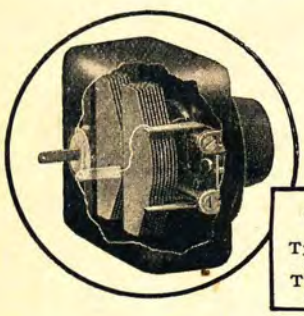

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