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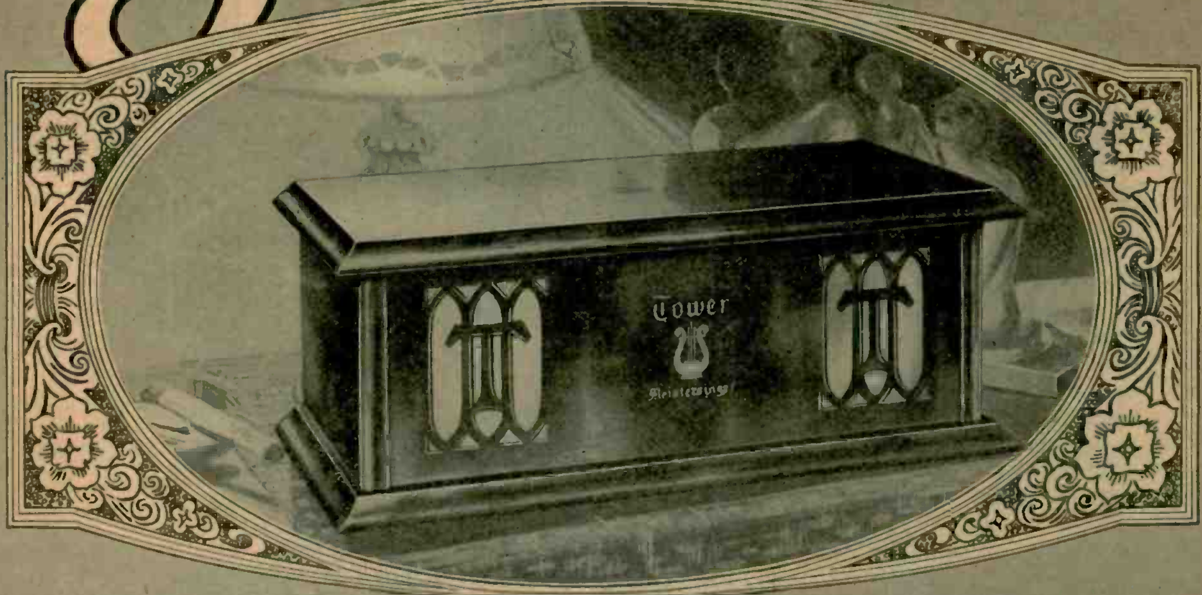
Tower



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RADIO

Established 1917

Published Monthly by the Pacific Radio Publishing Co.

ARTHUR H. HALLORAN,
Editor

GERALD M. BEST,
Technical Editor

H. W. DICKOW,
Advertising Manager

Branch Offices:
New York City—17 W. 42nd St.
Chicago—157 E. Ontario St.
Boston—52 Irving St.
Kansas City, Mo.—1102 Republic Bldg.

Rates:
Issued Monthly, 25c a copy.
Subscription price $2.50 per year in the U. S., $3.00 per year elsewhere.

Correct Addresses:
Instructions for change of address should be sent to the publisher two weeks before the date they are to go into effect. Both old and new addresses must always be given.

Advertising:
Advertising Forms Close on the First of the Month Preceding Date of Issue.

Member—Radio Magazine Publishers Association
Entered as second-class matter at Post Office at San Francisco, Calif.

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Address all communications to

Pacific Radio Publishing Company

Pacific Building, San Francisco, California

VOLUME VII — OCTOBER, 1925 — NUMBER 10

Forecast of Contributions for November Issue

Lieutenant Jennings B. Dow of the U. S. Navy, author of the "C. W. Manual," starts the first of a new series of articles on vacuum tube transmitters with an account of the vacuum tube and its circuits.

H. de A. Donisthorpe gives some advance information on the radio beam as a revolution in methods of radio communication.

Roy C. Hunter discusses short wave reflectors for amateur use.

A. Binneweg, Jr., 6BX, has devised an excellent antenna for transmitting on 80 meters and less, which is described in detail.

Formal announcement of the new calibration laboratory established by RADIO for service to readers will be made by an article describing the equipment used.

A. J. Haynes tells how to make a good tuned radio frequency unit that may be used ahead of any standard receiving set to give a real gain in selectivity, distance and volume.

Ernest W. Pfaff describes the construction of an ideal audio frequency amplifier employing impedance coupling.

An interesting character sketch of Marius Latour, the French radio inventor, has been drawn by O. C. Roos. It throws some helpful sidelights on the radio patent situation.

James W. Harte in "After the License—What?" gives many valuable hints to the aspirant to the position of commercial operator on ship or shore.

J. E. Anderson gives some useful calculations of the comparative efficiencies of various styles of coils, his conclusions being based upon the ratio of inductance to length.

Henry W. Hall has a simple and unique idea for mitigating static effects.

R. Lewis Rockett's story on constructing an improved loop receiver, originally scheduled for publication in October, will definitely appear in the November issue.

Harry A. Nickerson presents some good ideas about changing various types of receivers so as to receive the very short wavelength stations.

The fiction feature is a weird and entertaining story, "The Beat Note," by H. A. Highstone.

CONTENTS

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EVERY TUESDAY AT 9 P.M.
Eastern Standard Time

For real radio enjoyment, tune in the "Eveready Group." Broadcast through stations—

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No ONE size or type of battery can be economical on every type of receiving set. That's why Eveready Radio Batteries are made in different sizes and types—so that every radio user can enjoy the economy that is to be had by fitting exactly the right Eveready Battery to his receiver. For owners of sets with five, six, eight or more tubes, and power amplifiers, there is the extra-large, powerful and unusually long-lasting Eveready "B" Battery No. 770. There is an Eveready dealer nearby.

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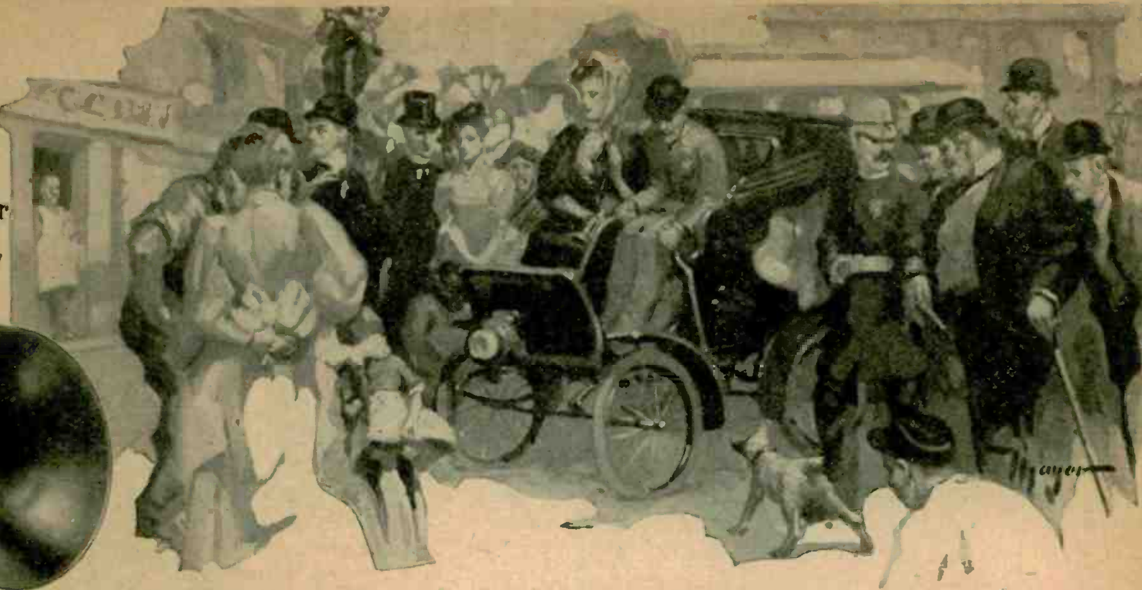

Music Master
Resonant Wood Insures Natural Tone Quality

Model VI, 14" Wood Bell $30
Model VII, 21" Wood Bell $35

Radio, too, is now Standardized

PIONEER owners of automobiles had to try out larger magnetos, different carburetors, more accurate timers and what not else, to get some degree of motoring satisfaction!

Pioneer owners of radio receiving sets likewise experimented with different tubes, more powerful batteries, condensers and all sorts of "loud speakers," trying to balance the power of the set with the quality of the amplifier. And they found that, no matter how good their set might be, Music Master Reproducer made any good set better.

Music Master Receivers provide efficiency of radio reception equal to the quality of MUSIC MASTER reproduction. MUSIC MASTER makes no claim to have developed new and sensational radio "hook ups." Standardization is the accepted principle of New Era Radio, and Music Master Receivers embody the demonstrated principles of radio research and electrical science.

An authorized MUSIC MASTER dealer will demonstrate—in your home if you wish—MUSIC MASTER's power of distance, clarity and volume, ease of operation—and above all, its faithful reproduction and superb musical tone quality.

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Five Tubes. Two stages of radio frequency, detector and two stages audio frequency. Selective, good volume and distance. Brown mahogany art finish cabinet. Price $60

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Six Tubes. Special Music Master Circuit. Very selective, long distance and splendid tone quality. Built-in Music Master Reproducer. Solid mahogany cabinet in brown mahogany art satin finish Price $175

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Five Tubes. New Music Master Circuit, involving special adaptation to radio frequency. Very selective, good volume and distance. Solid mahogany cabinet in brown mahogany art satin finish. Price . . . $100

Ten Models — $50 to $460
Guaranteed Unconditionally

(Canadian Prices Slightly Higher)

Music Master
RADIO PRODUCTS

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Valley Tone Radio Receiver

Selectivity means more with the Valleytone

Potential Balance exclusive in the Valleytone

The *potential balance* method of suppressing oscillation and preventing distortion is used for the first time and exclusively in the Valleytone Radio Receiver.

Reception is clear and mellow—free from the thin, hard, metallic sound and the howls and squeaks which have been the plague of radio.

Valley Toroidal Coils

The Valleytone is the first manufactured set to use Toroidal coils. The Valley Toroidal winding allows a greater coupling ratio between primary and secondary. The result is an appreciable increase in volume over the old solenoid winding.

Appearance

The Valleytone is mounted in a solid walnut cabinet, finished in two tones with inlaid gold stripes. It may also be procured in beautiful console models. Special Valley tables with buil• in loud speaker may be obtained for the cabinet model.

Finer tuning becomes a reality ᐧ ᐧ ᐧ selectivity means more with the Valleytone Radio Receiver.

For instance: The Valleytone has regularly received and separated clearly and distinctly, radio programs broadcasted simultaneously from stations on wave lengths from four to five meters apart.

Such selectivity is attained in the Valleytone because of the Toroidal coils. The Valleytone circuit brings in stations sharply, clearly, and free from distortion.

With the Valleytone, you can enjoy radio as never before. You can get a station if it is on the air and transmitting strongly enough to reach you. You can choose your stations by the clock and hear them with the Valleytone.

The Valleytone is a five-tube set. It is manufactured by an old established company with the experience and the resources to assure you always the utmost in radio value.

Before you buy a radio, see the Valleytone. Hear it. Let an authorized Valley dealer give you a demonstration.

VALLEY ELECTRIC COMPANY, *Radio Division*, ST. LOUIS, U.S.A.

Branches in Principal Cities

Valleytone Receiving Sets	Valley Battery Chargers	Valley B-Eliminators

Valley Electric

For radio at its best you need these, too

Valley B-Eliminator

The Valley B-Eliminator is made for receiving sets of from one to eight tubes. Binding posts and control rheostats are mounted on Bakelite panel. The unit is enclosed in a handsome black case.

It costs less at the start than wet B batteries and less in the long run than dry cells, too. Much more satisfactory than either.

Like new B batteries every night

Here is a new and better way of supplying B voltage for radio reception.

B batteries wear out. They cannot be the same two nights in succession. As they decrease in strength, volume decreases, too. Furthermore, they become noisy as they wear out.

The absolutely ideal B battery current can be obtained only by the use of fresh new B batteries every night. The same ideal results can now be obtained by the use of the Valley B-Eliminator as your source of B voltage. In its performance, the Valley B-Eliminator is like a new set of B batteries every time you tune in and every second you are tuned in.

The Valley B-Eliminator is more than a substitute for B Batteries. It is a new and better way of supplying B voltage for radio reception. It operates on the house lighting circuit and provides B current *at a constant voltage all the time.*

Hence reception is always at its best. There is never any decrease in the strength of signals and none of the frying noises or hum which are due to low B batteries. Volume is maintained. Reception is uniformly good.

The charger with ten points of superiority

The Valley Battery Charger has a reputation for results. It is based on principles which were proven successful long before radio became popular.

It is the only charger needed for all radio batteries:—6 volt A batteries; 24, 48, 72 or 96 volt B batteries; and 2 volt batteries.

It has ten points of superiority

1 No bulbs.
2 No liquids.
3 Quiet in operation.
4 Cannot harm your battery.
5 Efficient. Takes about a dime's worth of current for a full charge.
6 Correct 6-ampere charging rate enables you to recharge your battery overnight.
7 Ammeter mounted flush with panel shows if battery is receiving charge and if charging rate is correct.
8 Special switch for B batteries. Voltages: 24, 48, 72, 96.
9 Has only two wearing parts, the contacts, which can be replaced easily and cheaply. Average life of these contacts about two years.
10 Built in handsome black case with grained and engraved Bakelite panel and clear glass top which shows simple patented working parts. Harmonizes with the finest receiving set.

These features are all essential. Be sure of them by getting only a Valley Battery Charger.

Valley Battery Charger

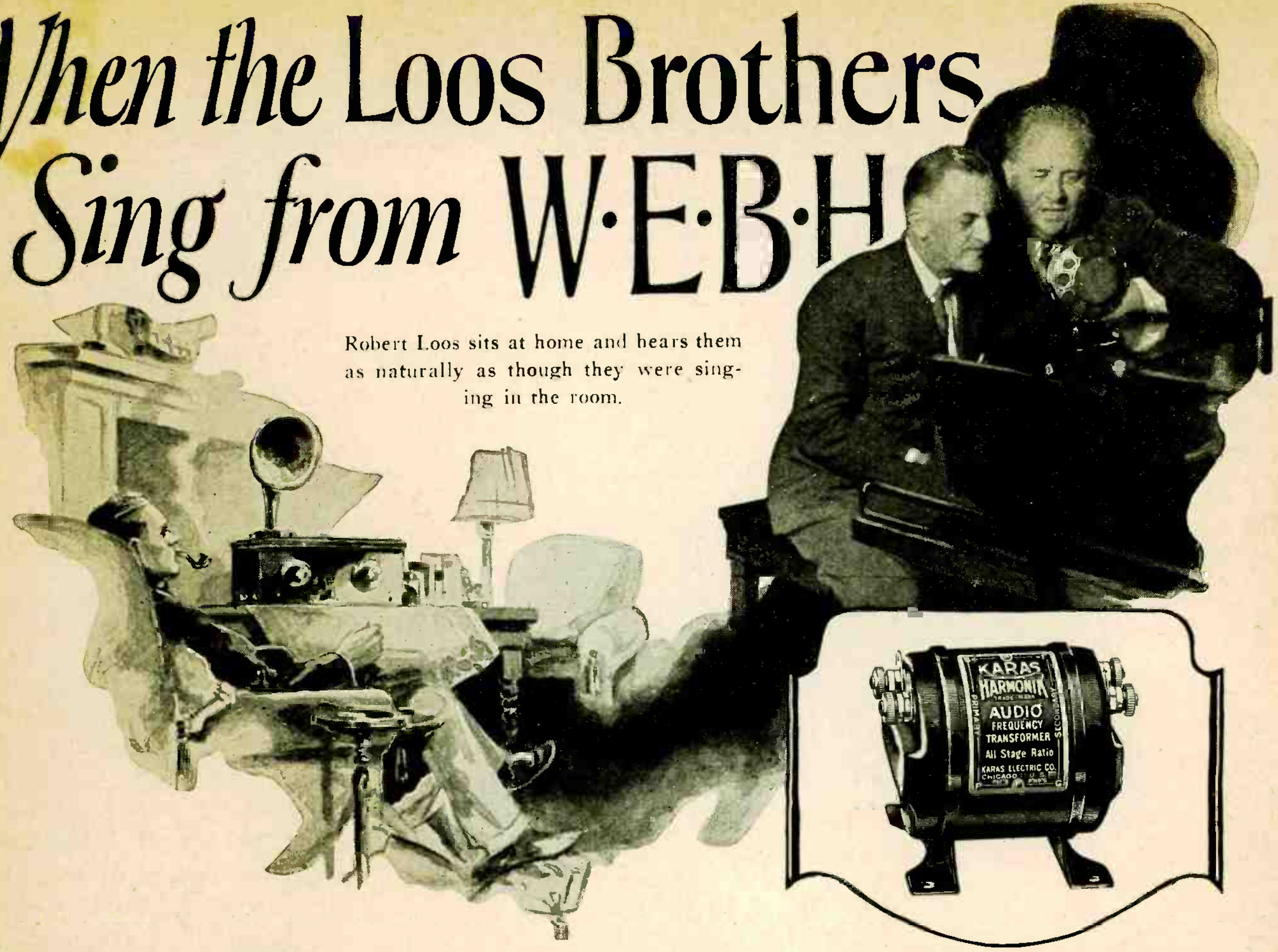
VALLEY ELECTRIC COMPANY, *Radio Division*, ST. LOUIS, U. S. A.

Branches in Principal Cities

Valleytone Receiving Sets — **Valley Battery Chargers** — **Valley B-Eliminators**

Valley Electric

When the Loos Brothers Sing from W·E·B·H



Robert Loos sits at home and hears them as naturally as though they were singing in the room.

Karas Harmonik Transformers

Amplify Radiocast Music with Absolute Fidelity!

No sooner had Karas Harmonik Transformers been introduced than letters began to pour in from all over the country.

Exacting set builders, after many disappointments, found in the Karas Harmonik an audio transformer which *really* amplified with tremendous volume — and positively without distortion.

"Now I know radio as I never knew it before." So Mr. E. M. Lubeck of Kokomo, Indiana, expressed himself. "Karas Harmoniks bring in every voice and every instrument as distinctly as one could get them in the room," wrote the Rev. Wm. Stellhorn of Columbus, Ohio. "I consider your transformer a real musical instrument. Like a good violin, it has fine tonal qualities at all pitches covering the musical scale," was the comment of Mr. Walter Krause of 7807 Burnham Ave., Chicago. Mr. G. C. Tubbs of Gratham, New York, told of his wonderful reception of a band concert from St. Louis, pointing out that every tone of every instrument could be picked out with perfect distinctness.

> Karas Electric Co., Chicago, Ill.
>
> Dear Sirs: I take great pleasure in praising your wonderful Karas Harmonic Transformers. I recommend them to the most critical. I am using two of them in a three-tube Low-Loss set which I built. I have two brothers singing from Edgewater Beach, WEBH Station, and whenever they are on we listen in. Well, their singing comes in so natural and clear that at times we think they are right in the same room with us. My brothers are known as Chicago favorites, the Loos Brothers, and they also tell me mine is the clearest set they have ever heard.
>
> Respectfully yours,
>
> Robert Loos, 1640 N. Leavitt St., Chicago, Illinois

These few reports—picked at random from scores of letters—tell you more convincingly than WE can tell you, the wonderful results YOU can obtain through installing Karas Harmonik Transformers in your new set if you build one—or your old set if you keep it. Nothing like it has ever been known before the Karas Harmonik was produced. Nothing approaching it has ever been developed since. Remember, the finest loud speaker can't overcome the shortcomings of defective or inefficient transformers.

Here, for your enjoyment, is an audio transformer, scientifically designed to reproduce through your speaker *all* of the beauty of Radiocast music — exactly as it is rendered in the studio, whether by a soloist or the largest band or orchestra.

The problem of amplifying high, low and medium audio frequencies to an equal degree has finally been solved. Sonorous bass notes pour forth from the speaker in full strength and rich tone quality. The vital harmonics and rich overtones are brought out in their true beauty by this marvel of audio transformers.

All last season, home set builders—the most discriminating class of radio enthusiasts — bought Karas Harmoniks and enjoyed a musical quality of radio reception that owners of factory-built sets knew nothing about. For set manufacturers mistakenly thought they could not pay a little more for Karas Harmoniks than common kinds cost.

If you want the utmost pleasure that radio has to offer, get a pair of Karas Harmonik Transformers at once. Whether you are building a new set, or intend to remodel an old one, it is very easy to put in Karas Harmoniks. Or, if you don't care to install them yourself, any radio repair man will do it for you at small expense. Why not make up your mind right now to have the best music your set is capable of giving?

Most good radio dealers carry Karas Harmoniks. If *your* dealer is out of them, order direct on the coupon below. Send no money, just pay the postman.

Karas Electric Co., 40-58 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*______________________________

____

If you send cash with order we'll send transformers postpaid.

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RADIO

VOLUME VII | OCTOBER, 1925 | No. 10

Radiotorial Comment

A GREAT stir has been created by the Westinghouse Company in finally taking action to protect its super-heterodyne patents against widespread commercial infringement. Some of the circuit diagrams and directions published in the radio magazines for the use of home constructors have been so good that they have been used by many radio dealers as the basis for making sets for sale. This is manifestly, although often innocently, wrong. When their attention has been called to the illegality of their practices, most of the dealers have voluntarily ceased manufacture.

The radio patent situation, in general, is in a worse muddle than has ever happened in any other industry. Nobody yet knows definitely whose patents are valid. Latour created a sensation last spring by claiming that his patents on iron-core transformers, common *B* battery for multi-tube sets, reflexing radio frequency stages, etc., antedate all others. Certain German inventors make similar claims. Many American inventors dispute these matters. General Squire's patents on wired wireless were thrown out because they were developed while he was in the army and are thus public property. It has been suggested that Armstrong's super-heterodyne patents are likewise clouded.

So there are many legitimate manufacturers not knowing just where they stand. Nor will they know until the patents have been finally adjudicated by the Supreme Court.

The larger companies claiming the patents can object no more to the publication of the circuit diagrams than to the publication of the patent office specifications. It would be questionable whether a home builder could legally assemble and wire a set for his personal use, were it not for the fact that the big companies believe in encouraging the man or boy who makes his own apparatus in accordance with published constants for coils, condensers and transformers.

Consequently the home mechanic need have no fear of injunction as long as he does not sell the product of his handicraft. Undoubtedly there are some who will continue to make and sell unlicensed sets, anticipating that their activities are too small in scope and too difficult to detect to warrant prosecution. Their actions parallel those of the liquor bootlegger.

THE outstanding accomplishment of this year's technical advance in radio will probably be the experiments in the radiation of horizontal waves. An antenna normally radiates two sets of waves, one polarized in a vertical plane and the other confined to a horizontal plane. Heretofore most of the energy has been contained in the vertically polarized waves. The experiments now being conducted represent an endeavor to put most of the energy into the horizontally polarized wave.

The vertical wave is the electrostatic component of the electrical energy radiated. It moves freely through space and is apparently refracted earthwards by means of the highly ionized layer that is believed to exist some miles above the earth's surface. The wave has well been called the sky wave.

The horizontal wave is the electromagnetic component of the radiated energy. It does not seem to travel skywards but to follow the curvature of the earth. It is thus earth-bound.

As the vertical wave travels, its plane of polarization is gradually twisted from a vertical to a horizontal position. So that at some definite distance on the earth's surface, dependent upon the wavelength, the refracted space wave, now horizontally polarized, unites with the earth wave which is also horizontally polarized. But as these two waves are exactly opposite in phase they neutralize one another so as to create a dead spot. This dead spot shifts as the refracting surface is changed by variations in atmospheric and light conditions. This theory, reinforced by experiments, constitutes as reasonable an explanation of dead spots as has yet been advanced. Yet there are still many instances that cannot be explained by this means so that there is still great need for thought and experiment.

It is found that the space or reflected wave is responsible for many cases of freak long distance reception at night, whereas consistent daylight reception seems to be more dependent upon the earthbound waves. But it is also found that the space wave is more affected by static disturbances than the ground wave, which thus offers a partial solution of the problem of minimizing static.

Elsewhere in this issue are pictures of the antenna system and transmitting equipment used by engineers of the General Electric Company to radiate waves whose electromagnetic component contain much more energy than does their electrostatic component. Similar experiments are being conducted by David Grimes of 2MG, who uses a horizontal antenna and counterpoise for transmission and a horizontal loop for reception.

By this means it is believed that two nearby stations, one radiating horizontal waves, the other vertical waves, may be enabled to transmit simultaneously on the same wavelength, one being received on a horizontal loop and the other on a vertical loop so as to eliminate interference between the two.

While none of these experiments have been completed and while world-wide ooservations are yet to be made and coordinated, sufficient has been learned to indicate that some of the present difficulties due to static, fading, interference and absorption may be largely overcome in the near future. So, as theoretical knowledge increases, practice may be improved.

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Piercing Neptune's Shroud

A Graphic Account of the Theory and Practical Use of the Radio Compass in Safeguarding Navigation

By Volney G. Mathison

HOMEWARD bound from the Orient, richly laden with South Sea spices and Chinese hand-made treasures of silk and gold, and booked to capacity with six hundred passengers, the magnificent steamship *President Washington* knifed her way through fog-hidden midnight North Pacific seas on a course that was carrying her swiftly toward destruction upon the sabre-like reefs of Vancouver Island. In one of the big ship's carpeted and white-enamelled corridors, a matron walked sleepily with a bottle of paregoric to a stateroom where a baby wailed plaintively; in the radio cabin far above a duplicator was clicking out two hundred copies of the midnight press. At one-minute intervals, the steamer's fog whistle hurled hoarse blasts into the white darkness, and occasionally rubber boots thudded on the clean, mist-wetted decks, punctuating, as it were, the whirring song of the powerful turbines below.

Up on the lofty bridge, a gray-haired man with four gold stripes on his coat-sleeves and the legend "Captain" on his wide-banded uniform cap glanced uneasily at the gleaming fog-haloes about his running lights, a greenish glow on the starboard side and a wavering red glare on the port.

A moment later, his third officer stepped out from the chart-room. Shivering a little in the chill mist, he addressed the captain:

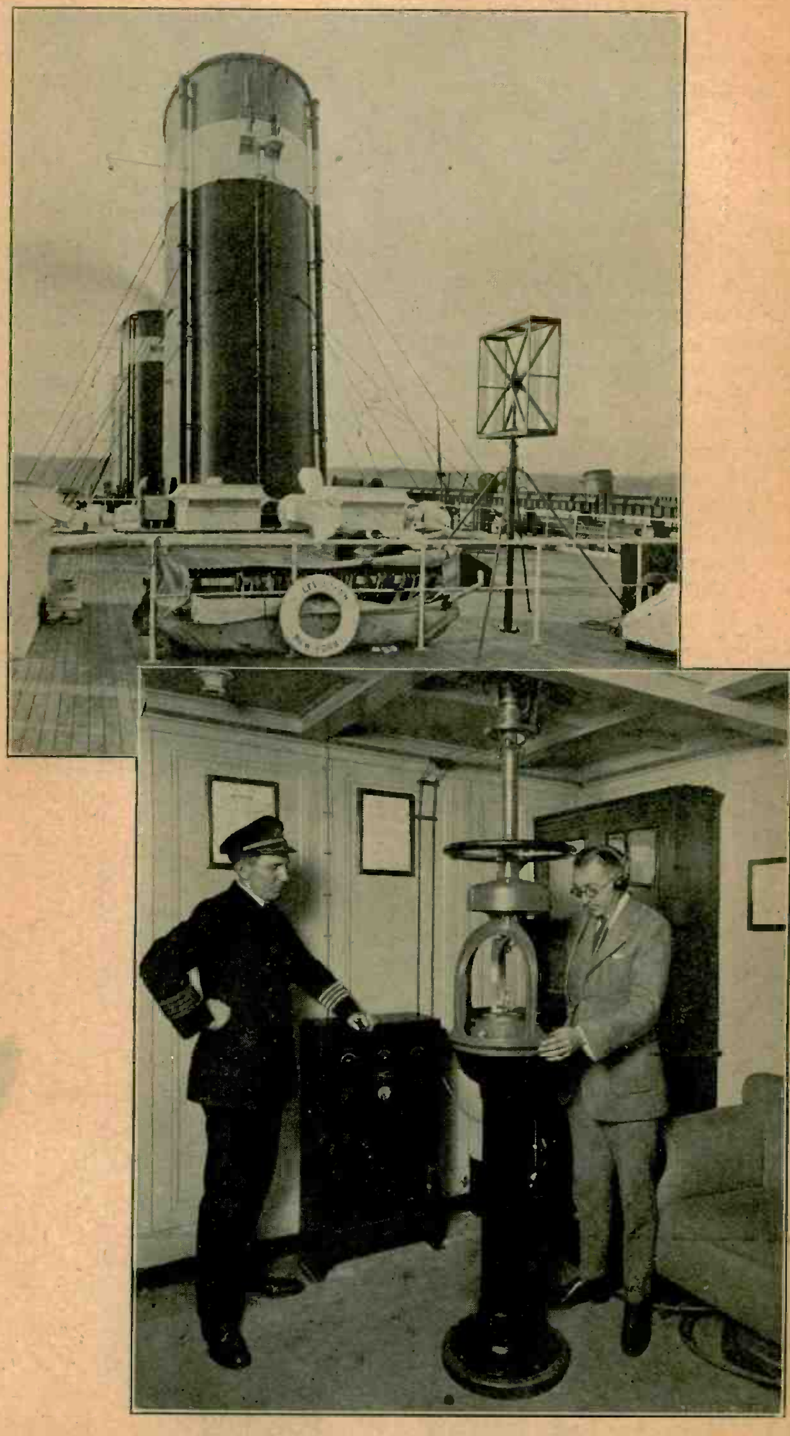
"According to our reckoning, we should make a fair entrance into the Straits within two hours, sir."

"I hope we do," growled the commander in the darkness, without moving his head. "Making port in a fog is as killing a job now as it was when I first tried it, thirty years ago. More so, indeed; for I used to sail small ships with no passengers; and now I have this floating city on a steel shell shooting through the dark at twenty miles an hour. In those days, if I lost twenty-four hours, the company was out three hundred dollars—now every hour's delay costs us a thousand."

The younger man nodded, silently. He, too, was learning what it meant to be a servant of the modern god, Speed, the right bower of Profits.

For the hundredth time, the captain peered into the damp mists pouring in over the canvas bridge-dodger and listened alertly for an ominous response to his own ship's deep-throated warnings thundered automatically each minute by the electrically controlled steam-whistle.

"It's the fog and unforeseeable ocean currents that's the curse of a seaman's life," he muttered. "We can weather any gale that ever blew; but when we



Dr. Kolster, inventor of the modern radio compass, operating the instrument on the S.S. "Leviathan." Above, loop with its supports on the flying-deck of the "Leviathan"; below, close to ceiling, the capacity compensating device, next, hand-wheel for rotating loop, mechanical compensator for error, sight-wires, dial; to the right, the six-tube receiver.

have to take six-hundred sleeping men and women and children, and a ten million-dollar ship and cargo, and lunge ahead blindly with them through a cold streaming white mist hour after hour, without being able to see our own bows fifty feet ahead—it's hell."

"But we have our new radio compass, now, sir," his third officer reminded him. "Here is where it does its work."

The commander did not cease his fruitless staring into the white wall that remained continually before his eyes.

"I can't use that thing; I don't understand it. I've every confidence we're making good our course; suppose that machine should show us off; I'd lose my nerve and delay, probably to find the thing in error, and a lot of valuable time would be lost."

"I watched the installation engineers calibrate it; it's dead accurate," returned the third officer, quickly. "Now is the time to find out what it can do."

The third officer switched on the six vacuum tubes in the receiver of the radio compass. Rather clumsily putting on the compass head-phones, the captain grasped the automobile-like hand-wheel on the loop shaft and swung the taut sight-wires over the face of the gyro-compass beneath them. Three times, he rotated the machine, and a disgusted look settled upon his heavy-sea-tanned features.

"I don't hear a damn thing—" he began; then he started a little as a shrill, warning *"dot-dot, dot-dot, dot-dot,"* began steadily in his phones.

Doubtingly, yet eagerly, he swung his sight-wires along the face of the dial below, until he came to a point where the high-pitched *"dot-dot"* in his receivers suddenly vanished. He moved his polished hand-wheel a trifle farther and the sounds returned. He pressed the wheel back, and the signals again vanished. The vanishing point was sharp, unmistakable,—and it was dead ahead!

"Two dots, coming in straight over our bows," he muttered to his attentive third officer. "Who's two dots?"

A book was quickly consulted.

"Pachena Point, Vancouver Island."

"Wrong," growled the commander, bluntly. "This says we're setting north, while the currents here are always to the south'ard, if any. I don't believe it—"

He paused, for another set of signals had begun vibrating in his head-phones, a monotonous *"dot-dash, dot-dash, dot-dash,"* lower-toned and slower than the first. The shipmaster moved his radio-compass hand-wheel to the right, until the new signals also instantaneously vanished. The sight-wires were now pointing well over the starboard bow.

The captain consulted his list of lights and beacons again.

"Tatoosh Island—away to starboard!"

Five minutes later, two new pencilled lines appeared on the chart on the table. One of them ran out into the Pacific from the radio beacon on Vancouver Island, the other likewise from the beacon on Tatoosh. At the point where they intersected, there was a new dot; and this dot was half-an-inch north of the old one.

"Ten miles too far north," growled the captain, pulling off his compass phones with two moist thick hands. "Two hours more and we'd have been—"

But the third officer had hastened away to chalk up a new course in the wheel-house.

In the early hours of morning, when the tall steamship *President Washington* shot like a huge green and white thunderbolt from the wispy border of the fog-belt into the gray glow of coming dawn, the shore lines of Vancouver Island and of the state of Washington stood revealed a comfortable distance upon either side. With a massive sigh, the commander turned over his ship to a pair of spick and span officers just come on watch; and back in one of the staterooms a baby ceased its plaintive wails and slept.

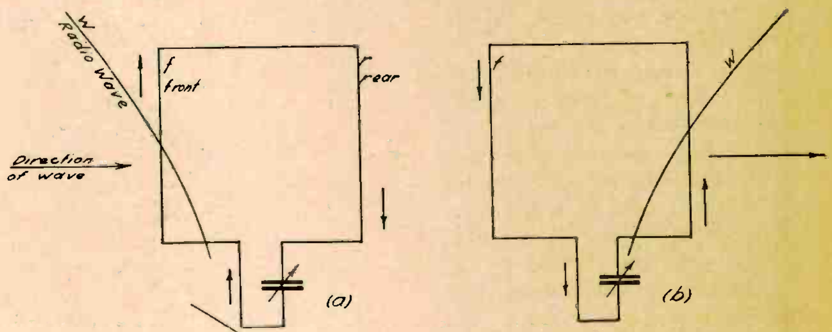
THE foregoing is a sketch of an actual recent occurrence aboard one of our largest American passenger liners. I have drawn it in the aim of bringing to the land-loving folks ashore some realization of the marvelous value to seafarers of one of the most lately perfected devices in the scientific world—the radio compass.

With all attention focussed nowadays upon the startling progress being made almost daily in music radiocasting, the no less interesting advances in other fields of radio are receiving comparatively slight notice. As one of the chief executives of one of our largest and most progressive radio companies remarked to me not long ago, the significance of the radio compass has been unappreciated, even by the radio fraternity itself—yet it is perhaps the only invention in radio that has already actually worked out a brimful "one hundred per cent."

Those of us who have heard of the compass, have accepted it as a matter of course. Few of us are called upon to navigate ten million-dollar steamships laden with passengers and cargoes through dense fogs at a speed of fifteen knots or more. An instrument that enables the commander of such a vessel to know precisely and continuously just where he is, in the thickest haze and on the stormiest night, is actually far greater in value to him than all the rest of the ship's radio installation put together. It supplies the last want in navigation, the power to "see" over great distances through fog and darkness.

The radio compass is not an overnight invention or a stumbling discovery; rather, like most modern inventions it is a product of high engineering skill and mathematical ability, a thing deduced by sheer brain power from knowledge already at hand. As science broadens and rises, it constantly serves as a basis for new and unsuspected additions to itself, just as story succeeds story in the construction of a skyscraper, until the cupola is reached—but who knows where the cupola of science shall be?

The action of the radio compass is based upon the perfect neutralization of the currents induced in two wires, or rather in two sections of a single wire, both of which sections are symmetrically exposed to an advancing radio wave. To make this statement clearer, we shall have to refer to diagrams. In Fig. 1 (a) is represented a large wire loop which is meant to be standing vertically and to be turned edgewise toward an advancing radio wave. In this position, the front section of the loop, marked *f*, will be struck by the oncoming wave an infinitesimal fraction of time before the rear section of the loop, marked *r*. Owing to the unequal potentials to which



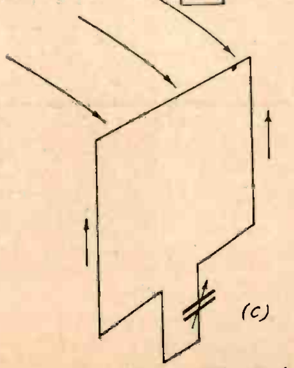


Fig. 1. Illustration of Radio Compass' Action.

the two sides of the loop are thereby subjected, a current, as indicated by the arrows, will flow in the loop from *f* to *r*. This current will continue to flow in the loop, and attached apparatus, until the peak or highest potential point of the moving radio wave passes over the

At or near this point, the current flowing in the loop will cease, owing to the fact that both the front and rear wires are now subjected to equal potential. As the rear, down-curving side of the advancing wave passes over the loop, the current in the wire will reverse and flow from *r* to *f*, since at this time *r* is being acted upon by a higher part of the radio wave is *f*. See Fig. 1 (b).

When the end of the wave passes over the loop, the current in the wires will again fall to zero, owing to the absence of surrounding or cutting potential. In a moment, with the arrival of the next wave, the above-described action will be repeated. The result obviously is an oscillating or alternating current in the loop, which may be amplified, detected, and re-amplified as desired.

This is the action of the loop of any radio receiver. It explains, incidentally, why the loop must be turned edgewise, and not flatwise, toward a transmitting station in order to get the loudest signals—simply that one side of the loop shall at almost all times be cutting into more or less potential than the other side. It will also be seen that the larger the loop, the greater the distance between *f* and *r*, the greater will be the difference in the strength of the currents induced in the two sides, and hence the stronger the signal received.

I shall pause here a moment to point out that a radio wave does not necessarily have to be conceived of as advancing in the form of hills and dales as pictured herein; it may be a series of outspreading etheric or electronic impulses, but the rising hills and falling hollows serve to represent the varying potentials at different progressive points.

Now let us turn our loop flatwise toward the advancing wave, as indicated in Fig. 1c. With this adjustment, both sides of the loop will be struck simultaneously by the wave. If the loop is *exactly* at right angles to the wave, that is, across it, the current induced in the side *f* will now be exactly counterbalanced or neutralized by an equal and opposing current induced in the side *r*. In other words, if the action of the radio wave on the side *f* is such that a current tends to flow upward in the wire, the similar action of the wave on the side *r* will also cause an equal current to flow upward on that side. Since two currents cannot practically flow toward each other in a single wire, the result will be neutralization or zero current. We will now have an absolute silence in the radio receiver connected to this loop, even though this receiver be extremely sensitive, and accurately tuned to respond to the advancing wave. By drawing a line at right angles to the loop we shall have an astonishingly accurate pointer showing the direction of the advancing wave and hence of its distant transmitter. This is the action of the modern compass.

One of the most remarkable things about this action is that if the loop is moved the slightest fraction of an inch from a true right-angled or flatwise position to the advancing radio wave, a signal will be heard in the attached receiver. This is because of the fact that one side of the loop is now *slightly* ahead of the other side, with respect to the oncoming wave; it is struck by the wave a trifle sooner, and hence a current is set up in the loop-wire, which results in a signal. The difference in time between the arrival of the wave at the two sides of the nearly right-angled loop may be immeasurably slight, especially when it is remembered that the radio wave is coming at a speed of 186,000 miles a second, and the difference in potential induced in the two sides of the loop is inconceivably little, to our minds; yet it does exist, hence signals are produced and the compass works.

Lest the editor be forthwith deluged with letters from owners of radio sets equipped with loops, declaring that they can hear stations with their loops set perfectly flatwise, I shall here hasten to point out that the perfect neutralization of induced currents in the loop of a radio compass set across an advancing wave depends upon the absolute absence of any disturbing or unbalancing factor. In nearly all radiocast receivers using loops, as in the superheterodyne for instance, the loop is connected to a vacuum-tube grid, or is subjected to various other battery currents and connections that interfere with its free action. In the radio compass, the loop (and its tuning condensers) is connected to the radio receiver only inductively through a transformer. See Fig. 3.

Another factor that will disturb the accurate operation of the radio direction-finder is the proximity of large metal surfaces or objects, which set up a capacity effect between themselves and the nearer side of the loop. These conditions, which are unavoidable aboard ship, are automatically compensated for in the radio compass by a small compound book-condenser connected as shown in Fig. 3. The middle movable plate of this condenser is grounded and the two stationary leaves are each connected to one leg of the loop. By an ingenious adjustable mechanical system of cams and rollers on the loop shaft, the middle plate is caused to move automatically as required toward one or the other of the two stationary plates connected to the sides of the loop; and the disturbing effect of any nearby metal surfaces is thereby accurately compensated for at all loop positions.

Another difficulty that had to be overcome in perfecting the compass lay in the fact that the steel masts and stays of a ship cause a bending in the front of an advancing radio wave, as sketched in Fig. 4. This produces serious errors

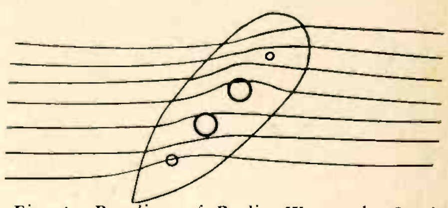


Fig. 4. Bending of Radio Waves by Steel Masts and Stays.

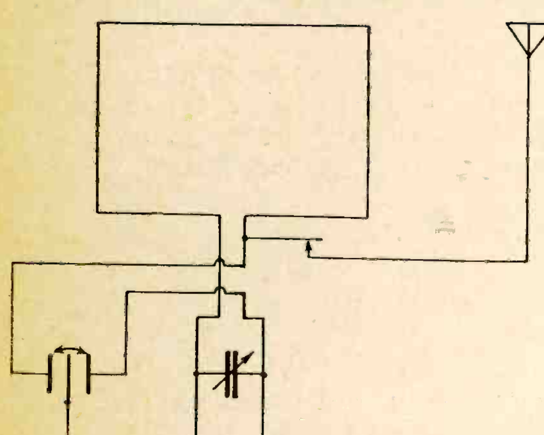
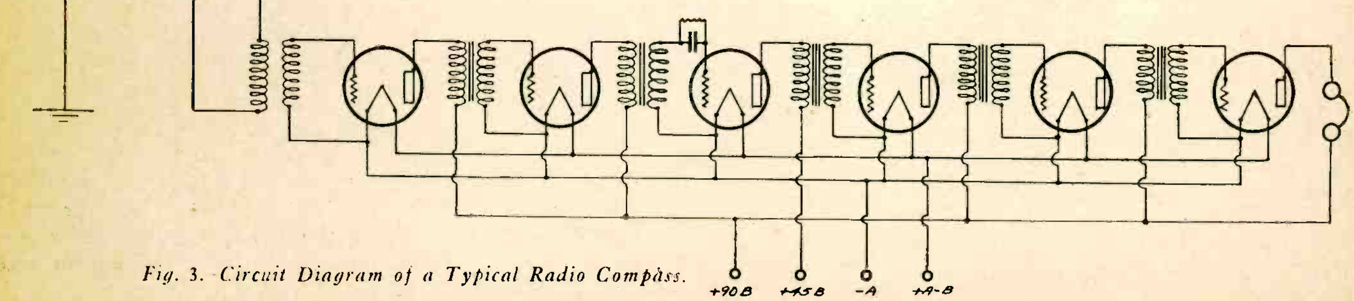



Fig. 3. Circuit Diagram of a Typical Radio Compass.

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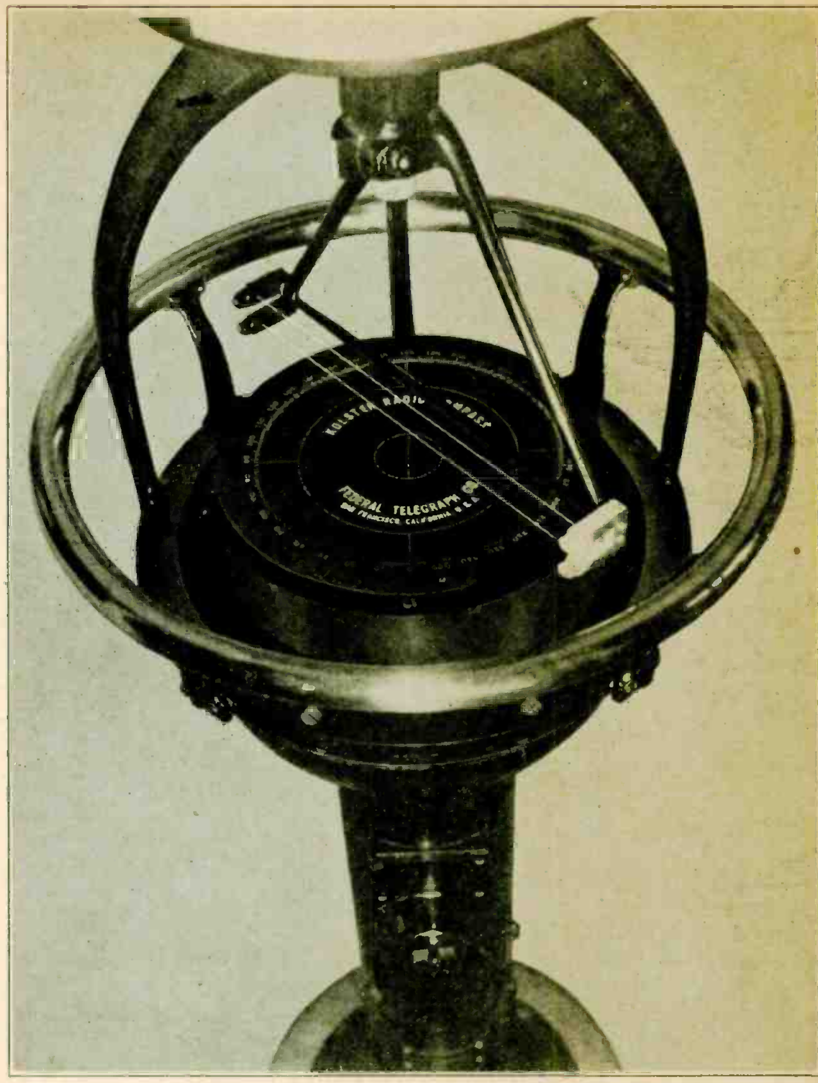
in the apparent direction of a distant transmitter. The amount of the bending varies according to the position of the ship with respect to the oncoming wave. The effect is generally greatest when the vessel is heading toward or away from the radio wave at an agle of 45 degrees, and is zero when the vessel is bow-on, stern-on, or broadside to the wave; because in these positions the ship presents a symmetrical structure to the advancing wave.

The errors thus produced often amount to as much as 25 degrees. Since they are constant and invariable, however, they are accurately compensated for by another adjustable mechanical device that causes the sight-wires of the compass to read toward the true direction of the incoming radio wave, the error being absorbed automatically by the mechanism. When the compass is installed aboard a ship, a motor boat containing a small radio transmitter is caused to circle around the vessel, at a distance of two or three miles. By operating the transmitter on the motor boat and comparing its direction as shown by the radio compass against the true direction of the little boat as obtained by direct visual means, the errors in the compass are found and permanently "adjusted out" in the sight-wire mechanism.

Undoubtedly the most novel point of the modern compass is the previously described use of the "silent spot" where the signals of the desired stations are not heard, instead of being heard. In some of the earlier compasses, efforts were made to utilize the point of loudest reception, obtained by pointing the loop edgewise toward the distant transmitter, as in Fig. 1. The fatal defect of this arrangement was the difficulty in making out just which was the loudest point. The signals would come in with gradually increasing intensity from a right-angled to an edgewise position of the loop, and it was quite impossible to decide with any certainty just where the signal was really loudest. The accuracy was so poor that the device was worthless. By using the vanishing point, however, astonishing results are obtained, since the signals vanish only when the loop is set flat across the incoming wave, and are more or less audible at every other position. A movement of less than 1/100 part of a circle from the silent spot cuts the signals in.

It will be seen that the compass, as I have so far described it, is subject to a possible error of 180 degrees, owing to the fact that there are two positions in which the loop may be set flatwise to an advancing radio wave. The second position is obtained, of course, by rotating the loop half a turn. This second position of the loop causes neutralization quite as effectively as the first



Close-up view of sight-wires attached to lower end of vertical loop-shaft, and compass or dial over which they swing.

position; therefore, when the loop is rotated through a complete circle, there will be two "silent spots," half a revolution apart.

When taking a bearing from a distant station, the general direction of which is already known, the two vanishing points in the compass present no difficulties, since the correct point is immediately recognizable. If the direction of the distant transmitter is entirely unknown, however, we have here a serious possibility of error. A ship taking bearings on another vessel in the vicinity would be unable to decide whether that vessel were ahead or astern, with safety in one position and danger of collision

(*Continued on Page* 72)

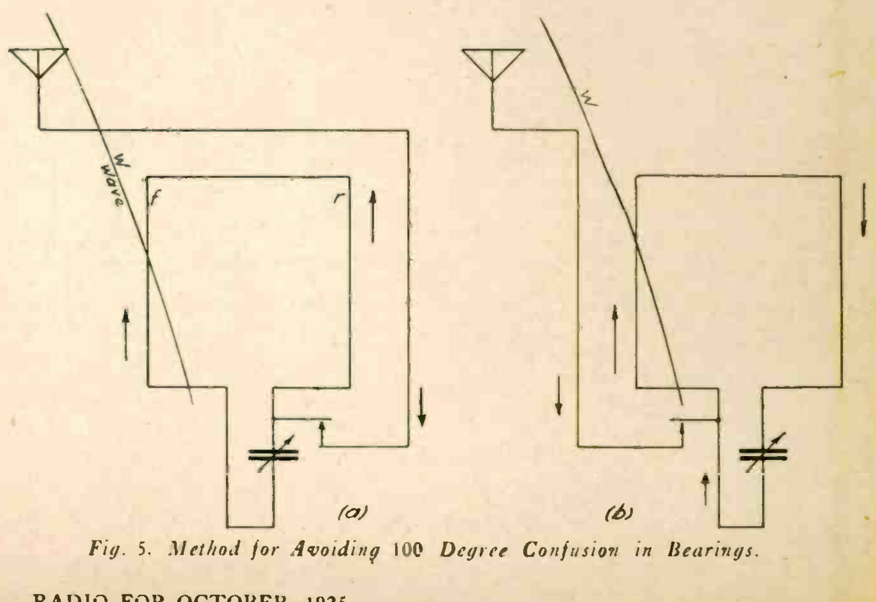


Fig. 5. Method for Avoiding 100 *Degree Confusion in Bearings.*

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The L-C Circuit

A Tuned R. F. Receiver Using a New Combination of Auto-Transformer Inductance and Feedback Capacity

By G. M. Best

THE popularity of receivers employing radio frequency amplification with regeneration is evident from the number of such sets that have been constructed, especially the Browning-Drake receiver recently described in RADIO. The receiver to be described herein is similar in principle to the Browning-Drake, in that it has one stage of radio frequency amplification, regenerative detector, and two stages of audio frequency amplification, but regeneration is obtained by means of capacitive feedback instead of by means of a tickler coil, and the radio frequency transformer represents a departure. In order that the set may appeal to the largest possible number, the controls and parts have been reduced to an absolute minimum, as may readily be seen by a glance at the illustration of the panel layout.

Before describing the procedure necessary for building the set, a brief discussion of the circuit will clear up any mysteries about the theory of operation. In Fig. 1 is a schematic wiring diagram showing all the actual connections. The two radio frequency coils consist of an antenna tuned circuit, and a radio frequency transformer. The antenna tuned circuit has an aperiodic primary and tuned secondary wound in the form of a continuous single layer coil, the ground tap being taken out at a selected point for any desired degree of coupling between the primary and secondary. The secondary coil is tuned by a variable condenser of .00035 mfd. (17 plate).

The output of the radio frequency amplifier tube is fed through the primary of the radio frequency transformer to the secondary coil and into the detector tube. The transformer consists of three equal windings placed close together to form a continuous single layer coil, and is really an autotransformer, as the primary is made to do double duty. The primary is made a part of the secondary circuit by means of a 1 mfd. condenser, which connects the *B* battery end of the primary to the filament end of the secondary. This condenser, having an extremely low resistance to radio frequencies, presents practically a short circuit and thus permits the secondary tuning

LIST OF PARTS

- 2 Variable condensers—.00035 mfd.
- 2 Vernier dials for above.
- 4 Cushioned vacuum tube sockets.
- 2 Audio frequency transformers.
- 2 Single closed circuit jacks.
- 1 Single open circuit jack.
- 1 Grid condenser .00025 mfd. with grid leak mtg.
- 1 Mica condenser .0005 mfd.
- 1 Mica condenser .006 mfd.
- 1 By-pass condenser 1 mfd.
- 1 Midget condenser, max. capacity .00005 mfd.
- 1 Neutralizing condenser, .000025 mfd. max.
- 4 Automatic filament cartridges, .25 ampere size.
- 1 Filament switch.
- 1 Binding post strip—7 posts.
- 2 Sections 3 in. bakelite tubing—5 in. long.
- 1 lb. No. 20 bare or double cotton covered wire.
- 1 1-megohm grid leak with mtg.
- 1 Panel 7x22x3/16 in.
- 1 "C" battery, 4½ volts.
- 1 Baseboard 8x22x½ in.
- 25 ft. Bus bar wire and like amount of spaghetti.
- 4 UV-201-A or C-301-A vacuum tubes.

Panel for Four-Tube L-C Receiver.

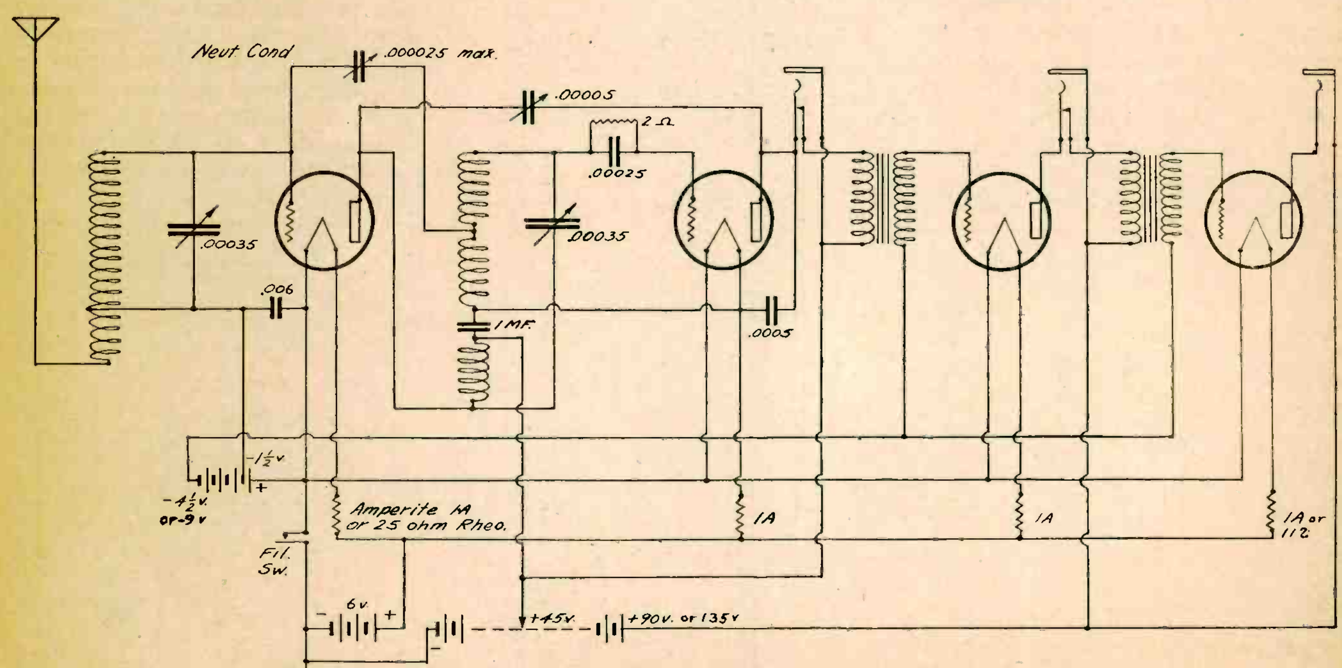

Fig. 1. Schematic Wiring Diagram of Four-Tube L-C Receiver.

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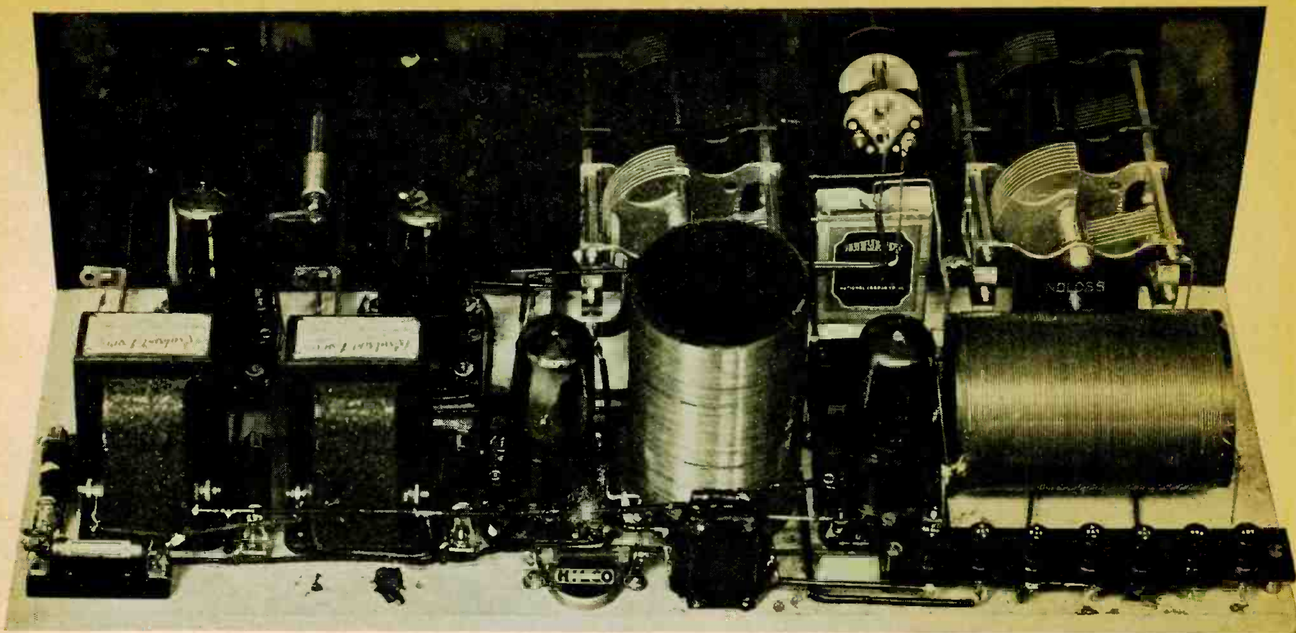

Rear View of Four-Tube L-C Receiver.

condenser, which is of .00035 mfd., to tune the entire primary and secondary windings to the particular frequency desired.

A tap is taken out at the center of the secondary winding for connection to a neutralizing condenser, where neutralization is found necessary. The plate circuit of the detector tube feeds energy to the grid circuit through a variable condenser having a maximum capacity of .00005 mfd., and through the primary of the radio frequency transformer. The audio frequency component in the detector plate circuit passes through the primary winding of the first audio frequency transformer, and thence to the two stage audio amplifier, which is equipped with high quality transformers, so that the set will properly operate a cone type loud speaker.

The 1 mfd. condenser used in connection with the radio frequency transformer also acts as a bypass across the 45 volt *B* battery circuit, and obviates the necessity of an extra bypass condenser elsewhere in the set. Filament rheostats are eliminated by the use of automatic filament cartridges, and the only filament adjustment is the battery switch mounted on the front of the panel.

The panel layout is shown in Fig. 2, a 3/16 in. panel 7 by 22 in. being used in the experimental set. The holes designated for the tuning condensers are for the type of condenser used in the set illustrated, and if other condensers are used, the template furnished by the manufacturer will give the proper mounting directions. A series of countersunk holes should be placed at the bottom of the panel, for mounting to the baseboard, which is 8 by 22 in., of ½ in. stock. The material should be selected from a good grade of non-warping wood.

The accompanying list of parts will enable the selection of appropriate apparatus, the only special parts being the coils, which are easily wound.

The antenna coil, which is shown on the baseboard in a horizontal position at the extreme right end, consists of 68 turns of No. 20 cotton covered or bare copper wire, for the secondary, and 7 turns of the same sized wire for the antenna Coil. This makes a continuous winding of 75 turns, on a 3 in. bakelite or fiber tube, it being only necessary to take a tap for the ground connection at the 7th turn. It will probably be most convenient to wind the coil with No. 20 D.C.C. wire. But for those who have access to a lathe, mount the tube in the chuck, adjust the screw cutting mechanism to 20 threads to the inch, and cut a groove over the entire length of the tube, the groove being deep enough to hold the No. 20 bare wire in place. The wire can be wound on the tubing while still in the chuck, insuring a tight winding.

The radio frequency transformer is wound on the same size tubing, and consists of 3 sections of 25 turns each, wound in the form of a continuous coil, but cut every 25 turns, and the two ends brought out to the proper terminals at the bottom of the coil. The first section of 25 turns is the combination primary and secondary while the next two sections are used exclusively as the secondary, with the 1 mfd. condenser connected between the 1st and 2nd sections. The neutralizing condenser is connected to the junction between the 2nd and 3rd sections, the other side of the condenser being connected to the grid of the r.f. amplifier.

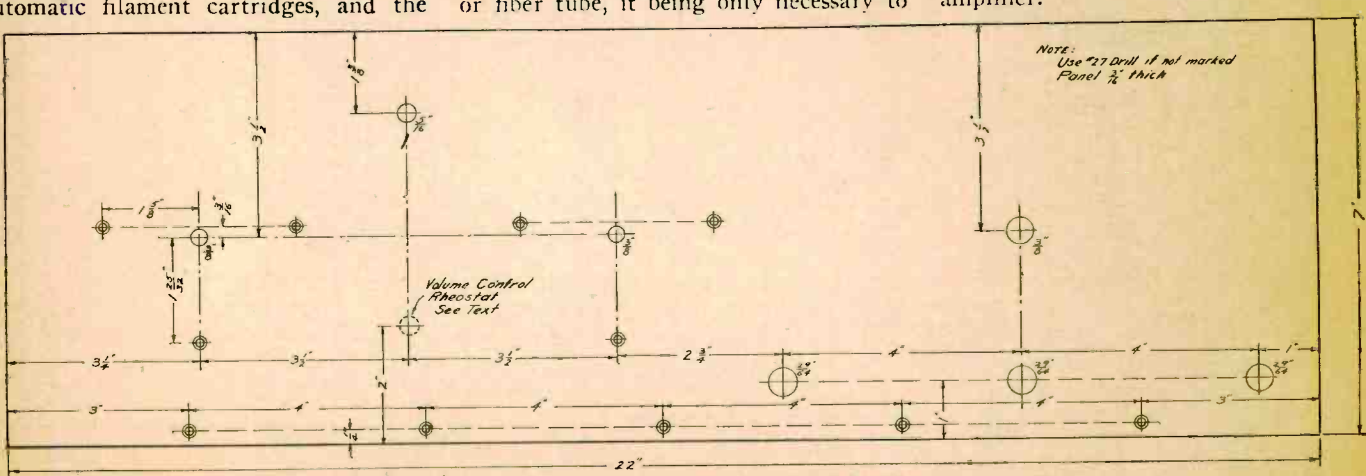

Fig. 2. Panel Layout for Four-Tube L-C Receiver.

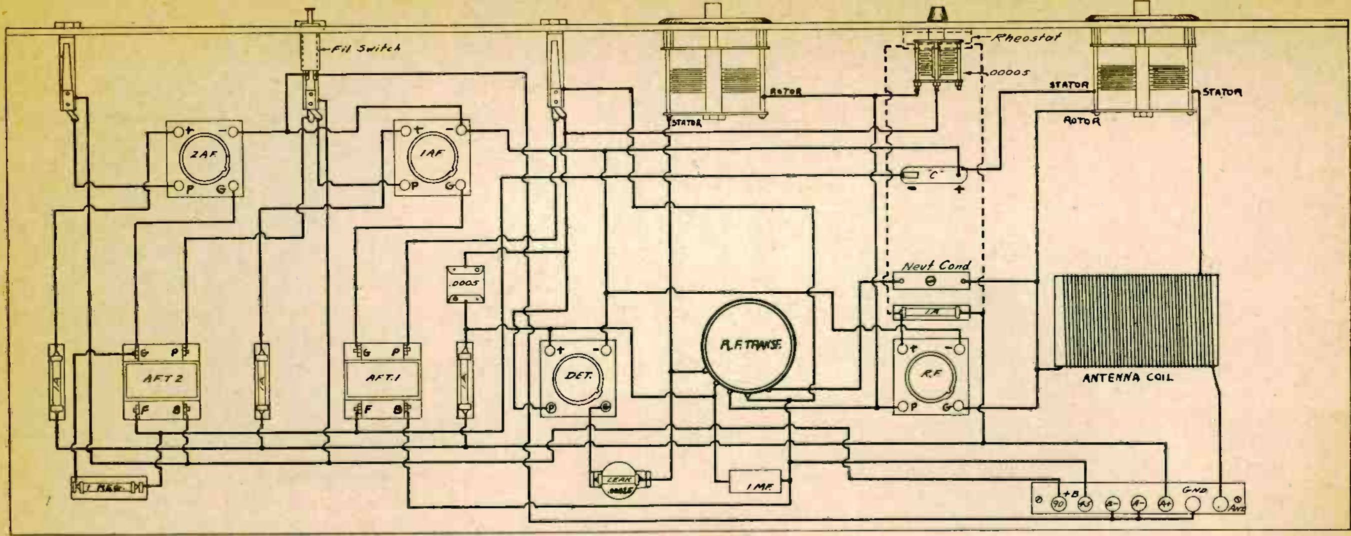

Fig. 4. Pictorial Wiring Diagram of L-C Receiver.

Place the coil in a vertical position, the r.f. amplifier being mounted between the transformer and the antenna coil. It is important to have as great a separation between the two coils as is structurally possible, as coupling will result with close proximity, and no amount of adjustment of the neutralizing condenser will overcome the difficulty. The detector tube socket is mounted next to the r.f. transformer, and as can be seen from the illustration, the audio frequency tubes are next the panel, with the associated transformers at the rear of the baseboard.

The regenerative feature of the receiver is familiar to all those who have built superheterodynes having a regenerative loop. The same type of variable condenser, having at least 50 mmf. maximum capacity, should be used. This condenser is connected between the plate of the detector tube and the plate of the radio frequency amplifier, so that energy is fed back from the detector plate to the grid through the primary and secondary windings of the r.f. transformer. While making the neutralizing condenser adjustments this condenser should be set at zero.

The .005 mfd. shunt condenser between the detector plate and filament is of the fixed mica type, and is necessary to bypass a large per cent of the radio frequency present in the detector tube plate, as only a small amount is allowed to pass through the feedback condenser, and it must be provided with a low resistance path to the filament. There may be sufficient capacity in the first audio frequency transformer primary winding, in which case the condenser is not necessary. This can be determined by removing the .0005 fixed condenser and observing the action of the feedback condenser, particularly on the shorter waves.

The tuned circuits have been designed so that the set will tune from 190 to 550 meters, thus insuring good reception of several new high powered stations operating between 200 and 225 meters. If trouble is experienced due to inability to tune to waves below 225 meters, on account of excessive distributed capacity in the r.f. coils, a few turns, say 5 for a starter, may be removed from the grid end of the antenna coil, and a couple of turns can be taken off the grid and plate ends of the r.f. transformer, without materially reducing the efficiency of the circuit.

The 1mfd. bypass condenser is mounted on the baseboard as near the r.f transformer terminals as is possible, with the grid condenser and leak mounted next the grid terminal of the detector tube socket. The Amperites are mounted on the baseboard close to their respective socket terminals, where they are easy of access.

As much of the wiring as possible should be done before the panel is fastened to the baseboard. The pictorial wiring diagram shown in Fig. 4 will be of assistance to those who cannot easily read schematic diagrams. This has been distorted to show all the parts properly.

The filament wiring can be ordinary flexible insulated wire, bus bar wiring being necessary only in the high frequency conductors, and in the grid and plate wiring of the audio amplifier.

The *C* battery, which may be one of the flat flashlight types, should be tapped at the 1½ volt terminal, most easily done by scraping away a small amount of the cardboard covering of the battery at the end nearest the positive terminal, exposing the zinc covering of the first cell, which will be the minus 1½ volt connection. A piece of flexible wire can be soldered to the zinc, and connection made to the rotor plates of the antenna coil tuning condenser. The 4½ volt negative terminal of the *C* battery is connected, by means of a piece of bus bar wire, to the filament terminals of the two audio frequency transformers.

On account of the great amplification obtainable with the transformers used in the layout illustrated, a 1 megohm grid leak was placed across the last audio transformer secondary to insure stability, but this can best be determined by test, as some transformers operate satisfactorily without grid leak termination, particularly if the shielding of each transformer is connected to the ground terminal.

Battery connections are all brought out to the binding post strip, as are the antenna and ground leads. The terminals on the strip which are marked antenna and ground are placed nearest the ground and antenna taps on the antenna coil, so that the connecting leads will be very short.

After the wiring of both panel and baseboard is complete, the four vacuum tubes should be placed in their sockets and the *A* battery connected. Short circuit each Amperite in turn to see that it is functioning properly, and if the filament of the tube does not become more brilliant, in each case, the filament cartridge is not working as it should. Disconnect the positive *A* battery lead and touch it successively to the positive 45 and 90 volt binding posts. If any of the tubes light, even very dimly, or a spark is seen when the connection is made, a short circuit is present somewhere in the set and should be located before the *B* battery is placed in the circuit.

Upon completion of the inspection, connect the batteries, antenna and ground, and the set is now ready for final adjustments. Turn on the filaments of the tubes and plug the headphones in either the detector or first audio frequency amplifier jacks, according to the volume desired. Tune in a local station to maximum volume, and you will probably find that the set will oscillate when the maximum point is reached.

The neutralizing condenser is adjusted

(*Continued on Page* 76)

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How to Reduce Interference

Directions for Adding a Loading Coil to Increase the Selectivity of a Set Having an Untuned Primary

By L. W. Hatry, 10x

MOST complaints of excessive interference may be traced to the use of an untuned primary circuit in the receiver. This consists of a fixed coil or condenser in the antenna circuit and is commonly found in three-circuit tuners, neutrodynes, reflex sets and those using tuned radio frequency. Fig. 1 shows various methods of connection coming under this category.

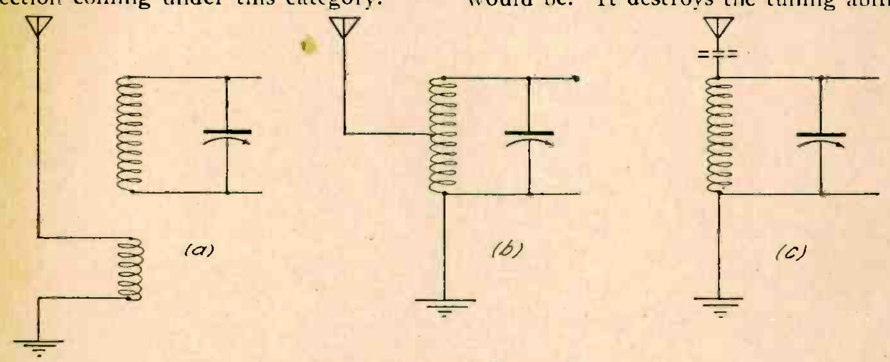

Fig. 1. Untuned Primaries.

You know that the station to which your set is tuned comes in with the greatest volume: a tuned circuit provides maximum energy. You can also conceive how an untuned primary in the antenna circuit may accidentally get in tune with an unwanted lot of radiated energy which is forced into the secondary by the decidedly energetic primary electromagnetic field, even when the tuned secondary may not be tuned to this wavelength.

A wave-trap is often ineffective in such a case because it does not eliminate 100 per cent of the energy from a powerful nearby station and the small quantity that does get through is enough to raise Cain within the set.

Consequently the answer is obvious: the antenna circuit must be de-tuned. This is sometimes easily done by using a loading coil to shift the tune of the antenna to a wavelength different from that which it picks up with too much noise. The method is shown in Fig. 2 as applied to a multi-tube three-circuit regenerative set.

Fig. 1_a shows the least objectionable untuned primary. It predominates in three-circuit regenerative sets and in some neutrodyne and tuned radio frequency receivers. Its natural period is usually at the lower end of the wavelength range and the addition of a load coil that throws the antenna period up to some higher wavelength (400 to 500 meters) will improve selectivity and increase efficiency at the higher wavelengths.

The circuit in Fig. 1_b, in which a portion of the secondary serves as the primary, is often found in neutrodynes and r.f. receivers. It is definitely not selective in many cases when near some station, whereas a different type of antenna connection using a separate coil would be. It destroys the tuning ability of the first r.f. stage by introducing the resistance of the antenna into the grid-circuit. It is apparently fairly selective for distant stations but this advantage is quickly dispersed by a station in position to overcome tuning with sheer strength. It will function satisfactorily in a location sufficiently isolated to have neither local station nor radio-telegraphic interference. Its lack of selectivity can be overcome by reducing the diameter of the primary of the second r.f. transformer to one-half that of its secondary. This leaves the primary within the secondary, as is necessary, and at the same time provides the loose-coupling essential to selectivity. The best diameter for this primary in your set can be told only by trial. Fig. 3 points that primary out specifically.

Fig. 1_c is the worst of the three. It is sometimes used with a condenser in series with the antenna to increase the selectivity of the arrangement. However, no matter how juggled, the method of connecting in the antenna is a vicious one; for, unless the antenna is unusually small, the selectivity of the set is at a minimum, extraneous noises and such at a maximum, and the tuning of the shunt condenser a failure. This method should only be used without a ground connection, when it may help to solve the problem for multi-tube set owners.

Tuning the antenna exactly is not entirely profitable for two reasons; one being that the antenna provides a high resistance circuit which is therefore broad and does not need exact tuning, and the second that the increase of sensitivity and volume of the set by such tuning does not warrant the additional complication attendant upon it. There is proof enough of this in the various sets with fixed antenna circuits. Therefore, the antenna circuit can be roughly tuned.

Rough tuning of the antenna circuit has three advantages; it gives greater volume on all waves than the fixed tune antenna circuit, it prevents complete selectivity collapse due to the fixed tune being on that of a particular station, and, being a rough adjustment, it leaves the hands free for the usual tuning—it adds a control, but yet it doesn't.

Fig. 2 applies to any variation of the regenerative circuits. It is better applied to multi-tube sets with loose coupling between the primary coil and the secondary. The winding of the coils as specified is not necessary. No part of the circuit is rigid nor critical in dimension, practically no radio circuit is that way, so there is little need for further word relating thereto by the writer, save in the case of the tickler.

The tickler not only tickles but also

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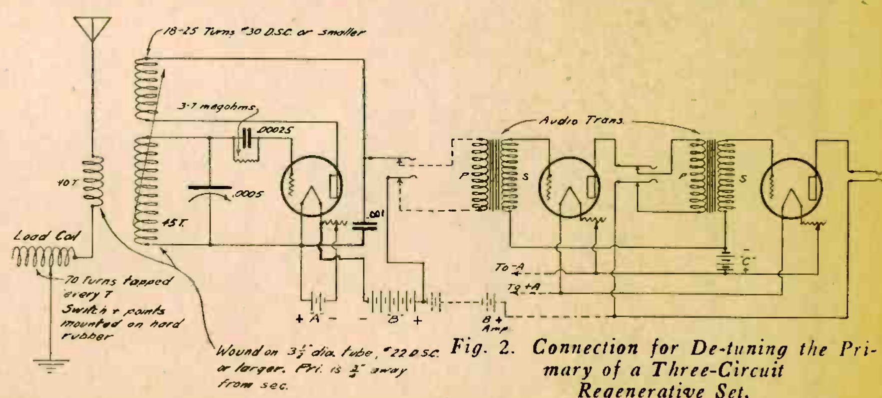

Fig. 2. Connection for De-tuning the Primary of a Three-Circuit Regenerative Set.

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Limitations of Horn Type Loud Speakers

A Helpful Interpretation of Response-Frequency Curves Showing the Performance of Various Horn Sizes and Shapes

By Dr. John P. Minton

COMMERCIAL types of loud-speakers include both "horn" and "hornless" types. The former employ short or long horns whose characteristics may be studied in accordance with the test methods described in Sepember RADIO. The conclusions derived from this study are presented in the form of a series of curves from whose interpretation many facts of popular interest and value can be gained.

Figs. 1 to 6 show the variations of sound intensity for six different types of speakers employing short horns.

The first two curves are for loud speakers with straight conical horns about 1 ft. long. The final opening in the case of Fig. 1 was about 4 in. in diameter and of Fig. 2 about 8 in. These two short horns give similar curves. The peaks in the region of 500, 1100 and 2300 cycles are due to the units. Ouside of these three regions neither gave sound output comparable to that at the peaks. In other words, the sound given off by these two loud speakers is not greatly increased by the presence of such small horns. Furthermore, the response is less for the horn with the 4 in. opening than it is for the 8 in. one. The peaks also are sharper for the former than for the latter. In the case of both of these horns the response, as measured by the sound pressure, is far from uniform or equal at the various frequencies. The high notes which are necessary for clearness and brilliancy are seriously diminished. The low notes, such as required for a cello, organ, etc., are absent entirely. Certain frequency regions will have clear and relative intense sounds while other regions will be markedly inferior in both these points. These two speakers will cover a range of about three octaves, beginning at about 400 cycles, but they will cover it in an unsatisfactory manner. Their response does not begin until we have passed over more than half the piano notes corresponding to the whole of the region occupied by the low notes. This limitation could hardly be more serious to good reproduction.

With Figs. 3 and 4 are curves for somewhat longer horns—about 15 or 16 in. These are conical; 10 in. openings

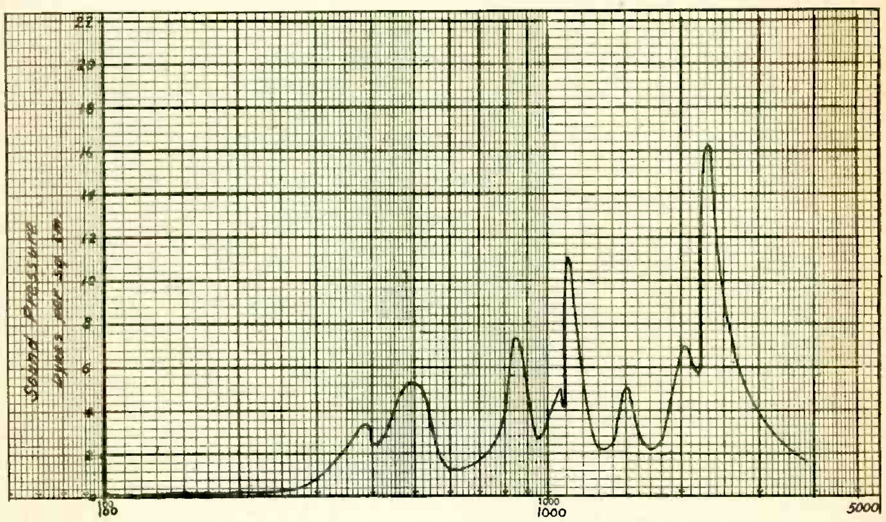

Fig. 1. Curve for 1 ft. Conical Horn with 4 in. Opening.

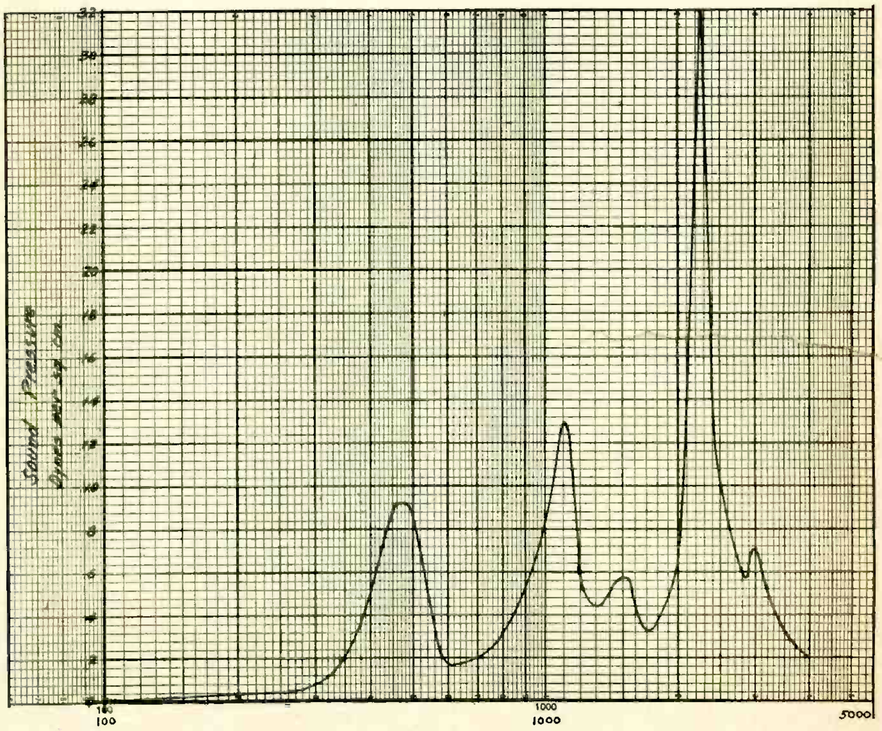

Fig. 2. Curve for 1 ft. Conical Horn with 8 in. Opening.

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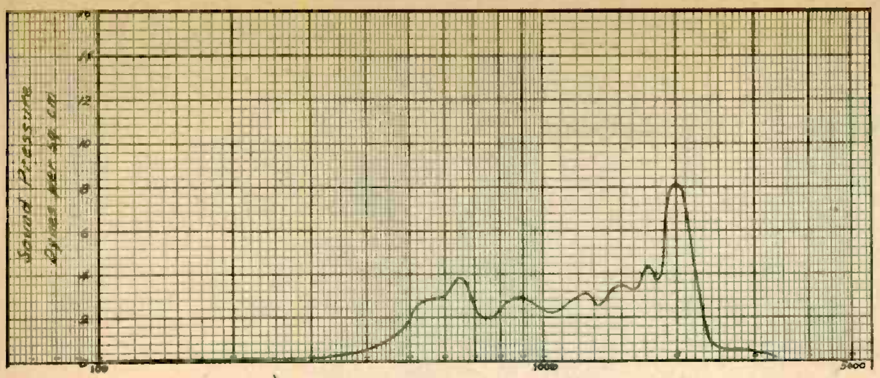


Fig. 3. Curve for 15 in. Conical Horn With 10 in. Opening and 90 Degree Bend.

Fig. 4. Curve for 15 in. Conical Horn With 10 in. Opening and 90 Degree Bend.

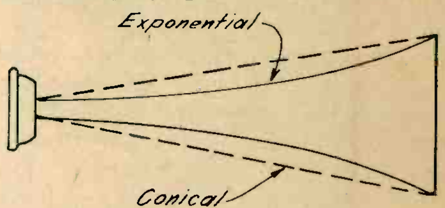
Fig. 5. Curve for 18 in. Exponential "Gooseneck" Horn With 10 in. Opening and Poor Unit.

Fig. 6. Curve for 18 in. Exponential "Gooseneck" Horn With 10 in. Opening and Good Unit.

with a 90 degree bend at the large end to direct the sound outward toward the listener. Although the bend causes some of the sound to be reflected back into the horn, it is better to direct the sound to the listener than toward the ceiling. Fig. 3 indicates that the response for this type of horn is more uniform than it is for the two small straight conical horns. However, it does not cover as wide a frequency band nor is it as sensitive as those shown in Figs. 1 and 2.

Fig. 4 is similar except that this speaker does not respond satisfactorily to the low and intermediate frequencies. The curve begins to rise at about 700 cycles and reproduces satisfactorily up to 2500 cycles. This range corresponds to two octaves on the piano beginning half an octave above high C. Compared with No. 3, however, it is more sensitive over its transmission band and compared with Nos. 1 and 3 speakers, it has a more uniform response over this band; it does not cover, however, as wide a frequency range as these.

In the conical horn, the cross sectional area increases as the square of the distance from the small end—doubling the distance means multiplying the area by four, etc. For such a horn the rate of increase of area is much greater near the small end than near the large end. The maximum amount of sound energy cannot be transmitted under all conditions along such a horn. Under most conditions, the maximum sound can be given up to the horn by the unit and radiated from the horn into a room, when the rate of increase of cross sectional area is constant. That is, the horn is designed, say, so that is area increases 25 per cent per inch. If the area is 1 sq. in. at the start, then at 1 in. away it will be 1.25 sq. in; at 2 in. 25 per cent larger than 1.25 in. or 1.56 sq. in., etc. Such a horn would look like the accompanying sketch where the dot-



Exponential and Conical Horns.

ted lines represent the conical horn and the solid lines the exponential horn, as it is called.

The curves for two loud speakers whose horns essentially follow this law are shown in Figs. 5 and 6. The horns are not straight, but "goose-neck", being about 18 in. long with openings 10 to 12 inches in diameter.

Fig. 5 indicates that excellent results cannot be expected for the loud speaker which this curve represents. The horn, which is approximately exponential, can-

(*Continued on Page* 68)

How Antenna Characteristics Affect Reception

Showing the Influence of Resistance, Capacity, Inductance, Direction, Height, Length and Surroundings on Results

By Kirk B. Morcross

THE average radio antenna not only nullifies any scheme of city beautification but also falls short of its possible effectiveness as a receiver of radiant energy. On the other hand, pride in the appearance of a neat and business-like antenna is usually accompanied by the satisfaction that it is operating at higher efficiency than the usual slovenly installation. The efficiency of an antenna is determined by its constants: resistance, capacity, inductance, natural wavelength and associated characteristics. These antenna constants are just as important a part in the functioning of a receiving set as are the similar constants of the parts within the cabinet. Each in turn is worthy of the careful consideration to be here given.

By *resistance* is generally meant the "effective" or "apparent" resistance. Lowered resistance will deliver more power to the radio set, resulting in increased volume of signal with a given amount of amplification and in proportionally less noise originating in the receiving circuit itself. It will also increase the selectivity of the set.

The determination of antenna resistance is beyond the ability of the average radio fan. However it is possible to determine what *changes* are necessary in order to reduce the resistance and thereby secure increased efficiency.

First let us consider an "ideal" antenna: a sloping wire of large surface area, from 75 to 100 ft. long, with its ends about 30 and 50 ft. above the ground, freely suspended in space with no intervening objects in its field other than the supports; the lead-in wire brought down vertically from the low end, kept clear of obstructions and connected to the receiving set located on the first floor of the building; ground wire short and direct and connected to large plates buried in moist earth or to a water pipe leading directly into the ground. The resistance of this ideal antenna, over the radiocast range of frequencies, will be less than 15 ohms, perhaps not more than 10 ohms. The usual receiving antenna has a somewhat higher resistance than this.

A copper wire (soft or hard drawn) or a stranded or braided conductor (enamelled or tinned) having an area equal to or greater than a No. 14 wire will serve very well as a low resistance conductor. The decreased resistance resulting from a very large conductor is hardly sufficient to warrant its use because the usual antenna environment causes a proportionally greater increase in resistance due to intervening objects. Also, a very large conductor increases the strain on the supports, causing more sagging.

This conductor should be continuous right down to the point where the lead-in wire is connected to the receiving set. If the lead-in is connected to an outdoor lightning arrestor or grounding switch or if splices are necessary such points should be soldered. A poor connection left exposed to the weather may cause a greater increase in resistance in the receiving circuit than would result from a set completely wired with splices but without soldering, because such connections would not be exposed to rapid corrosion.

A poor ground connection may cause a high resistance to an otherwise good antenna. As an interesting illustration, the resistance of an antenna used with a ground connection obtained by means of a clamp on a corroded pipe, was found to be over 80 *ohms*. When a clean connection was made the resistance dropped to less than one-fourth this amount. Again, an antenna connected to a gas pipe having a circuitous route to a ground gave a resistance of 70 ohms. This connection was shifted to a direct ground and the resistance was reduced to 17 ohms.

After a few months' use a solid conductor generally has less resistance than a stranded or braided conductor which corrodes so that the separate strands become partly insulated at some points and electrically connected at others. Stranded conductor with weatherproof insulation or enamel is desirable when properly installed so that a good connection is made to each individual strand. In the case of the enamel wire, carefully separate the strands, heat to dull red, plunge into alcohol, wipe with a clean cloth, twist the strands together, and sweat with solder.

An antenna of two or more wires generally has more resistance than a single wire because of the greater number of joints and insulators and greater sagging. But if the antenna must be short two or three wires may be used in the horizontal portion.

Another factor which greatly affects antenna resistance is the dielectric in its field. The antenna insulators form a part of this dielectric, while supports, trees, roofs and walls of buildings near the antenna or the lead-in have a more pronounced effect. An antenna is essentially a condenser, of which the ground is one of the conducting plates. If air were the only dielectric in the field of this condenser, that part of the antenna resistance which is due to a poor dielectric would be eliminated. However the use of poor insulators and the nearness of obstructions form a "mixed dielectric" causing increased resistance. This effect is similar to that obtained by placing a poor grade of insulation between the plates of a condenser. Of course it is generally not possible to erect an "ideal" antenna; nevertheless care should be taken to avoid obstructions as much as possible and to use insulators which will not absorb moisture.

Sharp bends in the antenna or lead-in contribute to its resistance and although this effect may be small, it should be avoided as much as possible. Sometimes, owing to the location of the receiving set under the center of the antenna, the lead-in is bent back at a sharp angle. In such cases a T-type antenna should be used, the lead-in wire being soldered to the *center* of the horizontal portion.

THE *capacity* of an antenna is determined principally by the total length of the conductors and by their nearness to other objects and to the ground. An antenna of proper capacity will give better results as a receiver of radio energy. If its capacity is too high, the selectivity of the receiving set is reduced and interference from static is more pronounced. With some receiving sets an antenna of either too high or too low a capacity will prevent tuning to the required range of frequencies. The average receiving antenna should have a capacity of not more than about 400 nor less than 200 micromicrofarads.

The larger the antenna, without changing the capacity, the more effective it becomes as a receiver of energy. This is due to the fact that as the size is increased it must be made higher and

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moved further away from obstructions. As an illustration, if the free end of a horizontal L-type antenna is elevated, it may be made longer without increasing its capacity.

The capacity may be readily computed so as to show what changes are necessary in the arrangement, size or location of the antenna to secure a proper value. The more closely the antenna approaches the "ideal," the more closely the computed value will check with that obtained by actual measurements.

For a single wire antenna the formula for computing the capacity is

$$C=K\sqrt{l}\ (1+\frac{.347\sqrt{l}}{h})$$

where C=capacity in micromicrofarads.
h=height of antenna in ft.
l=length of nearly horizontal portion of antenna in ft.
K=a constant depending on l, being 21.23 for 30 ft., 23.16 for 40 to 60 ft., 25 for 70 to 80 ft. and 27 for 90 to 100 ft.

For the ideal antenna previously described, h=40, l=75 and K=25. Consequently $C=25\times8.7\ (1+\frac{.347\times8.7}{40})$ =233.9 mmf. To approximate the conditions of the usual installation where trees and buildings are near the ideal antenna we increase this computed value by about 20 per cent.

The *natural frequency* of an antenna is that to which it responds when connected directly to ground. Natural frequency squared varies inversely as the capacity and inductance. An antenna should not have a lower natural frequency than the highest frequency to be received. Natural frequency may be computed—sometimes giving a result which checks surprisingly well with the measured value—from the formula:

$$f=\frac{219,000}{l^1}$$

where f = natural frequency in kilocycles per second, and l^1=total length of antenna in feet, including *ground lead*. Computed from this formula the natural frequency of our ideal antenna is $f=\frac{219,000}{75+30}$=2085 kc. Suppose we placed a few trees or buildings near this ideal antenna. Its natural frequency would then be *decreased*. Hence in applying this formula to the usual antenna, the result should be decreased by about 15 per cent.

The *inductance* of an antenna is another indication of its effectiveness as a receiver of radio energy. A high inductance is generally due to numerous kinks and bends and since these also cause an increased resistance, an antenna of low inductance is generally best. The inductance of an average good receiving antenna is about 25 microhenries. In a very *limited space*, an antenna in the form of a coiled spring may give better results than a single wire. This is however not due to an increase in inductance, but rather, to an increase in capacity. Having predetermined values of natural frequency f and capacity C, inductance L in microhenries may be computed from the formula:

$$L=\frac{2535\times10^7}{C\times f^2}$$

This formula is theoretical rather than empirical, hence the inductance computed from it will generally not check very closely with a value obtained by measurement. From the formula, the inductance of our ideal antenna is

$$L=\frac{2535\times10^7}{234\times(2085)^2}=25 \text{ microhenries.}$$

An L-type antenna gives better reception from a direction opposite to which the free end points. This effect is not nearly as pronounced as generally thought. It becomes less as the far end of the antenna is raised, hence one advantage of a sloping antenna. Some experimenters believe that they are unable to obtain good reception from certain stations because of this directional effect, when as a matter of fact, this trouble is not due to the directional effect of the antenna, but to shadow effect of obstructions. Directional effect is pronounced only with a comparatively long and low antenna, or when the antenna is worked close to its natural frequency. Assuming freedom from obstructions, one may install a long antenna of such proportions that its fundamental frequency approximates the frequencies to be received, and thus take advantage of its directional properties. A wire strung over a metal roof may have the effect of a long low antenna, hence

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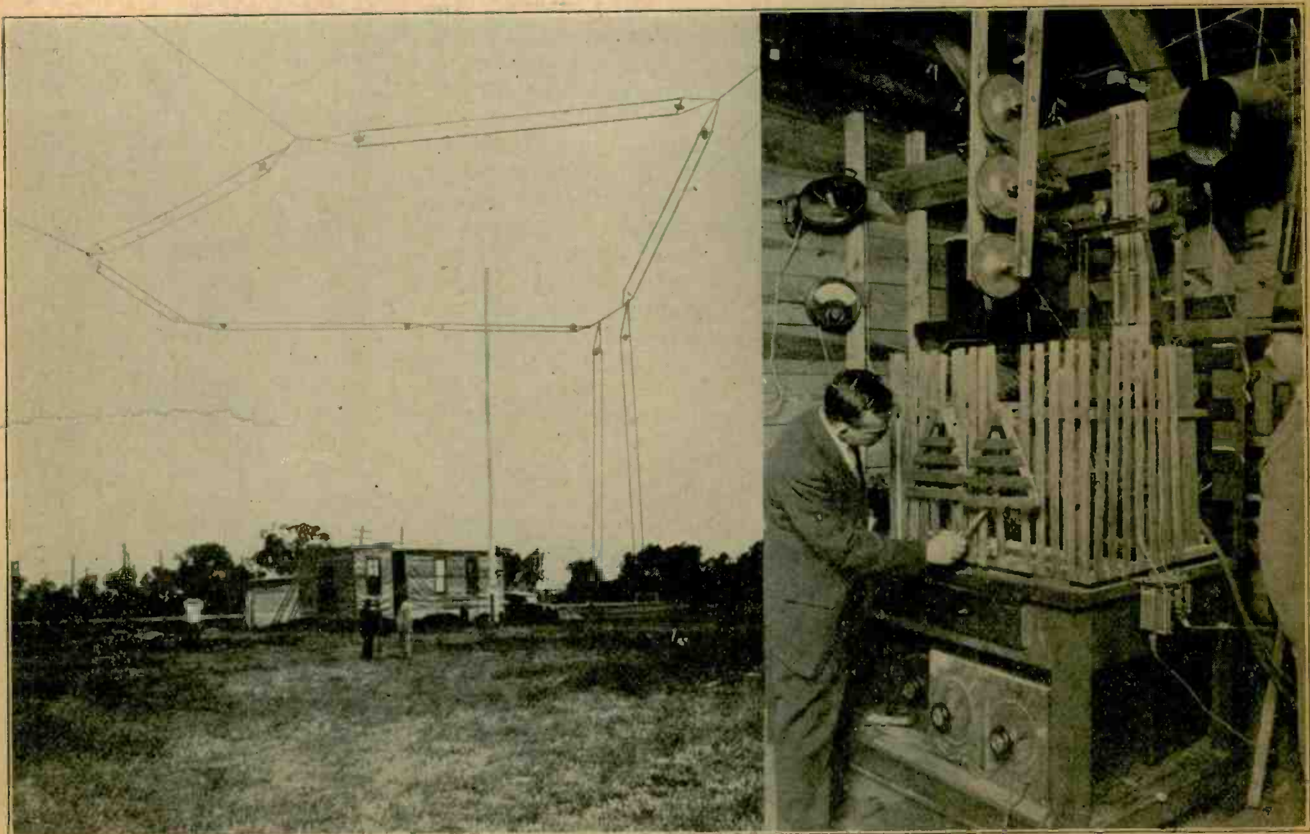

Horizontal Antenna and Equipment Used by General Electric Company Engineers for Radiation of Horizontal Waves. (*See Radiotorial Comment on Page* 9)

Elimination of Oscillations in R. F. Amplifiers

A Simple Explanation of the Causes of Oscillation and of the Various Methods Employed to Prevent It

By Dr. Maurice Buchbinder

RADIO frequency amplification in one form or another is the best way which we now have of increasing volume and distance range while simultaneously adding selectivity. Theoretically we can make a set infinitely selective and sensitive by piling one tube on another with the proper tuning circuits. Very soon, however, practical limits are reached when the entire circuit begins to oscillate. Unless precautions are taken this disturbing oscillation will commence with the very first stage of tuned radio frequency amplification. Properly arranged, as many as three or four radio stages may be readily cascaded without undersirable effects. Many devices are being used in present-day receiver design to eliminate oscillation and it is the object of this article to analyze each of the commoner methods.

Before going into the main subject it will be necessary to briefly discuss the causes for oscillation in a radio frequency receiver. To simplify matters we should assume a single stage amplifier plus a vacuum tube detector. This will consist of two tuned circuits, *A* and *B* in Fig. 1.

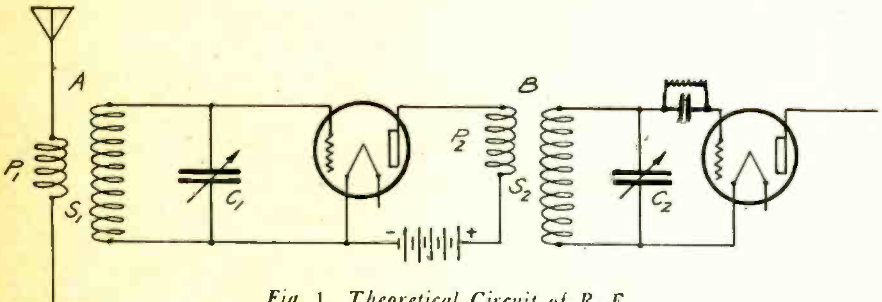

Fig. 1. Theoretical Circuit of R. F. Amplifier.

Each tuned circuit has inductance capacity, and some resistance. The inductance values are P_1, S_1 for the *A* circuit and P_2, S_2 for the *B* circuit. The radio wave carrying the signal is impressed upon the first tube by the antenna. A magnified current results in the plate circuit of this tube which is introduced into the second tube through the radio frequency transformer P_2 S_2. At this time rectification results and the signal is detected.

This is the desirable phenomenon in a radio frequency amplifier. Unfortunately, oscillations will occur unless they are headed off—namely a definite radio frequency current will flow all the time, regardless of the presence of a signal and will interfere with the signal when the latter does come in. This interference is the familiar whistle or squeal or merely a distortion of sound.

How does this continual radio frequency current, this oscillation, arise? How may it be eliminated? There is only one reason why an amplifier will oscillate—namely if energy is being reintroduced in some manner from the higher stage tubes to the lower stage tubes. Suppose, in our simple example, that some coupling were introduced between coils P_2 S_2 and S_1. In that case any slight radio current upon S_1, going through the amplifier current tube, would be amplified and would appear again in P_2 or S_2, augmented in strength by the amplification process. If the coupling is sufficiently great the oscillation will tend to persist—and we have an oscillating receiver.

The exact relations of current in circuits *A* and *B* can only be expressed mathematically since the difficult question of phases will come up. But enough has been described to give a fairly true qualitative picture of the process. The coupling between *A* and *B* is either an electrostatic or a magnetic coupling, or both. Coils P_1, S_1, P_2 and S_2 are not entirely free of an external magnetic or electrostatic field. No matter how we design these coils geometrically, we shall always have some interaction between them. It is merely a question of how much. Yet by close attention to design and arrangement of coils and condensers, the stray fields, which are the chief causes of oscillation, can be reduced to practical ineffectiveness.

The methods used in eliminating oscillation may be classified into three groups. In one group an attempt is made to damp out the oscillations by making the amplification less efficient. In another group it is aimed to reduce to a minimum all stray magnetic and elctrostatic intercouplings. In still another group there are special arrangements to balance out whatever intercouplings do exist.

The first group suffers from a reduction in sensitivity and in selectivity. The oscillations can be damped by using coils and condensers of high resistance or by inserting fixed or adjustable resistances into each tuning unit. The immediate result is to decrease selectivity and also sensitivity for distant stations. Yet there are receivers on the market which seem to rely upon this crude method. Such receivers, and they are the cheaper ones it must be stated, are characterized by marked inferiority in selectivity and by inability to get distance. Local signals may come in quite well since the available energy then is overabundant.

Another method which is not so crude and is more popular is to use the so-called biasing potentiometer which places a variable amount of potential upon the grid of each amplifying tube. When this voltage is strongly negative, the tube is working most efficiently and there will be maximum amplification and consequently maximum tendency to oscillate. As the potential is made positive the amplifier becomes less efficient and there is diminished tendency to oscillate. When the grid potential is positive then the grid to filament path of each tube acts somewhat as a leak or short circuiting path. This is because electrons are free to travel to the positively charged grid. We have in effect a leak across each tuning condenser and this obviously dampens the oscillations. The advantage of this method of damping the amplifier circuit as against the insertion of a fixed resistance in series with each coil or inherent in the coils is that the *amount* of damping may easily be controlled through the potentiometer. Hence for each wavelength adjustment the damping may be made as little as possible so as to *just* prevent oscillation. Sensitivity and selectivity will thus be disturbed as little as possible.

In the group of methods which aims

(*Continued on Page* 80)

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The Girl With the Madonna Voice

By H. Penrose Bridge, Jr.

"I was a little curious to see what she looked like."

WITHOUT knowing anything about it from actual experience, until very recently, I would say that love is apt to make a fellow funny in a lot of different ways. I have seen friends affected by it. But when Hen Fisher, my room mate, took to listening to bedtime stories over the radio I didn't fall to the big idea for a long time. Of course it struck me funny but I put it aside as being either due to the fact that he was falling heir to his second childhood or else hadn't fully grown up yet.

Never being much of a guy to fuss over kids anyhow, his baby stuff worked on my nerves, especially when he kept it going while I was looking over the daily scandal sheet. I figured folks must make their kids tune in to this kind of stuff nights when they want to dig out to a show themselves so the poor little devils will go to sleep rather than have to listen to any more of it.

Well, I stood it for two weeks, then got all set to bawl Hen out one evening when I noticed the expression on his face. He was sitting at the radio with his head leaning into the horn and an expression so vacant it reminded you of a desterted house where the last people to move out even took the paper off the walls.

"For the love of Mike, Hen, if you feel like you look you're in bad shape," I burst out, "Pull in some good snappy jazz music and come back to earth. That stuff would'nt be popular in a kindergarten."

Henry seemed to wake up by degrees.

"Wasn't that wonderful, Bub?" he asked, "Do you know who it is?"

"Offhand I would say it is soothsaying Sarah, the slumbertime-sleep-producer passing the chloroform from station SAP."

"Which shows you don't know a real honest-to-goodness voice when you hear it," snaps up Henry. "That's the Dream Lady from KYTX of the Lorndenger Company."

"Too bad," I says, "I feel sorry for her having to make a living doing that. Seems like some charity ought to take her on."

"Talk sense, can't you. I mean it. That voice belongs to a real, one hundred per cent American girl."

I laughed. "With your imagination, Hen, you oughta get rich selling Florida real estate. She sounds to me like a girl that escaped the Follies and landed in something worse."

Henry shook his head. Then, in sudden resolution, he drew his chair up close to mine and gave me the once over with an air like he might have been my grandfather.

"Listen here, Bub," he said real earnestly, "Let's talk sense for just a little while. Maybe you do think I'm a nut

(*Continued on Page* 50)

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How Radio Circuits Work

A Simplified Explanation of Reactance and Susceptance Diagrams as Used to Determine Response to Various Frequencies

By G. F. Lampkin, 8XAV

A LITTLE study of alternating current theory should enable any person with a knowledge of high school algebra to understand how a radio circuit will function. The basis of this ability is an understanding of resistance, inductance and capacity and of the simple formulas which express their relations in a circuit. All radio circuits carry alternating current of high frequency, corresponding either to the audio or voice frequencies and to the radio or transmission frequencies.

The resistance of a circuit to high frequencies acts much like the resistance of a circuit to a simple direct current. Ohm's Law, $E=IR$ or $I=E \div R$ is valid with a slight modification of R, the resistance. Frequently we find it easier to express $I=E \div R$ as $I=Eg$, where g, the conductance equals $1 \div R$. This merely defines the current carrying ability of a conductor instead of using the resistance it offers to the flow of current, so as to simplify the calculations. The unit of conductance is the mho; the name being derived from the fact that conductance is the opposite of resistance—so the name of the unit of conductance is the name of the unit of resistance spelled backwards.

Inductance in alternating current circuits causes an opposition to the flow of current, in addition to that inherent in the resistance of the wire. This additional resistance to current flow is called reactance, and is expressed in ohms. If the value of the inductance L is known in henries, and the frequency f of the current is known in cycles per second, the inductive reactance, X_L, can be calculated—

$$X_L=6.28fL \text{ ohms.}$$

The amount of current which will flow through a reactance is $I_L=\frac{E}{X_L}$, which is similar to the expression for the flow of direct current through a resistance. The alternating current flowing through an inductive reactance, however, lags behind the voltage by 90 degrees. The expression for current flow through a reactance could be written, $I=E\left(\frac{1}{X_L}\right)$, and the quantity $\left(\frac{1}{X_L}\right)$ represented by the symbol b; then $I=Eb$. The reasoning is the same as that used in the case of conductance. The symbol b is called susceptance—in this case inductive susceptance.

Capacity adds a reactance to alternating-current circuits whose value in ohms is given by

$$X_c=\frac{1}{6.28fC}$$

in which C is in farads. A microfarad is one-millionth of a farad. The value of current which will flow through a capacity is $I_c=\frac{E}{X_c}$ The quantity $\frac{1}{X_c}$ is called the capacitive susceptance, is expressed in mhos, and has the same significance as inductive susceptance. The current through a capacitive reactance leads the voltage by 90°.

As the current flowing through an inductive reactance lags the voltage by 90°, the effects of inductance and capacity are exactly opposite. This fact leads to the fundamental principle of all radio circuits. For by making the capacitive reactance equal to the inductive reactance, at any one frequency, the two will neutralize; and the circuit is said to be tuned to that frequency. The frequency at which an inductive reactance will neutralize a capacitive reactance can be found from the fact that the two must be equal.

$$X_c=X_L \text{ or } 6.28fL=\frac{1}{6.28fC}$$

and solving for f, $f=\frac{1}{6.28\sqrt{LC}}$

This is the resonate frequency for the capacity and inductance, whether connected in series or parallel.

The effects of these two connections, however, are entirely different. A series offers a very small opposition to currents of the frequency to which it is tuned, its value being only the ohmic resistance of the circuit as given directly by Ohm's law. The smaller the resistance, the larger the current, and vice versa. The current flow through the condenser and inductance causes voltage drops across them, which may be greater than the impressed voltage, but, as the two voltages are opposite and equal, they cancel.

On the other hand, a parallel circuit of inductance and capacity offers a very large opposition to currents of the resonate frequency. This opposition, in the case of typical radio circuits, is numerically equal to $\frac{(6.28L)^2}{R}$ ohms, in which L and R are the coil inductance and resistance, respectively.

The first step in an analysis of a radio circuit is to find how it will respond to currents of varying frequencies. This can be accomplished best by the use of what are known as reactance diagrams. These are graphs which show how the circuit reactances vary with changing frequency. The points where the curve of total reactance cuts the zero axis are resonate points. The frequency, or frequencies, to which the circuit is tuned at these points of zero reactance can be read from the horizontal frequency scale.

The three circuits which occur in practically all receiving sets are the antenna, the grid, and the plate circuits. Usually the antenna circuit includes all apparatus connected between the antenna and the ground; the grid circuit, all between the grid and filament; and the plate circuit, all between the plate and the filament. The source of voltage in any one circuit must first be determined. This may be an antenna, a vacuum tube, or the secondary of a transformer. The circuit had best be redrawn by itself, in a simplified form. The reactance diagram can then be plotted, remembering

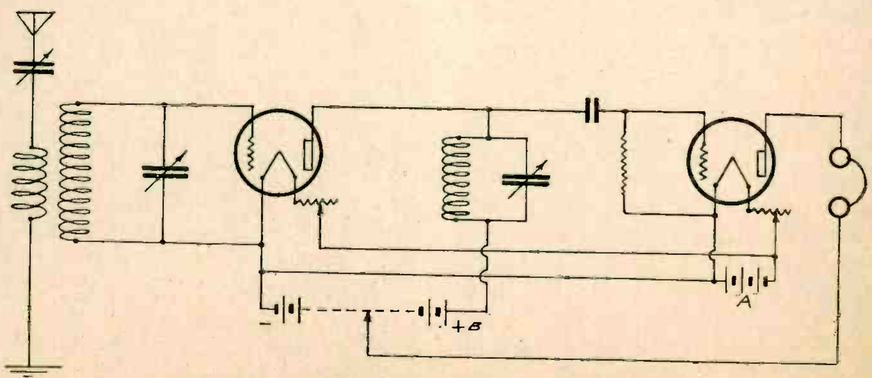

Fig. 1. One-Step Amplifier and Detector.

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a few facts. The reactance due to a coil is $6.28\,fL$, and is positive, while the capacitive reactance, which is $\frac{1}{6.28fC}$, is negative. If the capacity and inductance are in series, their reactances are combined; if in parallel, their susceptances are combined to give a curve of total susceptance, which is then divided into 1 to give the total reactance.

A few examples will help to illustrate the procedure. Consider the circuit of Fig. 1, a one-step tuned radio-frequency amplifier and detector. The first circuit to be tackled is the antenna circuit. If the antenna is considered only as a source of voltage, this circuit may be redrawn as in Fig. 2, so as to appear as a simple series circuit. It is not necessary to know the exact values of inductance and capacity, for all that is desired in the reactance diagram is a picture of the general way in which the circuit will act. Later the details may be worked out. So an assumption of 250 microhenries as the value of the inductance, and .00025 microfarads as the capacity value, will serve the purpose. These are average values which are used in radiocast receivers. The upper frequency range of the radiocast band is 1,500,000 cycles, so the frequency scale will be made to include this.

On a sheet of graph paper the frequency axis is run horizontally through the middle, and a scale chosen, and marked down, ranging from zero to 1,500,000 cycles (0 to 1500 kilocycles). On the vertical axis the reactance scale is marked in ohms; points above the frequency axis being positive for the inductance values, and those below negative for the capacity values. Five or six points will usually be enough to determine each curve, so the reactances may be calculated at 0, 300, 600, 900, 1,200 and 1,500 kilocycles. A table as shown, will help to keep things straight. For instance, at 600,000 cycles, the inductive reactance is $6.28 \times 600{,}000 \times .00025$, or 943 ohms. The capacity reactance at the same frequency is

$$\frac{1}{6.28 \times 600{,}000 \times .00000000025}$$

or 1,060 ohms. The reactances at other frequencies are computed similarly. The capacitive reactance is subtracted from the inductive at each point, and the curve of resultant, or total, reactance, is obtained. It crosses the axis, or is zero, where the frequency is 639,000 cycles; corresponding to a wavelength of 470 meters. This result is fairly obvious, and could have been obtained from the simple formula for resonant frequency. The use of the diagram, however, is the foundation for the solution of more complex circuits, which cannot be analyzed so easily by means of simple formulas.

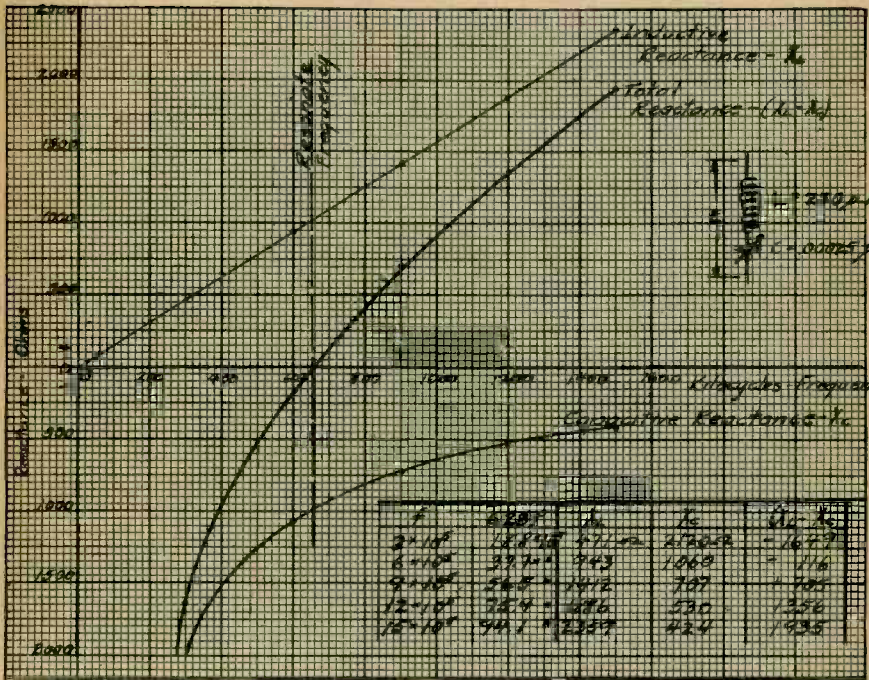

Fig. 2. Reactance Diagram for Series Circuit.

There are one or two "tricks" which will simplify calculations somewhat; chief of which is the use of exponentials to save writing long strings of ciphers. The capacity .00025 mfd., .00000000025 farad, could be written 2.5x.0000000001, or 2.5×10^{-10}. The exponent is minus because the number is a decimal, and 10 because there are ten places in the decimal. When exponentials are divided, the exponents are subtracted; when multiplied, they are added; an exponential may be transferred from numerator to denominator of a fraction, or vice versa, by changing the sign of the exponent.

Another example of a typical circuit is the tuned R. F. transformer in the plate circuit of the amplifier tube, which is an ordinary parallel "trap." In this case the source of voltage is the fluctuation in plate voltage, due to the corresponding radio-frequency voltage on the tube grid. The direct-current, *B*-battery voltage has this fluctuation superimposed on it; but only the radio-frequency voltage need be considered across the parallel circuit as the *B*-battery voltage has no effect on the conditions to be considered.

In this case of parallel connection, the susceptances must be used; therefore b_L and b_c are calculated, and b_c is subtracted from the b_L for the corresponding frequency. The differences are plotted as points of total susceptance on this curve. Dividing values from this curve, into 1, the points on the final curve of resultant reactance are obtained. The simplified connection diagram, the table of values, and the curves are presented in Fig. 3. The total reactance curve shows

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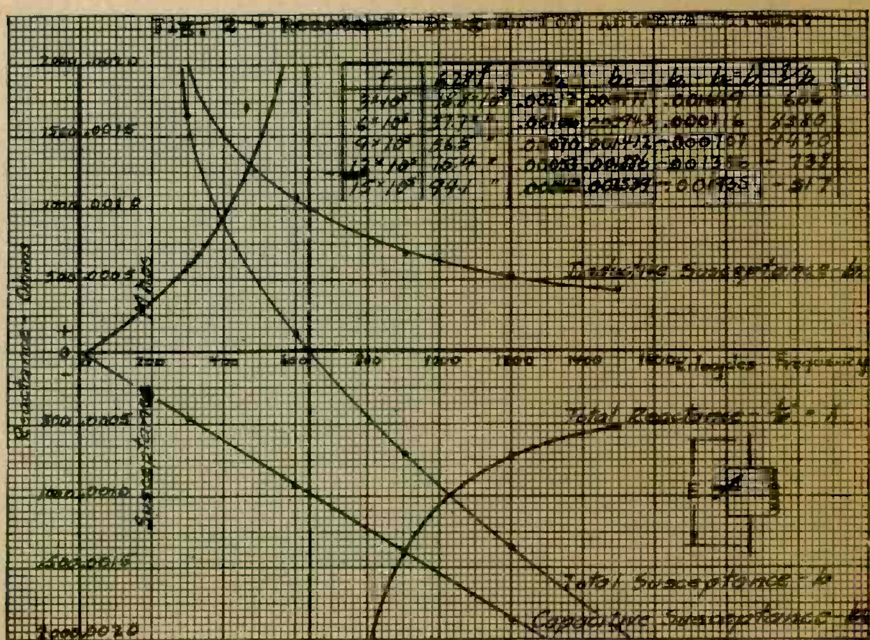

Fig. 3. Reactance Diagram for Parallel Circuit.

A Universal Meter for the Home Laboratory

Detailed Directions for Changing a Meter so That It Will Cover .001 to 200 Volts and .001 to 10 Amperes

By M. K. Lock

THE instrument to be described herein is designed for the amateur experimenter who cannot afford half a dozen different meters. It will enable him to measure with one meter, all the direct voltages and currents he is likely to use, and with a fair degree of accuracy.

One good D.C. milli-ammeter or milli-voltmeter is required in the construction. This should not have a full scale deflection of more than 20 M.A. or 50 M.V. and if one of a lower value is obtainable so much the better. It is essential that this be a high grade instrument if accuracy is desired.

A good moving coil type D.C. voltmeter or ammeter of any other range, with a little extra work, can also be made to serve the purpose. Open the meter case and carefully remove the shunt, if an ammeter, or the series resistance, if a voltmeter. Then connect so that the small coil, which rotates between the magnet poles, is connected directly across the meter terminals. You now have a milli-ammeter or milli-voltmeter, depending on how it is calibrated. For our purpose it must be calibrated for both. If it is one of the larger type ammeters using an external shunt it may have something like this printed on the dial, "50 milli-volts on Coil=10 Amperes on Shunt." This will mean that half your work is already done for you as you know that without the shunt the moving coil itself will give full scale deflection with 50 M.V. across the terminals. Then it will only be necessary to determine the milli-ampere range.

Let us assume, however, that none of this information is given and we must calibrate the milli-volt and milli-ampere ranges of our meter. It will be necessary to borrow a regular milli-voltmeter and milli-ammeter, the former with a range of about 100 M.V. and the latter about 50 M. A. The only other necessary equipment for the calibration will be one or two half dead dry cells, any kind of S.P.S.T. switch and a potentiometer of 400 or more ohms resistance. For the ampere calibration it may also be necessary to use some fixed resistance, which you probably have lying around to reduce the current to a low enough value for calibrating the lower ranges.

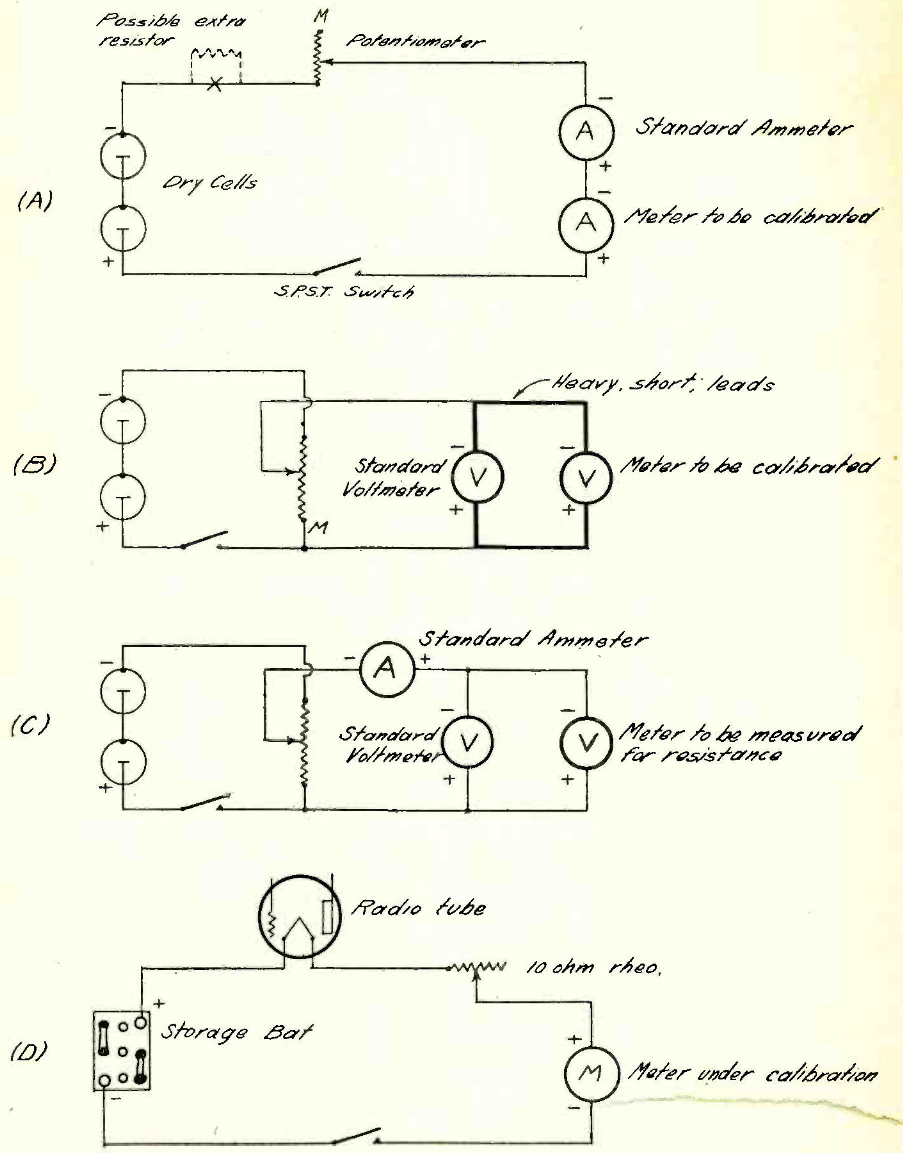

Fig. 1. Various Connection Diagrams for Meter Tests.

To calibrate for milli-amperes connect up a regular milli-ammeter (hereafter designated as the standard) in series with the meter to be calibrated, also connect up the dry cells and potentiometer with a single pole switch as shown in diagram "A" of Fig. 1. Be sure the switch is open when connecting in the dry cells and do not throw it in until you have brought the potentiometer arm down to the position designated as *M* in the diagram. If this is not done there will be a possibility of burning one or both of the meters out. It is also advisable to connect in some fixed resistors as shown, until you are certain that the current which will pass is not too high for the meters. Now throw in the switch and gradually move the arm of the potentiometer—note that it is used as a rheostat in this circuit—until the pointer of the meter under calibration is exactly at the end of the scale. Now note the reading of the standard.

The chances are that it will show some odd value like 17 milli-amperes, in which case you will have to obtain some small resistance wire (iron wire will be o.k.) and shunting about 2 ft. of it

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across your meter terminals proceed to get a reading as before. If you now get full scale on your meter with the standard reading 18½ or 19 M.A. your shunt is of too high a resistance and you will have to cut off a few inches and try again. If on the other hand full scale is obtained with say 21 M.A. on the standard then your shunt is too short and a longer piece of wire must be tried. The idea is to adjust so that you get full scale deflection on an even value of milli-amperes viz: 10, 20 or 25 so that a 0-100 scale can be used. This is truly a cut and try procedure but after a few trials no difficulty should be experienced in getting just the right length of shunt to give the desired full scale reading. After this is determined the wire may be wound around a section of pencil or stick and placed somewhere inside the meter.

In all D. C. meters the scale should be in direct proportion. Therefore if full scale is 20 M.A. then half scale will be 10 M.A. and ¼ scale 5 M.A. and so on. While you have the apparatus hooked up it would be well to check this by taking several readings on those points and if they do not come out right there is something wrong with your meter and it would not be advisable to use it.

To calibrate for milli-volts the same procedure is followed with the exceptions that the circuit shown by B of Fig. 1 is used and the adjustment for obtaining an even milli-volt scale reading is made by adding a length of resistance wire in series with the instrument instead of in shunt, as was done for the current calibration. Greater care must also be taken with the connecting leads. The two leads connecting the meters in parallel will have to be very heavy stranded cable, as short as possible. The reason for this is that the voltage drop due to the slight resistance of these leads is surprisingly great when dealing with milli-volts and may seriously affect the accuracy of the calibration.

Thus you have either made a milli-amp-voltmeter as described above or else you are using a regular milli-ammeter which you have calibrated for milli-volts following the instructions given. In either case it would be well now to find the internal resistance of the meter while you still have the standard milli-ammeter and milli-voltmeter at hand. Using the same apparatus connect it up according to the diagram C of Fig. 1 again making sure that the resistance of the leads is negligible by having them as short and heavy as possible. Bring the potentiometer arm down to *M* then close the switch and gradually turn the potentiometer up until any even and convenient value of either voltage or current is noted on the standard meters. Note down the readings of both these meters, disregarding entirely the reading of the meter under measurement. It is now a simple matter by means of Ohm's Law to calculate the resistance. Assume that we obtained the values of 25 milli-volts and 10 milli-amperes (actually one of these will be an odd value but for illustration we take even figures). According to Ohm's Law *E* divided by *I* equals *R*, viz; voltage divided by current equals resistance. Therefore 25 divided by 10 equals 2½ hence 2.5 ohms would be the resistance of the meter in this case.

These figures can be put aside for a time and the construction continued. The first requirement will be a suitable cabinet. The writer used the case of one of the old type Aeriola Senior crystal radio sets, but anything of about the same size and equipped with a cover will do just as well. To fit this, a panel 7¾ by 6½ in. is required.

Mount the meter in the center of the panel, in each of whose upper corners is put a large size brass instrument type binding post. You will now have to get two exceptionally good switch levers. The ordinary kind sold for radio purposes with only one leaf for contact with the switch points will not do. The switch should have at least three leaves to make contact with the switch studs and have very large, solid bearing surfaces. The best thing to use would be the switch levers from an old decade resistance or capacity unit. The reason for so much stress being laid on these switches is that any slight variation of resistance in their contacts would cause the meter to read inaccurately. This is especially applicable to the ampere switch.

The number of switch points will depend on the number of ranges it is desired to cover with the meter. The instrument constructed by the writer has six points for each switch. Mount the switches one in each of the lower corners of the panel as shown in Fig. 2. The one on the left will be the ampere range switch while the one on the right is the voltage range switch. If desired they may be labelled accordingly.

If the meter is not already equipped with a 0-100 scale it would be well to have some draftsman friend draw out a scale calibrated in that fashion and of the same dimensions as the original scale. This may then be pasted in position over the old scale. Now wire up the meter, binding posts and switches as shown in Fig. 3. Use something like a No. 10 wire so as to keep the resistance down.

The instrument is now complete but has only the two ranges. Let us assume these ranges are 20 M.A. and 50 M.V. When using either of these the switch levers are both set at their No. 1 points. It might be well to state here that whenever the voltage ranges are used the ampere switch must be on its No. 1 point and when the ampere ranges are used the voltage switch must be kept on its No. 1 point. It can be readily understood by anyone familiar with Ohm's Law that if a resistance, of the same value as the internal resistance of the meter, is connected between the binding post marked

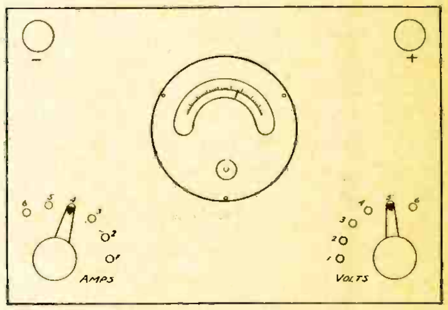

Fig. 2. Panel Layout.

Positive in Fig. 3 and the No. 2 point of the voltage switch; then when the switch lever is set on point No. 2 this resistance will be in series with the meter and it will take twice the voltage to give full scale deflection on the meter. Thus we would have another voltage range available, 0-100 milli-volts.

To prepare this range it will be necessary to measure the actual resistance required. Connect up the apparatus used previously as shown in B of Fig. 1, the standard meter may be left out this time, however. Adjust the voltage by means of the potentiometer so that full scale deflection is had when the voltage

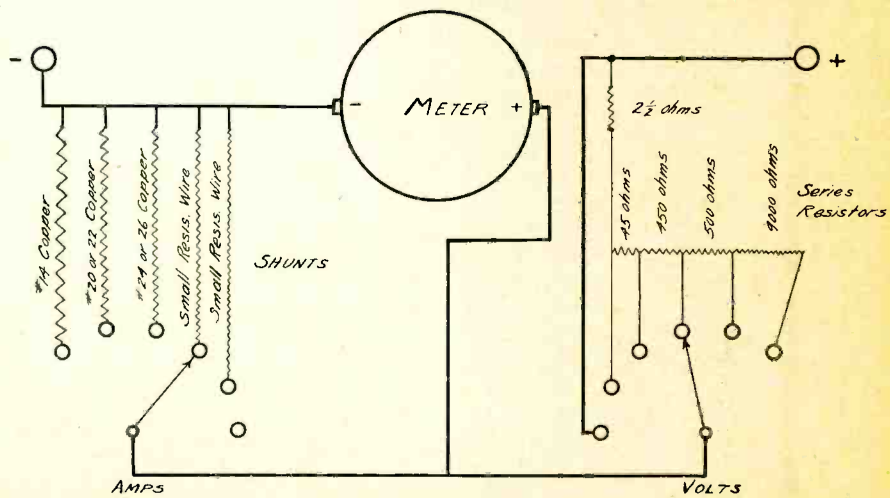

Fig. 3. Wiring Diagram.

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switch is set on point No. 1. This is known to be equal to 50 M.V. Now solder one end of a piece of any kind of small resistance wire to the No. 2 switch stud. Move the switch lever to point No. 2 and bring the resistance wire (connected to the point) up to the positive binding post on the panel. Hold it there with one finger so that it makes good contact. Observe the needle of the meter and with the other hand draw the wire along under your finger so as to gradually increase the amount of wire connected between the binding post and No. 2 switch-point. The meter pointer will drop down as more and more wire is put in series. When it has dropped to half scale the wire may be cut at that point and permanently soldered to the binding post. Now again check this up to make certain that the soldering has not affected the resistance. To check simply turn the switch lever alternately to No. 1 and No. 2 points and if full scale on No. 1 equals half scale on No. 2 then you are o.k.

The next higher milli-ampere range may be determined in the same manner but using circuit A of Fig. 1, the wire will be connected between the negative binding post and the No. 2 point on the Ampere switch. In this case, as can readily be seen from Fig. 3, the wire is connected as a shunt and not in series as for the voltage range.

Our universal meter is now capable of reading four ranges, 0-20 and 0-40 milli-amperes and 0-50 and 0-100 milli-volts. If desired this same process may be continued for all the other ranges, each time doubling the values, but with six points on each switch the highest ranges available would be 0-1.6 volts and 0-.64 amperes, which would hardly be worth while. Let us therefore make the remaining four voltage ranges 1 volt, 10 volts, 20 volts and 200 volts. Knowing the internal resistance and the current required to give full scale deflection on our meter, it is easy by means of Ohm's Law to determine the approximate value of series resistance required to give any desired voltage range. Thus for the one volt range we will require 20 M.A. to pass through the meter at a pressure of 1 volt—1 divided by .020 equals 50—therefore 50 ohms resistance is required in the circuit. We already have 5 ohms resistance in the circuit, the internal resistance of the meter being 2½ ohms and the series resistance between point No. 1 and No. 2 is also 2½ ohms, therefore only 45 ohms additional resistance is necessary.

The same method of determining the exact value is used as before for the 0-100 M.V. range. The voltage switch is set on point No. 2 and the potentiometer adjusted so as to give full scale reading—this is known to be 100 M.V. Now without disturbing the potentiometer adjustment the voltage switch is moved to point No. 3 and a reasonable amount of the resistance wire (depending on the resistance per foot of the wire used) is wound on a spool and connected between the switch points No. 2 and No. 3. The amount of wire must then be varied to give a reading of 1/10 full scale. As you know the voltage applied is 100 M.V. or .1 volt then if this reads 1/10 scale full scale must be ten times this or just 1 volt.

The next range is 0-10 volts. Using the same calculation as before we find that 500 ohms resistance is required in the circuit. The total resistance already in place is 50 ohms so only about 450 ohms more is to be connected between switch-points No. 3 and No. 4. It would be rather difficult and inconvenient to wind up enough wire to make this resistance and the ones that will be necessary for the remaining two higher ranges. It would be better to purchase standard resistance units such as the Ward Leonard or Daven resistors of the nearest value below that required and then it would be only necessary to add a small amount of the resistance wire in series with these for adjusting to the exact value. For the 10 volt range, therefore, get a resistor with a value of about 440 ohms. If it is impossible to purchase an odd value like this it will be all right to get say one 400 ohm resistor and two 20's or four 10 ohm resistors, and connect them all in series to make the required value.

Having placed approximately the right value resistance between point No. 3 and No. 4 proceed as before. Adjust the potentiometer so that with the switch lever on point No. 3 the meter needle will be at the end of the scale. This is one volt. Now switch to point No. 4 and vary the amount of resistance wire between the points until the needle indicates exactly 1/10 full scale.

Now for the next range, 0-20 volts on point No. 5, we find an additional 500 ohm resistance is required to be connected between points No. 4 and No. 5. Let us therefore get standard resistors of a value say 490 ohms more or less and then proceed as before, only this time we will have to use a 22½ volt radio *B* battery or some other source of D.C. voltage higher than the 1 or 2 dry cells we have been using for the previous calibrations. This time with the switch on point No. 4 adjust potentiometer for full scale reading, then switch to point No. 5 and adjust resistance between points 4 and 5 until meter reads just half scale. For the last and highest range, 0-200 volts, a total resistance of about 10,000 ohms is necessary. We already have a total resistance in the circuit of 1000 ohms so that only additional resistors of a value of about 9000 ohms will be needed. Proceed as before, reducing full scale value on point No. 5 to 1/10 scale on point No. 6.

Now for the remaining four ampere ranges. These will be much simpler than the voltage ranges as no high resistors will be used. Two ranges are completed, point No. 1 gives us a range of 0-20 M.A. while point No. 2 gives a range of 0-40 M.A. Let us make the other points .1, .5, 1.0, and 10. amperes respectively. For the ampere calibration connect up the apparatus again as in diagram A of Fig. 1, but leave out standard meter.

With the Ampere switch on point No. 1 adjust so that full scale deflection is had. Connect a piece of the resistance wire between the negative binding post and No. 3 switch-point. With the switch lever moved to point No. 3, reduce the length of this shunt wire until the needle indicates 1/5 of full scale then make the connection of the shunt permanent. Be very careful that, when tightening up the connections the needle does not vary from 1/5 scale. Due to the contact resistance changing as it is tightened up or soldered this may happen. If it does there will be no recourse but to remove and possibly make the shunt wire a bit longer and then try again. For the next range 0-500 M.A. or .5 Amp., leave the switch lever on point No. 3 and increase the current by means of the potentiometer (used as a rheostat) until the needle shows full scale deflection. This is known to be 100 M.A. or .1 Amp. Move switch lever to point No. 4 and using a length of ordinary copper wire, No. 24 or No. 26, shunt it across between the negative binding post and No. 4 point. Vary its length as before until the needle indicates 1/5 scale, then make it fast.

For the two higher ranges our potentiometer and dry cells will not suffice. It will be necessary, in order to get the higher current required, to connect up a 5 watt or other high current filament radio vacuum tube with a storage battery and 10 ohm, or higher, rheostat, as shown in diagram D of Fig. 1. With the meter connected in this circuit set the ampere switch on point No. 4 and carefully turn the rheostat up (if the rheostat is turned up too high or if a low resistance rheostat is used so that more than .5 ampere passes, the meter may be burnt out). Adjust rheostat until needle just reaches the last division on the scale, then leave this adjustment and move switch lever to point No. 5. For the shunt between the negative binding post and No. 5 point use a piece of No. 20 or No. 22 copper wire. Adjust length so that meter reading is reduced to half scale, then solder in place permanently. This completes the 1 ampere range. Leave the switch lever on point No. 5 and gradually turn rheostat up until you again have full scale deflection, then switch to point No. 6 and between No. 6 and the negative binding post adjust a shunt made of No. 14 copper wire, until you have reduced the

(*Continued on Page* 82)

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A Detecting, Oscillating and Modulating Radiocast Wavemeter

An Indispensable Instrument Constructed From Standard Parts Which Also Serves as an Efficient Receiver

By E. E. Griffin

THE terms wavemeter, oscillator and modulator, to the mind of the average radiocast fan, are generally associated with radio engineers, calculus and meaningless hieroglyphics, and he is apt to shy off at their appearance. However, when we find that the ordinary regenerative receiver can be both a wave meter and an oscillator, and that the ordinary buzzer can be used as a modulator, we are traveling well known ground, and interest is developed in new applications of understandable ideas. Also, when we find that wavelength, capacity and inductance can be quite easily and accurately measured without knowledge of higher mathematics, new fields of endeavor are at once opened to the experimenter and constructor.

The wavemeter is the fundamental measuring instrument in radio, and in the laboratory its associate is the oscillator. In the absence of an oscillator, a buzzer is often used in conjunction to produce a source of highly damped oscillations. By only slight sacrifices we can combine the three instruments into one, increasing their separate uses manifold, the final product resolving itself into somewhat the form of a highly efficient single tube receiver, the total cost of which is only slightly more than any good one tube set. The finished product is quite portable, being entirely self-contained, which makes it available for use by the repair and maintenance man.

A few of its uses are the measurement of wavelength, capacity and inductance; calibration of receivers; balancing of tuned radio frequency amplifiers; trouble shooting on standard sets, antennas, etc.; to all of which uses it is instantly available without changes of connections or wiring of any kind. It is the source of either continuous or modulated waves, the length of which may be varied at will through the entire radiocast band. Since it is also an efficient receiver when augmented by an antenna and ground connection, the apparatus used in its makeup is not a dead loss for other purposes, as it is in the case of separate instruments and the customary simple wavemeter.

The apparatus necessary in construction is the same as is normally used in any one tube regenerative receiver. Fig. 2 shows the connections of the customary three circuit tuner, with the exception of the buzzer. Cabinet dimensions are optional, and depend on the dimensions of the parts selected. The one illustrated is 6 in. x 7 in. x 8½ in. inside measurement including cover. Some arrangement must be made for facilitating battery renewal, such as a removeable back, or unit construction permitting the apparatus to be lifted out as a whole.

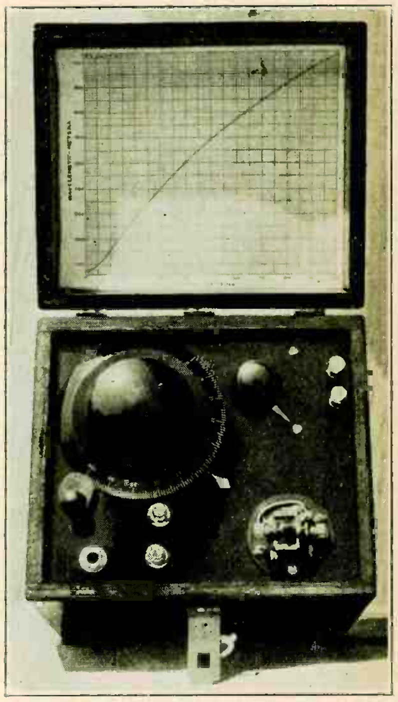

Fig. 1. Completed Portable Wavemeter and Testing Instrument.

The variable condenser and inductance coil are the most important parts of the circuit. It is imperative that we use a condenser of the "grounded rotor" type, unless we resort to shielding; that is, one in which the metal end plates are in direct connection with the shaft and rotary plates; the stationary or grid plates being supported and insulated from the frame. The shaft bearings must be fairly tight fitting, allowing no lateral motion nor tilting, thus eliminating discrepant readings from this cause. Condensers having conical end bearings are excellent. If a condenser of the vernier type is selected, such vernier must be of the geared arrangement wherein adjustment of the vernier knob causes movement of the complete set of rotor

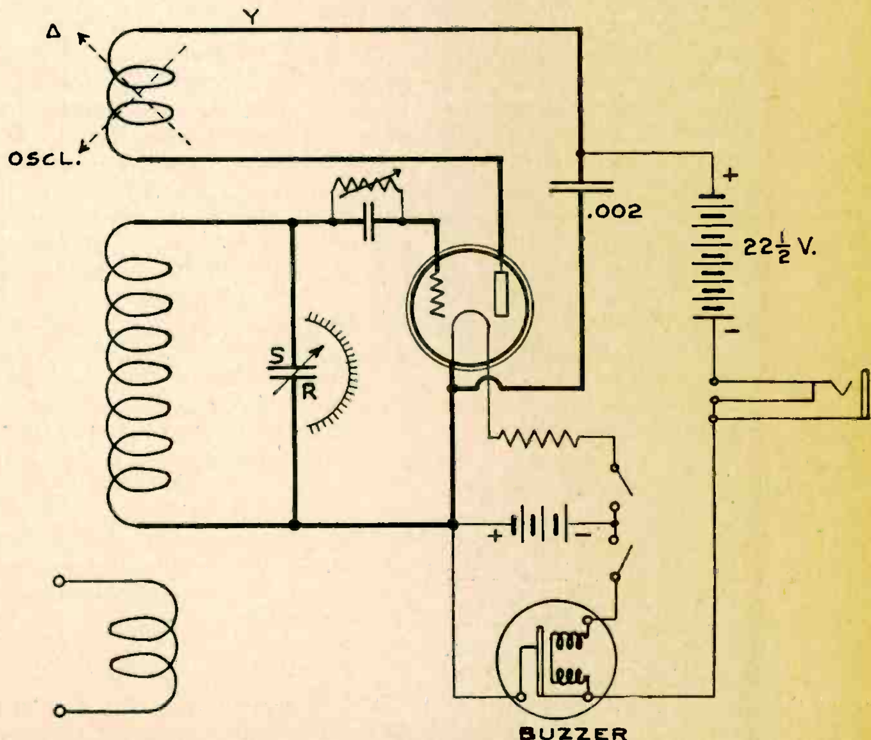

Fig. 2. Circuit Diagram for Wavemeter.

plates as a whole; vernier condensers having separate vernier plates are obviously unsuitable. It should have a very low minimum capacity and be at least of the straight line wavelength type.

The coupler or inductance coils may be of any standard three circuit type, the main requirements being stability of construction and low distributed capacity. The one illustrated was deemed particularly suitable on account of its small size. The Amperite serves to limit the tube current, and also automatically compensates for the voltage drop of the dry cell when the buzzer is used in modulating, which adjustment would have to be made by hand in the case of the customary rheostat. The buzzer's only requirements are that it must be capable of steady operation from the voltage of a single dry cell, and it must have an armature or third connection. The tube may be a WD or C,— 11 or 12.

All the parts may be securely fastened to the panel, as illustrated in Fig. 3,

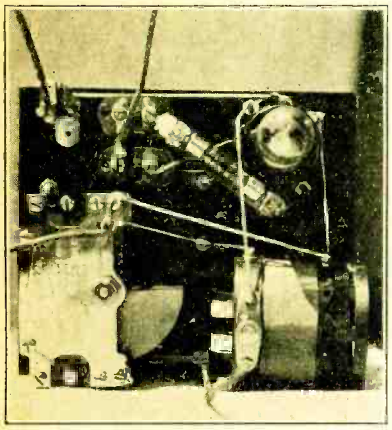

Fig. 3. Instrument Spacing and Wiring.

special attention being given to arrangement so that the wiring of the grid leads will be as short and direct as possible. The object is to make the completed instrument self-shielding, the grid and plate leads being completely surrounded by filament and other wiring. Thus the inside end of the coupler will become the grid end, and the lower connection of the regenerative coil will go to the tube plate; the knob and pointer end being connected to the bypass condenser and plate battery. It is desirable to remove any binding posts from the coupler, extending the wire itself direct from the coil for connection, thereby eliminating unnecessary length of connections.

The knob and pointer end of the regenerative coil, marked *Y* in the diagram, is connected through the bypass condenser to the metal end plates of the variable. In the diagram the leads from this bypass condenser are necessarily drawn out long, but in actual connection the condenser lugs are soldered direct to the bearing of the coupler shaft and to the metal end plate of the variable, no additional length of wiring being necessary nor desirable. The closed circuit phone jack is connected between the negative *B* battery terminal and the third post or armature connection of the buzzer. At this point it will be noted that the plate circuit of the tube is completed through the contact points of the buzzer. When the buzzer is not being used the contact points remain closed; when in operation the plate current is interrupted at the frequency of the buzzer, thus modulating the tube's output.

The foregoing points are quite important to the end of eliminating body capacity effect and obtaining accuracy; the remainder of wiring may be made in any manner deemed suitable. Leads to the batteries may be made of just sufficient length to permit the batteries lying flat on the cabinet bottom.

The next item of importance is the mounting of the 4 in. dial. The ordinary setscrew against the round condenser shaft is not sufficient. The set screw should be taken out and filed to a sharp tapered point, and a hole smaller than the taper drilled through the shaft. The dial should then be affixed so that the tapered point of the screw wedges firmly into the shaft hole, thus preventing any possibility of relative motion between dial and rotor plates of the condenser. Likewise, precaution should be taken to prevent relative motion between the regenerative pointer and the coil, but this is of smaller importance, since the coupling of this coil may be varied a few degrees either side of maximum without appreciably affecting the wavelength. One dial marker is suitably affixed for reading of the large dial, and one mounted to denote the position of maximum coupling of the regenerative coil, as in this position must the wavemeter be calibrated and used in measurements.

Operation

THE first test of operation of the completed instrument will naturally be as a receiver. Antenna and ground connection is made to the two binding posts and headphones plugged in. The regeneration pointer is moved away from the oscillation marker, and the tube switched on. If our construction and selection of instruments is proper, we will obtain a wavelength range from about 130 to 600 meters; adjustments of the regeneration will be quite stable, and selectivity quite sharp.

Adjustment of the variable grid leak can be made at this point; first for tone and volume, then the antenna and ground is removed and the regeneration advanced to the maximum point. If the tube howls under these conditions, slight readjustment of the leak will suffice. After final adjustment, the grid leak should not be again changed throughout the life of the tube.

When used as a receiver the usual precautions should be taken in tuning so as not to interfere with other receivers by causing the tube to oscillate. In this regard it is well to affix a third dial marker to the panel, denoting the non-regenerating limits of the regenerative pointer, which may be appropriately labeled "Receive." Here let it be pointed out that with the tube oscillating and the buzzer switched on, with antenna and ground connections the set constitutes a transmitter in every sense of the word, the penalties and consequences for the unlicensed use of which are specified by statute that are quite undiscriminating.

The next test must be made in conjunction with a regenerative receiver, and determines the quality of wiring and effective shielding of our instrument. In this and subsequent explanations, antenna and ground connections are not used, and the regenerative pointer is left on the oscillation marker, the point of maximum coupling.

The regenerative receiver is caused to oscillate, and our wavemeter with head

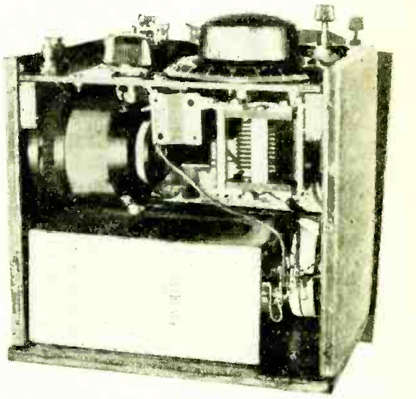

Fig. 4. Panel and Battery Arrangement.

phones plugged in is tuned to the same wavelength, so as to cause a heterodyne or audible beat note, more commonly called a squeal. The pitch of this note is observed by listening in on the regenerative receiver; then the phones are disconnected from the wavemeter. If our wiring is correct and we have observed the proper precautions in construction, removal of the phones from the wavemeter circuit will not change the pitch of this observed note, thus showing that the wavelength settings of the meter are the same under either condition. This should hold for all wavelength settings except the very short, where slight variation in tone may be had. In tuning the wavemeter by turning the 4 in. dial, no appreciable change in wavelength will be noticed by the approach of the hands except on the extreme lower settings, as above. During this test, the separation of the regenerative receiver and wavemeter can be anything up to 10 or 15 ft. If your finished instrument stands this test you may be assured that the wiring and spacing is correct. If not, recheck and remedy; try this test again, and if still unsuccessful the only alternative will be to artificially shield the back

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Plate and Grid Modulation Systems

An Analysis and Comparison of the Heising and the Improved Grid System, Favoring the Latter.

By L. D. Grignon and F. C. Jones

THE basis of any scheme of modulation used in radio telephony is a constant carrier frequency upon which is impressed a variable modulating frequency which varies the amplitude of the carrier wave. The most popular and practical scheme has been the Heising system which causes a decrease of antenna current when speech is impressed on the microphone. Another is the improved form of grid modulation whereby the antenna current can be either increased or decreased, preferably the former.

In comparing the action of these two methods first consideration should be given to their effect on the receiver. The rectified current from most detectors is proportional to the square of the impressed voltage, so that for most effective action the antenna current at the transmitter must vary so that the difference between the square of its amplitude when it is modulated and when it is not modulated varies as the sine of an angle which varies uniformly. According to Morecroft this result is secured when the maximum amplitude is equal to $\sqrt{2}$ times the amplitude of the antenna current with the microphone idle and when the minimum amplitude is zero.

Whether this effect is actually given by either the Heising or the improved grid system is a matter of question to the authors. However, we do find that the antenna current or received energy is not *directly* proportional to the voltage variation caused by the speech or microphone vibrations, and for the basis of discussion we assume that this theoretical requiment is met by both methods.

With Heising modulation as shown in Fig. 1 it is theoretically assumed that the reactance of the audio frequency choke coil is sufficient to prevent any audio frequency variation of current through it. Thus there will be no change in total current required by the load, which consists of both the oscillator and the modulator tubes. With the microphone inserted as in Fig. 1 any change that it causes in the grid potential of the modulator tube causes a corresponding change in the plate current. But as the total current to the two tubes is constant any increase in the modulator plate current must result in a corresponding decrease in the oscillator plate current. It is consequently apparent that the power output of the oscillator varies inversely as the square of the modulator plate current, provided that the oscillator is working with constant plate-filament resistance.

In practice, however, no audio frequency choke coil will function to give a constant current. This is due to incomplete choking of the audio frequency changes in the coil, caused by current changes of the modulator. This variation causes a variation of voltage drop over the coil, which varies the plate voltage of the tube, and so the power output of the oscillator. When the modulator draws more current, the total current becomes slightly greater and the voltage drop increases, decreasing the power. If the plate-filament resistance of the oscillator remained constant, the power output would vary directly as the voltage. However, this resistance changes as the voltage changes and in the opposite direction. When the voltage drops the change in current is not directly proportional to the voltage change but decreases a greater amount since the resistance has also changed. No matter which way the voltage varies the current change is greater with the variable resistance than with assumed constant resistance.

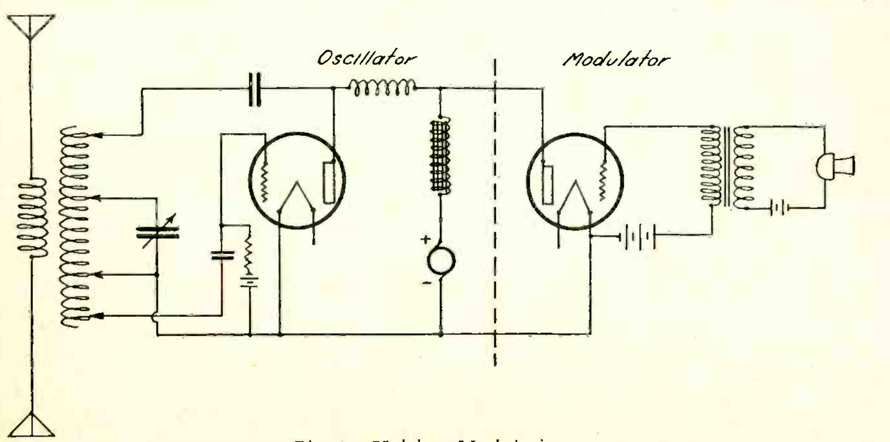

Fig. 1. Heising Modulation.

Power changes are directly proportional to the square of the current and the first power of the resistance. Assuming again constant resistance, a change in current of one-half its value would lower the power to ¼ of the first value.

Now let us consider the variable resistance. The current is decreased say instead of to ½ its first value, to ⅜ by virtue of the action just explained. The power would then be decreased to 9/64 of the original value, which value is less than before. An increase in the power would be caused by the increased resistance, due to lower voltage, and this increase of resistance we will assume to be twice its first value. Then the new value of power caused by both changes would be 18/64 of the original, which value is a smaller change than would have occurred with the constant resistance. The first change had the magnitude of ¾ of the original and the new value of change amounted to only 46/64, which is less than ¾. These values are only examples and have no actual basis but are used to show the trend of thought.

By proper experiments mathematical laws could be derived for these changes and great benefit obtained since the power modulation would be definitely known. In the first part of this article an attempt was made to show that distortionless reception could be obtained, other defects eliminated, by modulating the power in the same ratio, inversely, as the detector tube detects.

The other or next important scheme of modulation for use on short wavelengths, such as in the radiocast range, is the improved type of grid modulation. This system was described somewhat in November, 1924 issue of RADIO. In this scheme a small tube is used to vary part of the grid-leak current of the oscillator tube. Since it controls the grid current, the modulator tube can be of small rating and a great saving of tubes results. In Heising modulation the same number and size of tubes are needed for modulators as there are oscillators, while in this system one small tube will carry several large ones.

The principle involved is to control

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the grid and hence the plate power and antenna inputs. Fig. 2 gives the wiring diagram and as can be seen, the modulator has a fairly high resistance in shunt with it so that the oscillator is "kept alive" by the shunt resistance at all times. When the microphone is spoken into, the grid of the modulator becomes less negative and so the plate filament resistance of the tube is lowered. When this is lowered the total effective grid-leak resistance in the oscillator circuit is lowered and a greater grid current flows, allowing a greater plate current to flow which, within certain limits, means a greater output from the oscillator and an increase of antenna current.

What actually happens when the total grid leak resistance is decreased is that the effective grid potential of the oscillator becomes less negative and so the output impedance of the tube is lowered. This causes an increase of plate current, assuming practically constant plate voltage. This increase of plate current means an increase of power input and output, if the efficiency of the tube remains about the same. As can be seen from the above discussion, the antenna current does not vary directly as the speech but in a more complex manner due to the grid leak action.

In the ordinary grid modulation schemes using a vacuum tube modulator, the tube has to carry the entire grid current of the oscillator and so has to operate up near the top portion of its characteristic curve. If then the grid of the modulator were made more positive it would operate merely along the saturated part of the curve and so great distortion would occur and very little modulation would be obtainable. This means that the modulation must work the other way in order to give any kind of decent modulation and consequently the impedance of this tube is increased when speaking and the final result is that the antenna current is decreased when talking instead of increasing. The main trouble with this system is the distortion, since there are practically no tubes that will work with zero or a positive potential on the grid and give constant amplification, which is all that this tube is really used for.

In the improved type of grid modulation, a negative *C* battery is used to keep the grid of the modulator negative at all times and as this tube does not carry the total grid current of the oscillator, it can be operated along the lower straight portion of its characteristic curve giving very nearly constant amplification over the range of load used. Another advantage, as the authors see it, is that the antenna current is increased when talking into the microphone. This appears more reasonable, as in ordinary telegraphy a stronger received signal results when the antenna current at the transmitter is increased. Then for a modulated signal, the same reasoning should apply; that is, that for speech, the antenna current should increase in order to put a greater signal into the receiver.

In Heising modulation the antenna current decreases when modulating and so for a loud note of music, the antenna current is lowest. However, in the improved grid system, the antenna current is a maximum for a loud note.

The authors have made exhaustive tests of these two methods in the laboratory at the University of California, employing standard equipment for the Heising system and devising special equipment for the grid system. The circuit employed in the latter was that shown in Fig. 2, using the following values:

Value of Shunt Resistance R.	Oscillators		Modulators
	Number Used	Type	Type
10,000 to 30,000 ohms	1 to 4	C 302 UV 202	C 301A, VT 1, VT 2, or any amplifying tube
10,000 to 20,000 ohms	1 to 2	C 303 UV 203	C 301A, VT 2, C 302 and UV 202
10,000 to 15,000 ohms	1	C 304 UV 204	C 302, VT 2 and UV 202
5,000 to 15,000 ohms	2 or more	UV 204	C 303 or UV 203

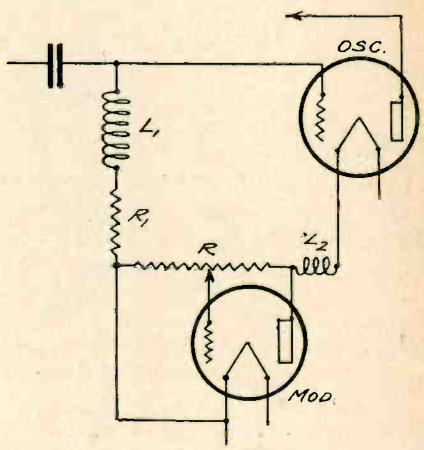

Fig. 3. Refinements in Grid Modulation.

These values are better than those given in the author's article in November, 1924 Radio. It was found that the value of the shunt resistance determines the per cent of modulation. Modulation was further improved by the refinement shown in Fig. 3 where the series resistance in the modulator plate circuit is from 1000 to 5000 ohms, this resistance keeping the resultant grid leak resistance from becoming too low when modulating a large per centage. Another refinement is to make R_1 about 2500 ohms. The radio frequency choke coils L_1 and L_2 were made up with 200 turns of No. 28 wire on a 3-in. tube. These chokes were for 180 meters.

Our conclusions were that the grid system gave no noticeable distortion and with the same oscillator adjustments gave an increase in power. We believe that the grid system investigated is at least equal to the Heising, and would possibly show up superior if given a more accurate comparison. This grid system is certainly cheaper in first and in operating cost than the Heising since it employs smaller tubes for the same percentage of modulation. It is now being used in several amateur stations besides one medium sized radiocast station, and is giving satisfactory results.

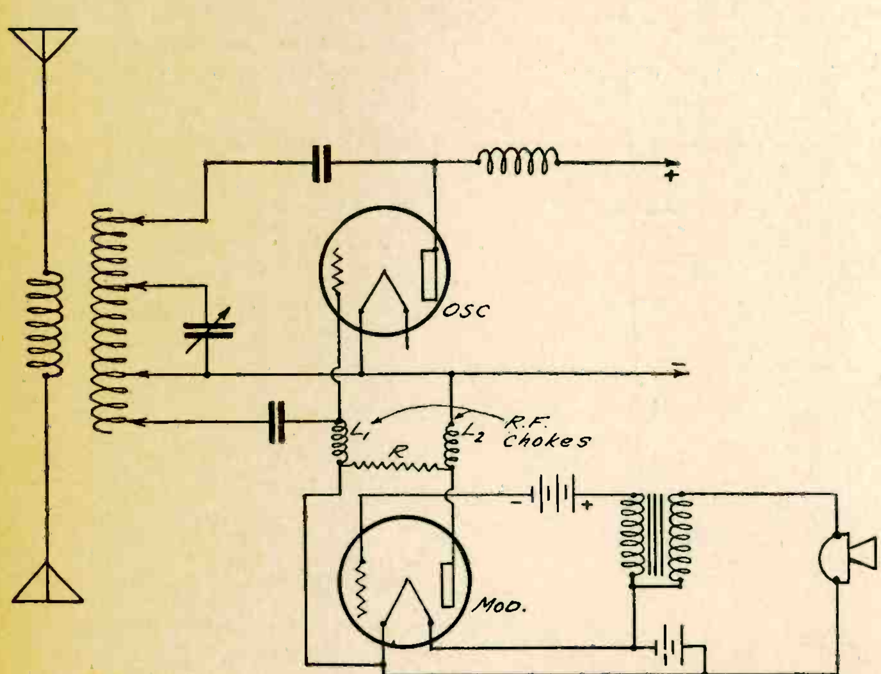

Fig. 2. Improved Grid Modulation.

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A Quartz Crystal Oscillator

By D. B. McGown

THE construction of a quartz crystal oscillator for checking and standardizing wavelengths is a relatively simple matter if you have a calibrated quartz crystal and a suitable means for permitting it to excite a vacuum tube having a variable tuned plate circuit. As shown in Fig. 1, the quartz crystal is held between electrodes, one terminal being connected directly to the grid of the tube, and the other to the filament. The plate circuit contains the air condenser C_1 is shunted by the inductance L through which the direct current plate supply is fed as it is measured by the milliammeter *MA*. The plate current also passes through the head telephones. A radio frequency bypass is provided in the form of condenser C_2 which thus completes the circuit.

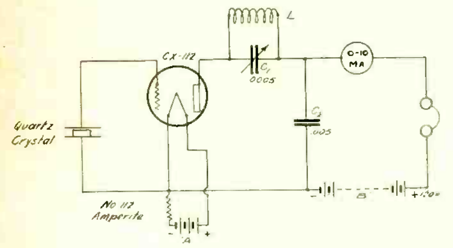


Fig. 1. Circuit Diagram of Crystal Oscillator.

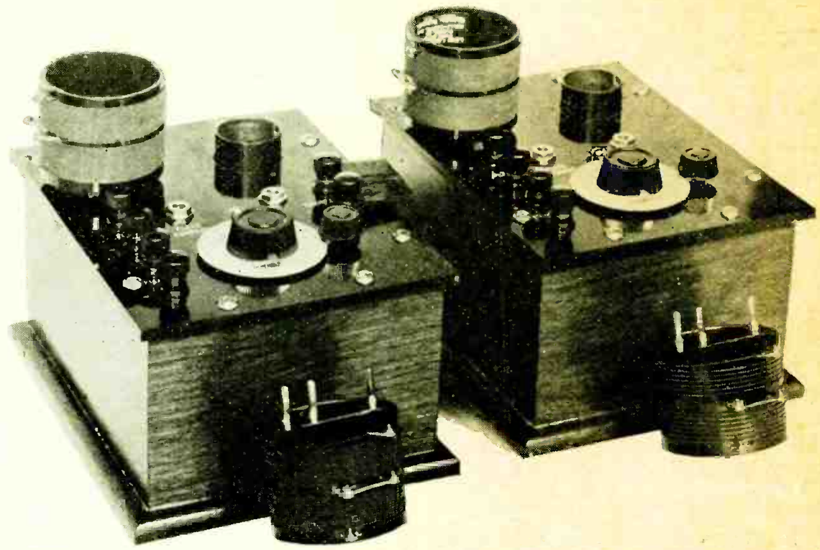


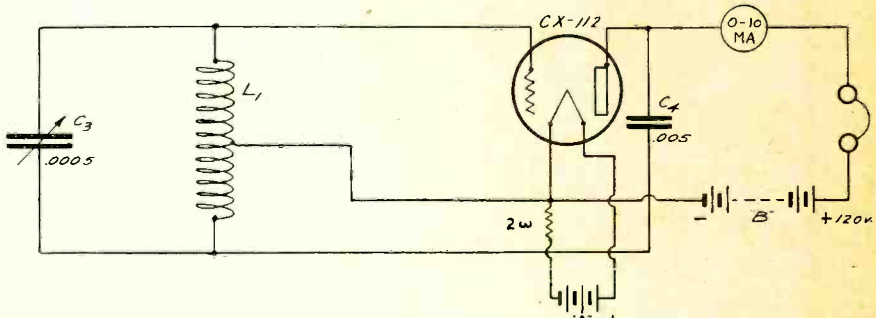
Fig. 3. Crystal Controlled and Tube Oscillator.

The quartz crystal is ground to certain dimensions in millimeters, from which the resulting wavelengths at which the crystal will oscillate can be determined by multiplying by 104.6. Therefore, with the dimensions of the crystal known, the wavelength required in the circuit C_1-L can be easily determined, and capacities and inductances of proper size selected so as to cover the wavelength range. In operation, the air-condenser is first set at zero, and then gradually increased until a sudden drop in plate current is noted in the milliammeter, which indicates that approximate resonance is reached. Gradually increase the condenser capacity until the downward deflection of the milliammeter is greatest. If at this point the plate current suddenly rises the tube has stopped oscillating and the resonance point has been passed, so that the process should be repeated, this time with more care in adjustment. A few trials will result in the proper adjustments being secured.

The large number of harmonics present when the tube is oscillating permits calibration over a wide range. If the tube is oscillating, for example, on 600 meters, we will have points available on the second harmonic, or 300 meters, the third harmonic, or 200 meters, the fourth or 150 meters, and so on, down on very short wavelengths. It must be kept in mind that all these harmonics are of much lower amplitude than the fundamental wave so that that the energy decreases as the wavelength decreases, thus making the harmonics harder and harder to find.

As the radio frequency oscillation set up and controlled by the quartz-crystal operated tube is set at one definite frequency the harmonics present are also at definite frequencies, and as it is not possible to check a wavemeter against these harmonics directly, we can use another "beating" oscillator so operated and controlled that it will beat with the crystal controlled circuit, and thus obtain a "beat note" within the audible range. The "beating" oscillator, which may be of any reasonable power, is adjusted so its fundamental will be the same as the frequency of any of the harmonics of the crystal oscillator and can be coupled directly to the wavemeter, or receiving set, which is to be calibrated.

In Fig. 2 we have a Hartley circuit where L_1 is the inductance, shunted by the variable air-condenser C_3 with a high frequency by-pass condenser C_4 in series between the plate and the inductance with the *B* battery feed through the milliammeter *MA*, and the head telephones. By selecting suitable values of inductance and capacity for L_1 and C_3 we may cover any wavelength range desired. By listening with the head telephones to the beating oscillator, the harmonics may be found, and "crossed" by finding the beat note, and locating the exact resonance by the position of "zero beat." This can be checked by listening in with the telephones in the crystal oscillator, and can be set by ear to within a few hundred cycles of an absolute value. If the wavemeter to be



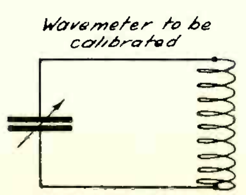


Fig. 2. Hartley Circuit Used for "Beating" Oscillator.

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calibrated is loosely coupled to the inductance L_1, we may tune the wavemeter to resonance, and at this point, we will notice a slight increase in the reading of the plate circuit milliammeter *MA*, which must increase in order to allow more power to pass to the plate to make up for that removed from the tuned circuit, due to the coupling at resonance of the wavemeter to be calibrated. If the coupling is set exactly right, we will find that a noticeable increase in the milliammeter reading is obtained at the resonance point, and that the two circuits are as close to resonance as can be desired. This same process is repeated to cover the whole range of the wavemeter to be calibrated.

This apparatus may easily be made up with commercial parts. Fig. 3 shows the set-up of a complete pair of oscillators, one being the crystal controlled one, and the other the tube oscillator. A pair of binding posts are provided on the crystal oscillator so that the quartz crystal can be connected in the circuit at will, and so that any desired crystal can be used. Owing to the simplicity of the circuits no exact sizes or dimensions are given for the method of mounting is entirely optional with the builder. A good tube to use in either oscillator is the new CX or UX-112, which has a satisfactory power output. A handy plug-mounted inductance coil designed for superheterodyne oscillator work and which is made up in various sizes, so as to be interchangeable was used in the oscillator illustrated. These coils also are supplied as bare forms, so that any desired size of inductance can be wound upon them, without trouble. Geared vernier type air-condensers were used, to permit the variation needed for condensers C_1 and C_3, these condensers being of .0005 mfd., maximum capacity. The filament current is controlled by an "Amperite," of appropriate capacity to suit the tubes, in order to simplify the panel arrangement and eliminate adjustments. Jacks were provided to allow the milliammeter and head telephones to be plugged into the circuit, and binding posts are arranged on the top to provide for connection to the plate and filament batteries. The two oscillators are mounted in mahogany cabinets with removable covers, and as they are light in weight, they can easily be carried from place to place.

HANDY HINTS

Rubber for placing under storage batteries can be obtained from old automobile inner tubes, which will prove to be a good acid-proof shield.

Radio panels shielded with tinfoil often will be found to be as effective as when shielded with heavier sheet metal, and generally the tinfoil is much easier to manipulate.

Insulation on an antenna lead-in should be at least as good as that on the antenna itself. The use of good quality lead-in bushings is but little more expensive than cheap ones, and is much better practice.

In soldering short wire leads, where there is danger of heating up and melting the other soldered end, if the end to be kept cool is stuck into a freshly cut potato, the latter will absorb the heat, and keep the wire cool.

In testing a telephone cord for an open circuit, a common pin may be used to stick into first one side and then the other, thus cutting out, and usually revealing the defective phone, or cord terminal.

Dirt on the contacts of jacks placed across the primaries of transformers in an amplifier may cause troublesome and hard-to-eliminate noises.

A SIMPLE MAST WITH LOW CENTER OF GRAVITY

By CARLOS S. MUNDT

Most folks would hardly try to balance a pencil on its point, yet a violation of the physical principle underlying such a simple thing as this is often seen in many of the masts erected by radio enthusiasts.

A good mast should meet several requirements. First and foremost it should be as stable as possible. Secondly, it should be easily assembled and erected. Thirdly, it should be inexpensive.

To meet the first requirement we must use care in design so as to throw the center of gravity of the affair as low as possible. By doing this properly we will find that we are able to meet the other requirements incidentally. So why not erect the mast described below, which need not be put up with prayers for its safety?

Materials: Two 1x2-inch clear pine (surfaced), length 12 to 18 feet; one 2x2 inch clear pine (surfaced), length half above.

Two carriage bolts 2½ inches long.
One quart outside white paint.
Miscellaneous small 2x4 inch blocks.
Necessary guys, nails and eyes.
Cost: Lumber 60c to $1.00; total $1.50 to $2.50.

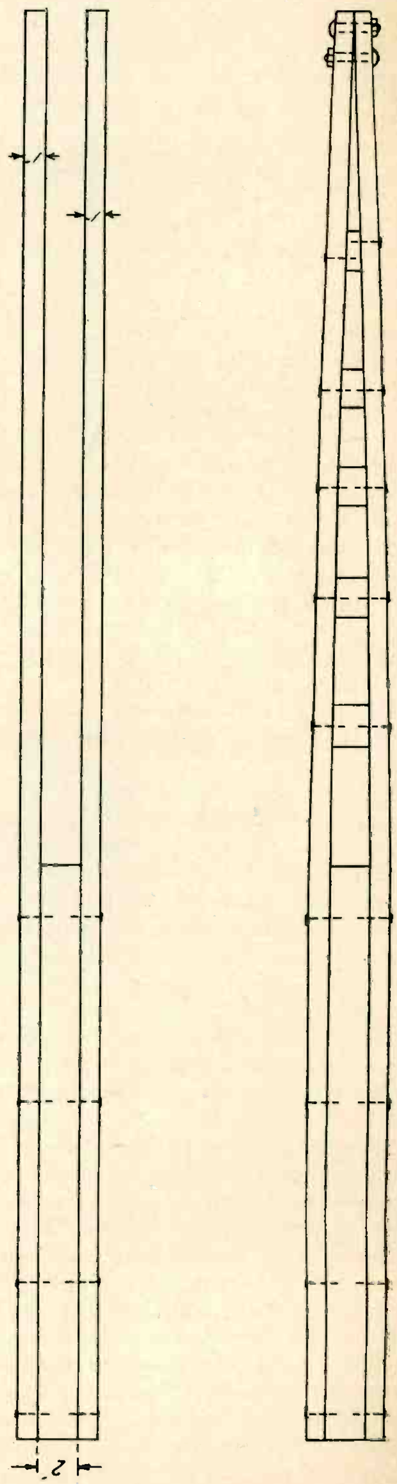
Set up two boxes to work on, as it will facilitate handling the lumber. Lay out the the two 1x2 pieces side by side with smaller faces ups. At one end slide the 2x2 in between them. Drive nails through the 1x2 wide faces, thus securing them to the 2x2 (see upper figure in sketch).

At the free end insert the two carriage bolts, the first about 2½ inches from the end and the second about 5 inches from the end.

From your miscellaneous 2x4 blocks cut pieces which are fitted into place every foot along the open space which remains between the 1x2's. Use slender nails to avoid splitting (see lower figure in sketch).

Guying and finishing is left to the individual but two coats of outside white paint are best and the mast should be mounted so that prevailing winds will tend to blow through the spaces between the filling in blocks.

Having a low center of gravity this mast will be unusually stable. It is easily assembled and erected and certainly inexpensive.



Sketch Showing Constructional Details of Mast.

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How to Wind a Toroidal Coil

By Geo. B. Hostetter

THE new toroidal or balloon coils, which minimize the necessity for any stabilizing device in a radio frequency circuit, may be easily wound in the home-work shop. The directions are simple.

First procure a cardboard tube 1¼ in. in diameter and 9 or 10 in. long (*G* in Fig. 1). On this wind a layer of ordinary twine *B* fastening the ends with a tiny piece of adhesive tape *A*. Over this wrap a thickness of writing paper. From a roll of half inch adhesive tape cut off a piece about 21 in. long; split both ends of this for a distance of 7 or 8 in.; lay the tape lengthwise on the tube, sticky side out, pushing the ends into the ends of the tube out of the way. Now wind on 225 turns of No. 24 DCC or SCC wire (D_1 D_2) securing the ends by punching a hole in the tape.

Lay one of the ¼ in. pieces of tape back over the coil and the opposite ¼ in. on the other side so as to form a ½ in. strip the full length of the secondary coil.

About ¼ in. from the end of this winding start the primary winding 4 turns of the same kind of wire, in the same direction. Do not break the wire but run it along the tape for 2½ in. Then wind 4 more turns, run along the tape again for another 2½ in. and wind a third coil of 4 turns. These are shown as E_1 E_2 and E_3. This makes 12 turns in all for the primary. Each coil of 4 turns could be held in place temporarily by small pieces of adhesive tape.

Now take the two remaining pieces of ¼ in. tape and stick them tightly in place over the primary as at *F*.

Pull the tape *A* loose and unwind the string, pulling it out the end so as to allow the coil to slip off the tube easily, when the layer of writing paper may be removed.

Cut a piece of light weight cardboard 1 in. wide and bend it into a ring whose outside diameter is exactly equal to the length of the secondary coil measured on the tape.

Cut two circles of heavy cardboard 2½ in. in diameter. Glue these to the ring, forming the spool as shown in Fig. 1.

With a piece of adhesive tape securely fasten one end of the coil to this spool, bending the other end around the spool until it meets. Fasten in place with tape. The wires may be straightened after the coil is secured.

You will now have a coil as shown in Fig. 2.

The leads may be brought out through holes punched in the disks as shown.

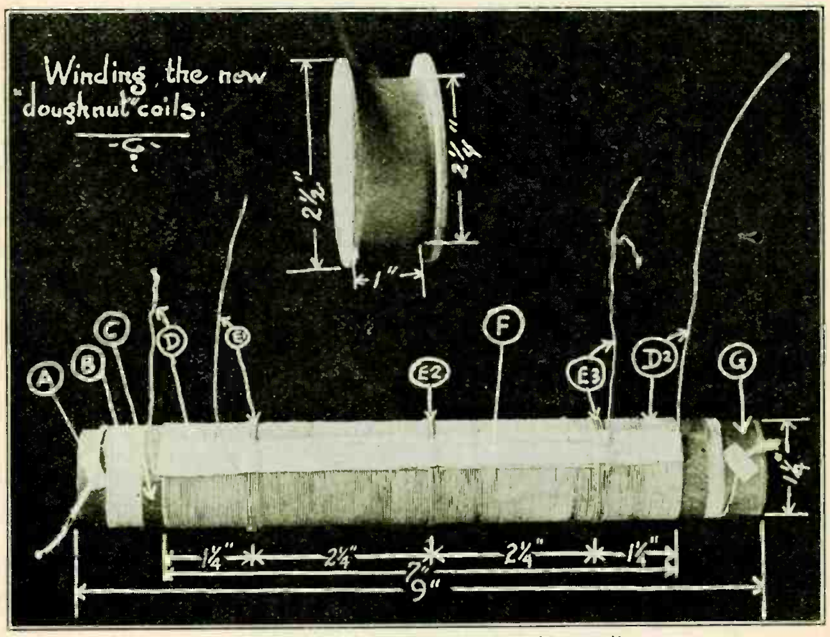

Fig. 1. Winding Details for Toroidal Coil.

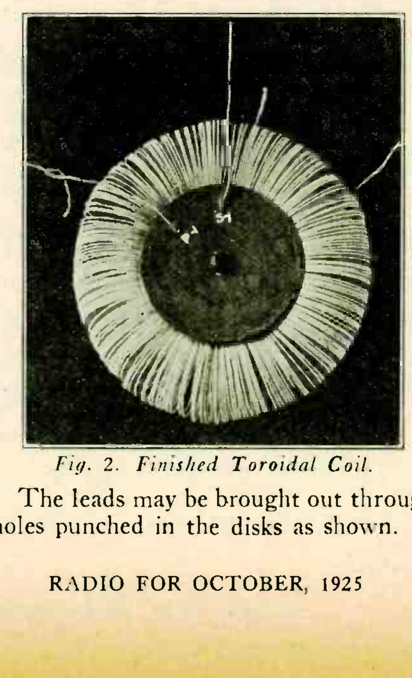

Fig. 2. Finished Toroidal Coil.

HANDY HINTS

A slight excess voltage on the filaments of vacuum tubes will often reduce their life by half or more.

Lead battery wooden cases will last longer if they are kept well covered with asphalt paint.

In an emergency, a small automobile headlight bulb will serve as a test for the voltage of a battery. A 12-volt lamp can be used to test a tapped 22-volt battery, or an 18-24-volt 2 c. p. lamp will serve nicely to test the whole 22-volt unit. Two or three lamps can be connected in series, if necessary to get the right voltage.

Don't connect filament circuits up with tinsel cord and expect the outfit to work satisfactorily, as the resistance of this is often high enough to reduce the voltage below normal, even if the filament rheostat is cut out entirely.

A single strand from a tinsel cord, attached to a suitable contact, will serve nicely as a "catwhisker" for a crystal detector.

When making up a set, the leads can be held in place by cementing them with a "dope" made up by dissolving celluloid in acetone.

For soldering small joints, where a torch is not available, a common candle will often give enough heat to do the job. Be careful not to cover the work with soot, while heating it, however.

If you are laying out a panel, and don't want to punch through the drilling template, a piece of new carbon paper will usually give enough of a mark on bakelite to locate the holes to drill.

Never add acid to a storage battery, unless you are an expert, and know just exactly what you are doing. Most of such experiments result in a ruined battery.

Worn out dry cells are said to make a good ground connection, if a sufficient number are laid over and under a copper sheet buried 6 to 8 ft. in moist earth.

If your gasoline torch leaks, a little yellow soap can be rubbed on the gaskets and joints so as to seal them.

A good grade of writing paper covered with a thin uniform coat of shellac on each side makes a very good substitute for "empire paper" for coil insulation.

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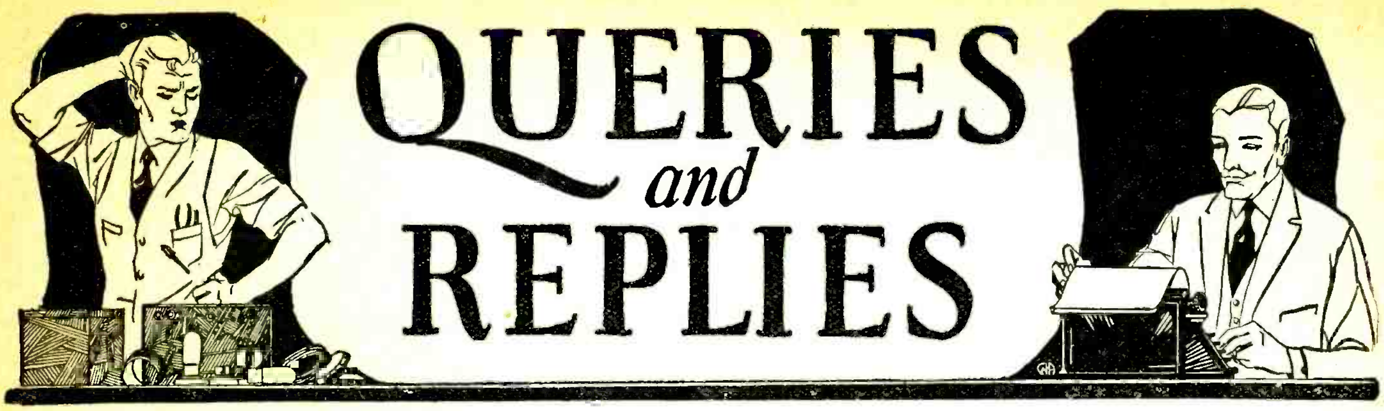

Questions submitted for answer in this department should be typewritten or in ink, written on one side of the paper. All answers of general interest will be published. Readers are invited to use this service without charge, except that 25c per question should be forwarded when personal answer by mail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

Please publish a circuit diagram for a 3-tube Roberts receiver. What kind of tubes could I use in the circuit?—D. B., San Leandro, Calif.

The circuit is shown in Fig. 1. Any of the standard tubes will function in the circuit, although it would be a good idea to use a power tube such as the new UX-112, CX-112 in the audio stage.

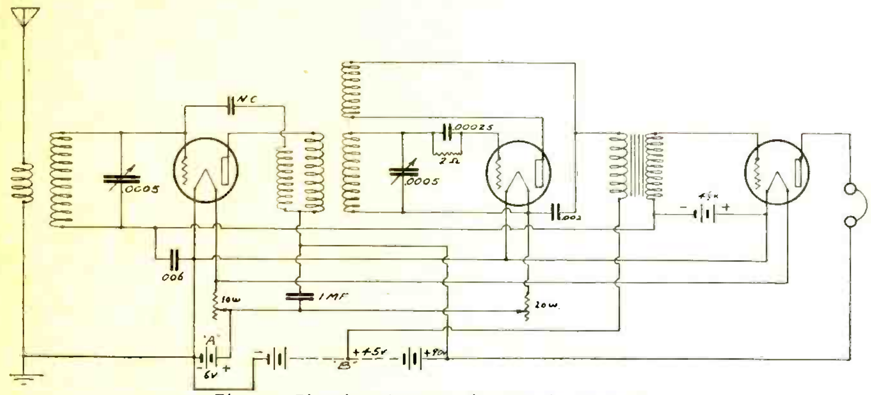

Fig. 1. Circuit Diagram for 3-tube Roberts.

What conditions in a superheterodyne such as that described in January, 1925 RADIO would cause music to become distorted, especially the bass notes, which make a sound like the beating of drums? This effect is noticed on all stations. Could static or other summer ether conditions cause this? L. G. G., Bakersfield, Calif.

Tendency of the intermediate stages to regenerate and cause oscillation would impair the quality of music or speech and might distort the bass notes. A capacity bridged across the secondary of one of the audio frequency transformers will tune the transformer to some audio frequency well within the voice range and will cause the music to become hollow sounding. If coupling is present in the intermediate stages, a brass or copper partition between each transformer will assist in eliminating this difficulty. Connect each shield to the negative *A* battery and the battery terminal to a good low resistance ground.

Kindly publish a circuit showing how I may use three Thorola doughnut coils in a two-stage radio frequency amplifier, with detector and two stages of audio frequency amplification.—H. L. P., Denmark, S. C.

The circuit you wish is shown in Fig. 2. The doughnut coils consist of two windings, and are shown in the form of double spirals on the diagram, the terminals being plainly marked with the proper designations.

Please describe the coils used in the filter circuit.—D. H., La Luz, N. M.

If you will tell us what type of filter you wish to build, we will be glad to furnish you with the information. There are several types of filters, such as the induction filter, for the antenna circuit, the filter system for the superheterodyne amplifier, and the filters used in rectifier circuits for smoothing out the rectified current for use in receiving sets for *B* potential.

Would like to build the low-loss receiver described by 8ALK in July RADIO. Would a 23 plate condenser work in this circuit, and is the primary movable or stationary? What would be the proper number of turns for each coil, with the 23-plate condenser?—C. E. R., San Francisco, Calif.

The condenser used in this circuit is of 7 plate size, and has a capacity of about .00012 mfds. It is not advisable to use a condenser having a capacity as high as .0005 mfd., which is the size you have, and it would be better to cut down the capacity by removing rotor plates until only 3 are left. With a large capacity condenser in the circuit, the settings for the shorter waves are too critical for accurate tuning. The primary coil is not variable with respect to the secondary.

In the August issue of RADIO is a description of a three-tube receiver by Volney G. Mathison. Where is the antenna coil tapped? Where does the .0001 mfd. condenser listed in the parts list go? Can I use a UV-201-A tube in the radio frequency stage? Can a UV-200 tube be used for the detector? Can an aperiodic primary be used in the antenna circuit, and how many turns should it have?—E. H. G., Milwaukee, Wis.

The antenna coil should be tapped at the center, or the 28th turn. The .0001 mfd. condenser is used in series with the antenna for the waves around 200 meters, where the antenna proves to be too long for tun-

(*Continued on Page 40*)

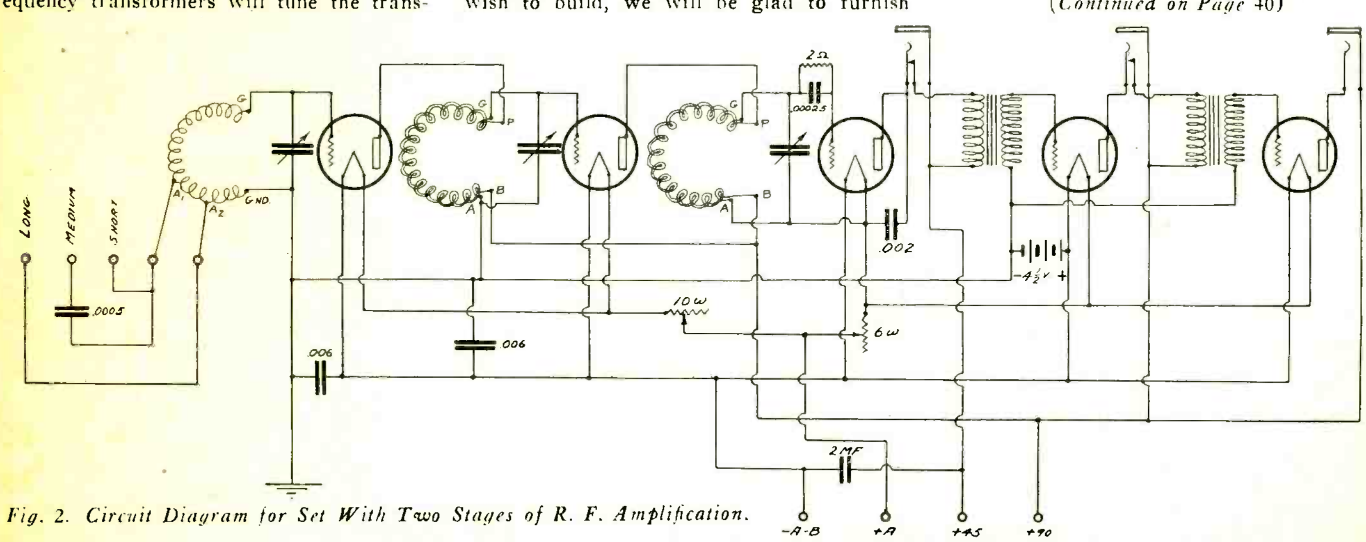

Fig. 2. Circuit Diagram for Set With Two Stages of R. F. Amplification.

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for The RADIO NOTE BOOK

Useful Facts and Theory

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VACUUM TUBE AMPLIFIER CONSTANTS

Aside from the operating characteristics—filament and plate voltage and current—the important constants of an amplifier tube are the plate impedance, mutual conductance and voltage amplification factor. These three constants are inter-related so that the third may be calculated when the other two are known.

The plate impedance is the opposition offered to the flow of an alternating current in the output or plate circuit of the tube. Its value determines the maximum power output which can be obtained from a tube. The lower its value the greater is the power output obtainable within certain limits. It varies with the voltages on the filament, grid and plate. Under normal operating conditions its value in ohms is about one-half the value of the plate resistance to direct current. It may be easily and accurately figured after measuring two values of plate voltage and plate current so chosen that there is a difference of 1 milliampere between the two plate currents. In this case the numerical value of the plate impedance will be 1000 times the difference between the two voltages.

Whereas the plate impedance is a measure of the *power* output, the amplification constant expresses the ability of the tube to amplify *voltages*. Thus if 40 volts are necessary to give a plate current of 1.2 milliamperes in a tube at zero grid voltage and 48.5 volts are necessary to give 1.2 milliamperes in the same tube at —1 volt on the grid, the difference between 48.5 and 40, or 8.5, is the voltage amplification constant of that tube. Its value is usually symbolized by μ, the Greek letter mu. So that a high mu tube is one having a high amplification constant. This is largely dependent upon the mesh and diameter of the grid and the spacing between grid and plate. Tubes are made with an amplification constant of 40, but the ordinary tube has a constant of 6 or 7. If it is too high very little power can be delivered by the tube unless the load resistance is also high.

The amplification constant of a tube determines the maximum voltage amplification per stage which can be obtained with a resistance coupled amplifier. In the case of impedance or transformer coupled amplifiers the voltage amplification may be much higher, depending upon the coil ratios and efficiencies.

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VACUUM TUBE CHARACTERISTICS

Model	UV-199, UX-199 C-299, CX-299	UV-200, UX-200, C-300, CX-300	UV-201A, UX-201A, C-301A, CX-301A	WD-11, WD-12, WX-12, C-11, C-12, CX-12	UX-112, CX-112	UX-120, CX-220
Use	Detector Amplifier	Detector Only	Detector Amplifier	Detector Amplifier	Detector Amplifier	Amplifier Last Audio Stage
"A" Volts (Supply)	4.5	6.0	6.0	1.5	6	4.5
At Filament	3.	5.0	5.0	1.1	5	3.
"A" Amperes	.06	1.0	.25	.25	0.5	.125
"B" Volts (Detector)	45.	16-22½	45	22½	22½-45	....
(Amplifier)	90	....	90-135	90	90-135	135
"C" Volts	4.5	....	4.5-9	4.5	6 7.5 9. 10.5	22.5
Plate Current Milli-amperes	3.5	....	3-4	2.8	2.4 2.5 5.8 7.9	6.5
Output Resistance in Ohms	15,000	....	12,000-11,000	14,000	8800 8400 5500 4800	6,600
Mutual Conductance Micro-Mhos	415	....	675 725	400	890 940 1435 1670	500
Voltage Amplification Factor	6.25	....	8	5.6	7.9-8.	3.3

The UV-, C-, and W-D- series have old style bases which fit either old style or new style sockets. The UX-199, UX-120, C-299 and CX-220 have the new standard small base; the others have the new large standard base.

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Useful Facts and Theory

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R-330
VACUUM TUBE CHARACTERISTICS
(Continued)

The UX-210 or CX-310 is an amplifier and oscillator, listing at $9.00, using the large standard base, and having a filament terminal voltage of from 6 to 7.5 volts with a corresponding filament current of from 1.1 to 1.25 amperes. Other characteristics are as follows for 7.5 volts *"A"* battery:

"B" Volts	"C" Volts	Plate Current	Output Resistance	Mutual Conductance	Voltage Amplifier
425	35	22	5000	1550	7.75
350	27	18	5100	1500	7.65
250	18	12	5600	1330	7.5
and for 6 volts *"A"* battery.					
157.5	10.5	6	7400	1020	7.5
135.	9.	4.5	8000	940	7.5
112.5	7.5	3.	9700	775	7.5
90.	4.5	3.	9700	775	7.5

The CX-374 or UX-874 is a voltage regulator tube, listed at $5.50, and using the large standard base. It is rated at 90 volts, d.c., requires a starting voltage of 125 d.c. and a maximum d.c. current of 50 milliamperes. The C-376 or UV-876 is a ballast tube fitting the standard mogul type of screw base. It has a current rating of 1.7 amperes over a voltage range from 40 to 60 volts. The C-377 or UV-877 is a protective tube using a double contact bayonet automobile type socket. It has a voltage drop of 2.5 across half the filament at 20 milliamperes d.c. and of 45 at 90 milliamperes d.c. The corresponding drops across the entire filament are 5 and 90 volts. These tubes are for the special purpose of regulating line voltage, plate voltage and for the protection of the plate circuit in radio receivers operated by rectified alternating current.

The CX-316B or UX-216B is a single wave rectifier tube for use in *B* battery eliminators and similar devices. It uses a large standard base and will deliver a maximum load current of 65 milliamperes for a maximum input voltage of 550 and an output of 7.5 volts. Its filament current consumption is 1.25 amperes.

The CX-313 or UX-213 is a full wave rectifier using a standard base and delivering a maximum of 65 amperes for a maximum input voltage of 220 and an output of 5 volts. The filament current is 2 amperes.

10

R-130
VACUUM TUBE AMPLIFIER CONSTANTS
(Continued)

In judging the relative merits of two tubes their amplification factors mean nothing unless you also know their plate impedances. But by dividing the former by the latter you get what is known as the mutual conductance, which is a fair basis for comparison as to the effectiveness of a tube as an amplifier. While this constant is thus usually determined numerically as the quotient of the amplification constant and the plate impedance, the operation gives no indication of the derivation of the term "mutual conductance."

So it is better defined as the change in plate current divided by the change in grid voltage producing it:

$$\frac{C}{E} = \frac{1}{R}, \frac{1}{R}$$

being the conductance corresponding to the resistance *R*. Thus the greater the change in plate current for any change in grid voltage the higher the mutual conductance and the better the tube acts as an amplifier.

For instance it may be noted that for the same plate current and voltage that an 'A tube has nearly twice the mutual conductance of a '99 or an '11 or '12 and that in the case of the 'X-112 it is nearly three times as great. By using higher plate voltage the latter is given over four times the mutual conductance possible with the former.

Another constant which is receiving increased attention in connection with radio frequency amplification is the internal capacity of the tube, the capacity between the grid and the plate. This capacity short-circuits or by-passes much of the radio frequency current, and energy from the plate is fed to the grid causing the tube to oscillate at higher frequencies. This internal capacity may be neutralized by a proper condenser in the circuit so as to balance it out. However, when obtainable, a low capacity tube is best for use in a radio frequency amplifier.

As yet, the capacity values of tubes are not published by the manufacturers. It naturally varies with the frequency in any one tube.

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Letters to the Editor

THE ARC COMES BACK

Sir:—In your April, 1925 issue, on Page 11 et seq., you published an article by S. R. Winters which—doubtless unconsciously on your part—contained certain derogatory statements with respect to the arc.

Statements have often been made that a tube transmitter has a greater communicating range than an arc transmitter for a given rating, giving the impression that one is more efficient than the other. In almost all instances no mention is made of the conditions under which the transmitters were operating. These statements are usually made by individuals who due to their lack of knowledge of the radio art, are not qualified to make such comparisons.

The factors that affect the range of communication are wavelength, antenna current, effective height of the transmitting antenna and probably most important, the time of day and atmospheric conditions when transmission is undertaken. An arc transmitter delivering the same current to the same antenna as a tube transmitter on the same wavelength will establish communication over the same distance. It is absurd to make any other statement.

Arc and tube transmitters are not rated on the same basis. Federal arc radio transmitters are rated by the input to the transmitter. For example, a 2 Kw. arc transmitter is designed to operate on a direct current power input of 2 Kw. The output of the transmitter depends on the characteristics of the antenna system. For transmitters of this rating the output is from 25 to 30 per cent of the input. Tube transmitters are rated by their output. A 500 watt tube transmitter requires an input of a little more than 2 Kw., which is no better than the efficiency of the arc.

Because of the different methods of rating tube and arc transmitters, it is very easy for someone comparing the performance of these two types of transmitters to be misinformed unless they are cognizant of the basis on which the transmitters are rated.

It will be of interest to note here that tube transmitters cannot be overloaded with safety to the extent that arc transmitters can be overloaded. Federal arc transmitters are liberally designed and can be overloaded from 50 to 100 per cent during periods from one to two hours without danger. This is a very important advantage when additional power is required to establish communication over unusual distances or through atmospheric interference.

A large number of vessels both Government and commercial are equipped with Federal arc radio transmitters, which are giving most reliable service. Quite remarkable results are obtained with the Federal 2 Kw. transmitters which are in service and which do not incorporate the latest developments and improvements. It is nothing unusual for a 2 Kw. Federal arc radio transmitter to establish communication over distances from 1,000 to 2,000 miles in the day time and from 3,000 to 5,000 miles at night. The U. S. Army Transport "Thomas" on which a Federal 2 Kw. arc transmitter is installed maintains communication with the Pacific Coast several days out of Honolulu on the way to Guam and the Philippine Islands. Communication over a distance of 5,000 miles is quite common.

As a result of the experimental work undertaken during the past two years, the engineers of the Federal Telegraph Company have developed an improved 2 Kw. Federal arc radio transmitter for marine service. In addition to being more efficient, the equipment requires less space for installation. The complete equipment includes a small synchronous spark transmitter, which operates directly from the ship's power supply for operation on 600 and 706 meters for communication with ship and shore stations not equipped to receive continuous waves. This low power spark transmitter also serves as an auxiliary transmitter for operation from a storage battery in accordance with government regulations. This auxiliary transmitter being of the synchronous gap type produces a clear signal requiring sharp tuning and does not give broad interference.

This simple and compact transmitter can also be separately installed on vessels of coastwise trade where long distance communication is not required and very satisfactorily fulfills all requirements on boats where only a limited power supply is available.

The complete transmitter consists of five units.

(1) Auxiliary spark transmitter panel which contains the complete equipment.

(2) The arc panel which mounts the loading inductor, signalling system, wave changer, send-ground-receive switch and starting switches.

(3) The arc converter.

(4) Cooling water tank.

(5) The motor generator set.

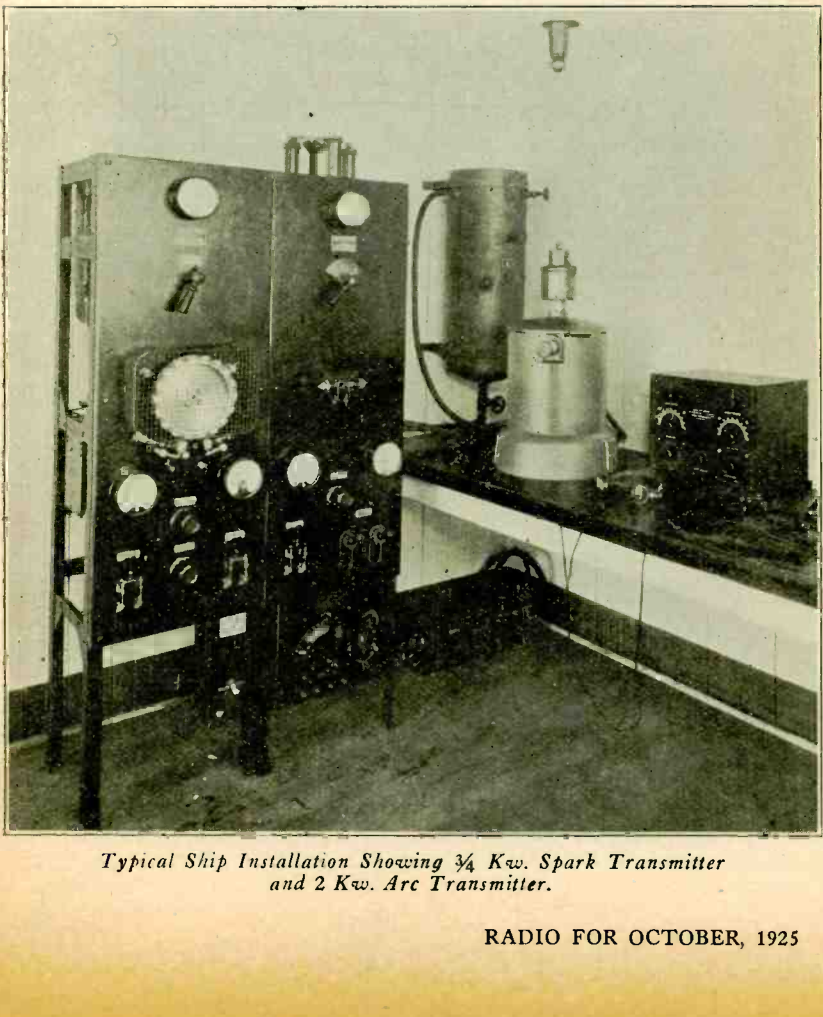
Both the main and auxiliary transmitters are equipped with a wave changer which readily permits the use of any one of four different wavelengths. The units have been so designed that the installation and tuning of the equipment is simple and requires but a short time.

The remarkable results and satisfactory service that is being obtained from the large number of Federal arc radio transmitters is evidence of the reliability of the arc transmitter for marine service.

The improvements that will be made from time to time as a result of further experimental and developmental work will maintain Federal arc radio transmitters as the most efficient and practical type of continuous wave transmitter for both marine service and long distance radio communication.

In the interest of fair play I hope that you can see your way clear to publish this statement.

ELLERY W. STONE,
President Federal Telegraph Co.



Typical Ship Installation Showing ¾ Kw. Spark Transmitter and 2 Kw. Arc Transmitter.

More About Static

Sir:—I want to compliment Mr. Anderson on his very excellent article, "Selectivity versus Distortion," in your July issue. Let us have more articles giving accurate information on radio, as that is the only way to clear up the hazy ideas and misinformation so prevalent.

I would like to correct an erroneous impression concerning radio waves which your readers might get from the article on static by Mr. Edward T. Jones in the same issue.

He compares the supposed variable proportion of lead and sulphur in galena with the supposed variable proportion of the electrostatic and electro-magnetic components of a radio wave. From this the reader might be led to believe it possible for a radio wave to have unequal amounts of electrostatic and electromagnetic energy.

Many of your readers probably know that an equal number of atoms of lead (Pb) and sulphur (S) combine to form galena (PbS.)

Substituting the atomic weights of lead and sulphur (207 and 32) we find that pure galena is about 13 % sulphur and not 40% or more as stated by Mr. Jones. However,

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I do not believe that this proves anything about radio waves.

Many of your readers probably know that equal amounts of electrostatic and electromagnetic energy combine to form a radio wave.[1] Using the ratio of electrostatic to electromagnetic units, we find that[2] $E=300H$, where E is the electric field intensity in volts per cm, and H is the magnetic field intensity in gilberts per cm.

The foregoing applies practically to the field one or more wave-lengths distant from the source[3]. Quite near the source, the induction field (which is associated with the source) predominates over the radiation field on radio wave[4] (which is propagated with the velocity of light.)

Dellinger says[5], "It is possible to separate the electrostatic and magnetic induction fields associated with a circuit by an arrangement of magnetic shields, but the electrostatic and magnetic fields in a *radiated wave* cannot be separated." (*This refers to a radiated wave and not to its effect upon an aerial*). "In considering any effect of the electro-magnetic wave, it is equally permissible to consider the electrostatic or the magnetic field associated with the wave. They are equivalent and lead to the same result."

Thus if static is a form of radio wave, (that is radiation from a distant source) it is, like any other radio wave, composed of equal electric and magnetic energies. If the static originates very near the antenna, its effect will be largely due to the induction field (electric or magnetic) rather than to its radiated wave. If the static is due to the irregular discharge of a variably charged antenna, its effect is due directly to the currents in the antenna.

All of these forms of static exist: Case 1. As a highly damped radio wave from distant electrical discharges. Case 2. As a loud and sudden click from nearby discharges. Case 3. As a constant hissing due to physical contact of the antenna with currents of charged air.

High selectivity and a directional loop antenna help considerably in Case 1, but less so in Case 2. Static is reduced in Case 3 by removing the antenna from the highly charged atmosphere above the earth and placing it near, on, or under the surface of the earth. This also benefits Case 2.

I believe that calculation and measurements would show that an underground wire would have much larger capacity and somewhat smaller inductance than the same wire used high in the air. The reader would scarcely infer this from Mr. Jones' statement that "The main idea (*of the Rogers underground system*) was to get away, as far as possible, from the electrostatic component of the wave," especially as Mr. Jones does not state just what means, if any, were used to reduce the electrostatic effect.

[1]Morecroft, Principles of Radio Communication, p. 701.
Dellinger, Scientific Papers of the Bureau of Standards, No. 354, p.454.
[2]Morecroft, p. 703.
Dellinger, p. 454.
[3]Morecroft, p. 704.
Dellinger, p. 453.
[4]Morecroft, p. 703-4.
Dellinger, p. 453.
[5]Dellinger, p. 454-455.

A. H. MARSH, Route 1,
Santa Barbara, Calif.

Reception Footnotes

Sir: I feel it encumbent upon myself to clarify, by foot notes, my recent statement released to the press in America regarding radio reception on one tube. The statement issued primarily to the San Francisco "Morning Sandblast" was as follows:

"Sure, I pull[1] in 5000[2] miles[3] every night on my one tuber[4],—clear as a bell[5]—all over the room[6]."

The appended footnotes explain in detail.

Note (1). Experts disagree on the precise meaning here. Political economists aver a reference to favoritism in administration of the Radio Laws (see Ham's "Two KW on 100 Watt License.")

However, Marcus Hook in "Diodes to Doughnuts" states that "pull" here refers to retrocession of continental coast lines beyond the 100 fathom line, as, page 97, "We yanked (obviously meaning pulled) in the coast tonight, as well as some 'fives' and 'sixes.'"

Webster identifies "pull" with tractive effort, as page 973: "Pull in your horns—we got 2LO last night too."

Note (2). The figures here are problemental because Hank O'Hara in his classic "Five Watts from a Clothes Wringer" voices the following: "The ether is highly elastic."

Taking the latter statement as a point of departure, we assume that the mileage therefore cannot be otherwise than elastic also. However it is undeniable that the mileage was at least 5, if not 5½.

Another theory is pointed out by Prof. Sherlock Ohms, who strictly adheres to the "progagation by division" theory. He states "The naught (0) cell, when appended to the first figure (here this being 5) in radio reception, rapidly expands and propagates in proportion to the imagination of the B. C. L. Thus, starting originally with a DX distance of "5 miles on one tube," necessarily with each subsequent recital, the original may be transformed from 5 miles into 5000 miles—and further yet, the result may be appended with further descriptive phrases, such as: "With no aerial or ground," and "all over the room."

Note (3). The term "miles" is often misinterpreted. The Russo-Arab phrase "a mile for a camel" means in modern literal English, especially in these days of automobiles: "Not a helava ways."

Prof. Voltam-Ohm states that "mile," with respect to DX distances on one tube, should be interpolated as "mille," (indicating millimetres,)—and, despite appearances and tradition to the contrary, has no reference to camel, "old horse," O. M., or any other mammal.

Prof. Sarsaparilla in "Radio Active DX Insects" points out that "mile" is arbitrary. To wit: "I heard KGO a *mile* from the phones on a crystal" (page 39.)

Bureau of Standards Circular No. 98753 NBL ("No Body Lied") succinctly states that KGO was a mile from the phones on the given date, January 32, 1924.

This was further substantiated by investigations of the Smith Brothers.

Note (4). Professor Zinc-Chloride in a lecture before the Institute declared that "tuber" is ridiculously misconstrued. "Tuber," said the Professor, "refers to a branch of an ancient Irish family: Murphy,—sometimes allegated 'spud,'—as 'Spud—Murphy.'" (See "Spuds I Meat" by Ima Cooke. Doubleday-Leaf Co. 8 vo. $1.99 net.)

However, since the word "tuber" doubtlessly refers to radio in the quotation under analysis, it obviously may pertain to a set with many tubes,—probably 9 or 6.

Note (5) "Bell" no doubt refers to the telephone. Professor Gigliotti in his famous work, "Molecular Displacement in Spaghetti Centers," explains the relation in a concise yet roundabout manner. Professor Shortmuir's treatise on "Phone Numbers I Have Gotten" remarks on the distinct lack of clarity (see "The Bell Telephone," back numbers of "True Telephone Directory Adventures Magazine.")

Doctor David Harum-Scarum of London briefly describes the bell clarity to be grate.

Note (6). "Room" in this case, points out Doctor de la Tamale, is probably a misconstruction from the Spanish. The word "rum" is pronounced in the Castillian as is "room" in Englitska. The doctor further points out that the listener, by some fault or mistake in construction of this "5000 mile-one tube" set, probably included a demijohn of XXX in the responsive circuit,—and with the obvious result.

Refer, in this instance, to "B. C. L. Adventures in Havana," (Barr, Tender and Co., 8 vo. $1.68 net,) page 967:

"The music was intoxicating. Readjusting the detectors in his ears, the Count,—Manhattan-Martini,—drank in the happy chanson with baited breath. His Adam's apple vibrated in unison with the rhythm of the soulful rendition: 'A Member of the Bar.'"

I trust these exhaustive footnotes will clarify any misunderstanding of statement given to the press heretofore. I regret that my time is quite limited and it has been even necessary to call for help from central station,—from where fourteen guards have been delegated to politely, yet firmly refuse entrance to the great throng of editors who clamor for admittance to my study,—seeking interviews on the radio situation.

As I am working on a static eliminator, I expect to be quite as busy as heretofore—at least for a couple of days.

Respectfully, J. BRONT.
Hangtown-on-the-Fritz. October 32nd.

QUERIES AND REPLIES

(*Continued from Page 36*)

ing at the lower wavelength band. You may use a UV-201-A tube in the r. f. stage and a UV-200 in the detector circuit, with 6 volt *A* battery, if desired. The r. f. rheostat should be 20 ohms and the detector rheostat 6 ohms. An aperiodic primary may be used if preferred, but the present connection is in the form of an aperiodic primary autotransformer coupled to the secondary circuit, and it is doubtful if a separate antenna coil would improve the results. If a separate coil is used, wind 15 turns on the basket form and couple it to the secondary with about 1 in. separation.

Would like to know the maximum distance you can receive with the headphones with a superheterodyne like that illustrated in December, 1924 RADIO.—F. M., San Francisco, Calif.

The distance possible on any radio set depends upon the location, time of day or year, loop or antenna used, and the experience of the person operating the set. Under ideal conditions, the range of the receiver would be at least 2000 miles at night, when receiving standard 1000 watt Class B stations, and stations further distant are occasionally received with loud speaker volume when all the above conditions are met.

Can the Bradleystat Universal rheostat for all tubes be used in the Improved 45,000 cycle superheterodyne for volume and filament control?—D. R., Houston Heights, Tex.

The rheostat you mention is appropriate for use in the above circuit.

A. R. R. L. CONVENTION

The third annual convention of the American Radio Relay League at Chicago was a great success, both in point of attendance and discussions. Nearly 700 amateurs attended the opening banquet on August 17th. During the technical sessions announcement was made of the new tubes and bases now available as well as of new successes in short wave transmission. Dr. A. Hoyt Taylor of the U. S. Naval Research Laboratory described the quartz crystal oscillator and presented a theoretical consideration of the effect of the Heaviside layer on short waves. Professor J. W. Williams spoke on interference problems and their cure. W. H. Hoffman discussed beam transmission. The best attendance from distant points was won by delegates from Southern California. Many well known amateurs were present.

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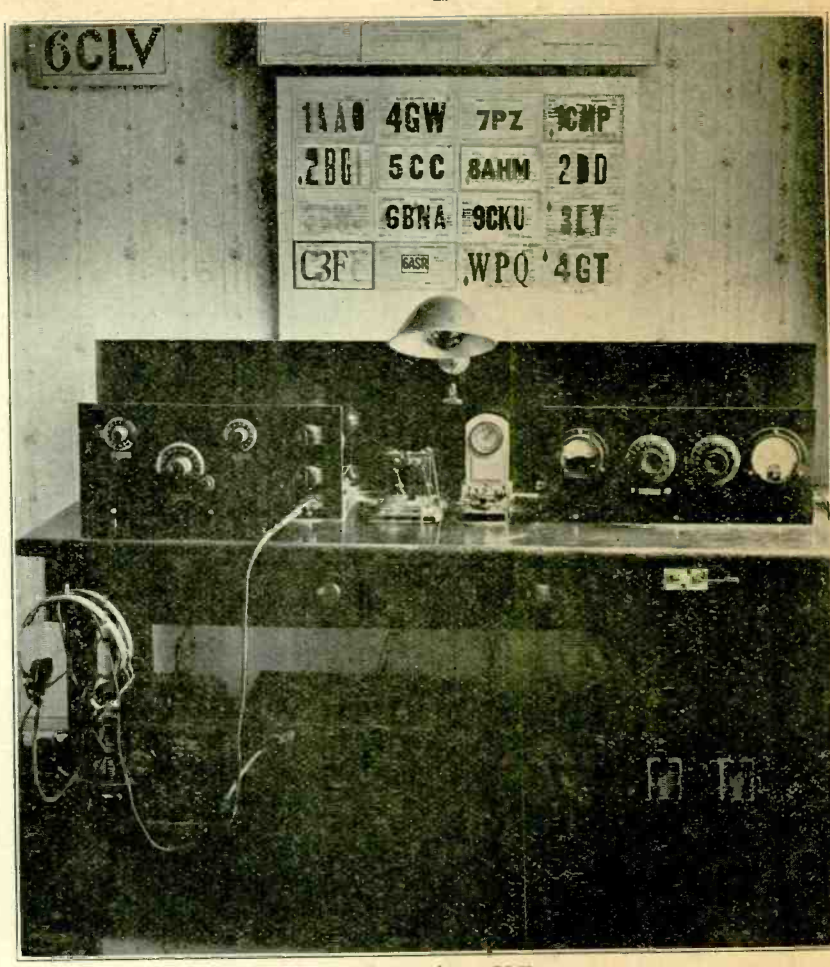
With the Amateur Operators

RADIO STATION 6CLV

An an example of how neatness and good workmanship may make for efficiency, the picture of the transmitting and receiving equipment at 6CLV is worth studying. The coupled Hartley transmitter, using a 5-watt tube, gives an antenna radiation of 0.4 amperes on 80 meters with 48 watts input. It has been reported in Japan, Guam, Hawaii, Alaska, through Canadian districts, and all U. S. districts.

The receiver consists of a detector and one-step audio, 20-100 meters, with a LoLoss circuit. On April, 1925, 6CLV worked Japan 1AA on 80 meters with this outfit from 155 Marston Ave., San Francisco. The antenna is a one-wire inverted "L", 30 ft. long and 40 ft. high, with one wire counterpoise 50 ft. long and 8 ft. high.

The owner and operator, Lloyd V. Broderson, built his first receiving and transmitting set in 1922 from Mecanno parts. He passed his examination for amateur license in 1923 and was appointed ORS of the ARRL in 1924. He got his first class commercial license in February of this year and in July shipped as second operator on the *Grace Dollar,* truly a remarkable record.



Radio Station 6CLV

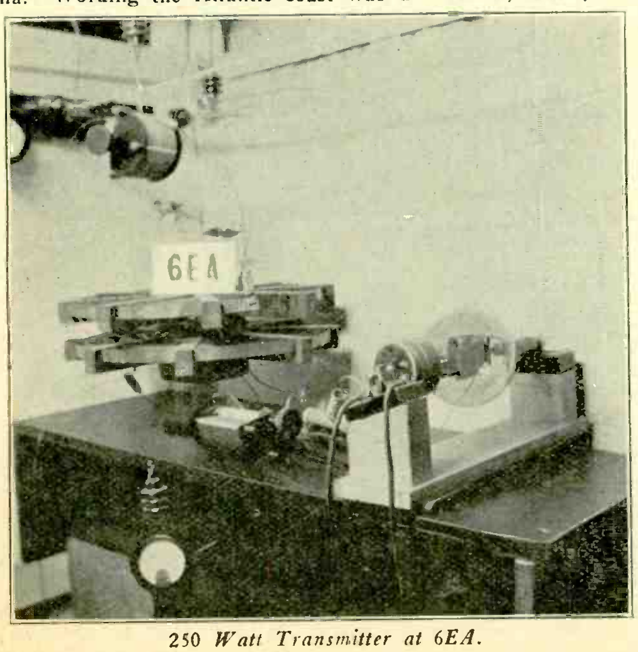
U-6EA 40 METER SUPER DX RADIO STATION

This station is owned and operated by Howard C. Seefred at 343 South Fremont Avenue of Los Angeles, Calif., U. S. A., whose call letters have been heard on the air since 1913. Its old spark will be remembered by the old timers of those days.

It was the first to be heard on the Atlantic coast, up in Alaska, and in the Hawaiian Islands. Then came the 5 watt A.C.C.W. in 1922 which worked the Hawaiian Islands. Next came the 50-watt synchronous rectifier C.W. which was heard in southern New Zealand and by a ship nearly 5,000 miles out in the Pacific Ocean. And on 150 meters with a 5-watt tube using a chemical rectifier, the Atlantic coast was worked.

In the fall of 1924, a 250 watt tube, on the 80 meter band was heard often in Australia, New Zealand, Guam, Central America, by a ship nearly 6,000 miles out in the Pacific Ocean and by another ship 1850 miles east of Boston. It was also heard several times in the Philippine Islands and China. Working the Atlantic coast was a regular nightly occurrence. Using the 40-meter band with the same power and synchronous rectifier on a 4-wire 95 ft. cage antenna hanging from a 101 foot-well-insulated pole and NO counterpoise or ground (harmonic system) with only 1¼ amps. in the antenna, u-6EA established direct two-way trans-Pacific amateur radio communication in the summer time with PI-1HR, A-2BK, A-2YG, A-2YI, A-3BD, Z-1AO, Z2-AC, Z-4AK, NPN, NPU, 6ZAC and F8Z at Samoa, NRRL, 3 days from Australia, NPM, NRRL at Hawaii, NKF, 8ER, NVE off coast of Mexico.

The following stations were heard on the 40-meter band: U. S. A.—1II, 1XU, 1YB, 1AAO, 1XAV, 2YT, 2ZV, 2BBX, 4GY, 4PU, 4TV, 8BF, 8BRC. Navy—NAS, NJE, NECR, NUQG. Army—CX1. Commercial—WIR, WIZ. Australia—A-2DS, A-21J. New Zealand—Z-2XA, Z-4AG. Philippine Islands—NPO. Porto Rico—4SA. Mexico—1AA. Canada—C-3VH, C-4GT, C-5BA, C-5EF. Hawaii—FX1, KFUH at Honolulu.



250 Watt Transmitter at 6EA.

40 and 80 Meter Low-Loss Tuner with 2 Stages of Audio at 6EA.

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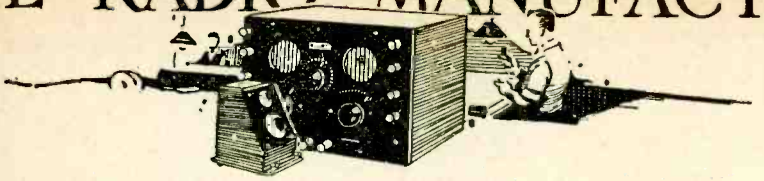
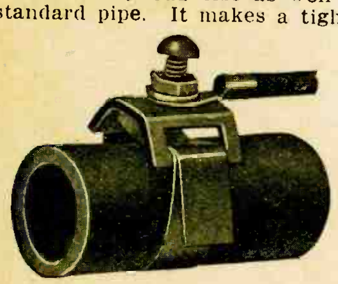
FROM THE RADIO MANUFACTURERS



The "Aero-Loop" is intended for direct use with multi-tube sets and as a booster and static eliminator in conjunction with an aerial. It consists of an outer rotating loop and an inner stationary one. It

is sturdily built, compact and quite portable. Bakelite insulation is used throughout. The finish is in mahogany. It is made in either two- or three-tap styles.

The "Saddle" ground clamp is an adjustable and shape-conforming clamp designed to fit any odd size as well as it fits standard pipe. It makes a tight job

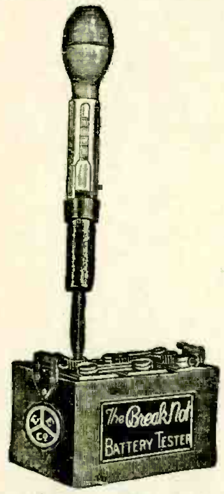


on anything, anywhere,—and stays tight. The strip is of non-corroding bronze and the remainder is brass. It is made in three sizes so as to fit from 1 in. up to 3 in. pipe.

The Tobe fixed condenser is a new claimant to favor because of its compactness and accurate rating. Made in eight sizes from 0.1 to 5 mfd., it is claimed to have a variation of less than 5 per cent from its rated capacity. For use as a

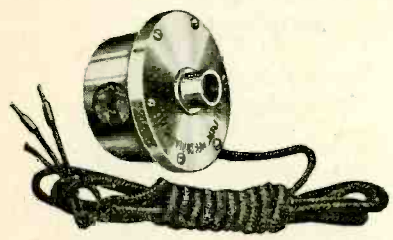
filter or by-pass condenser it is designed to withstand up to 700 volts, d.c., without breaking down or overheating. It has a high resistance, 150 megohms for the 1 m.f.d. size. It is rigidly constructed to withstand temperature changes.

The "Breaknot" storage battery tester is a hydrometer having just enough glass to facilitate reading the float, the balance of the housing being made of semi-flexible rubber so as to minimize possi-



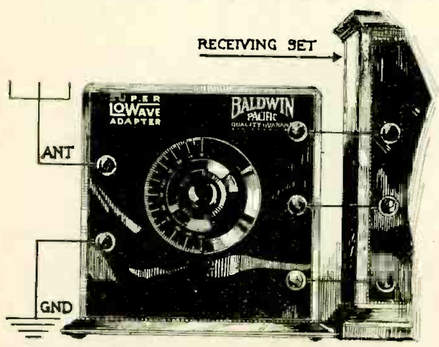
bility of breakage. The indicator scale is printed with large figures in three colors. A patented stabilizer prevents the float from sticking to the sides. The float rests against the rubber housing, thereby minimizing danger of breakage.

The Globe loudspeaker unit for phonograph attachment employs a new principle with balanced coils mounted upon a sound bridge above a special tone pocket.



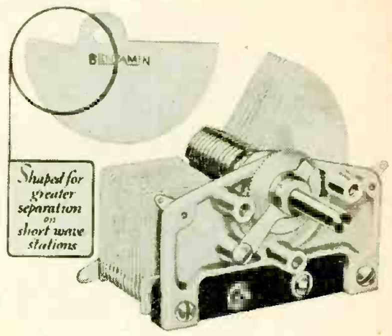
This, in combination with a silicon steel diaphragm, is claimed to give a surprising smoothness of tone and reproduction of music free from all distortion. The unit is made to accept any standard con-

The Super Lo-Wave Adapter is an antenna tuner adapted for connection to a superheterodyne so as to enable reception of stations on wavelengths from 50



to 125 meters. It may be used either with two-tap or three-tap superheterodynes without any change in their wiring.

The Benjamin low-loss condenser employs a rotor plate shaped so as to give definite and positive control of minute changes in condenser capacity, adapting it to both high and low-wave stations. A minimum amount of insulation is used and is so arranged that leakage must go through long paths outside the strongest



field. There is no end plate. A friction disc on the rotor shaft permits readjustment of the turning tension without throwing the rotor blades out of alignment. It is unusually small in size and is made in three styles: 13, 17 and 25 plate for .00025, .00035 and .0005 mfd. maximum capacity respectively.

The Acme cone type loudspeaker is distinguished by a double free edge that is claimed to give uniform reproduction of all sound frequencies. The cones are made of Japanese linen paper which is unaffected by dampness or sun. The ac-

tuating unit is so powerful that no mechanical levers are used, the cones being given a piston movement. The case is of metal finished like the cones so as to harmonize with any set. The plate current adjustment, once set, needs no further attention.

NEW RADIO CATALOGS

The Acme Wire Company has published an attractive folder, "Acme Wire Makes Better Radio," wherein are illustrated and described the advantages of both rigid and flexible Celatsite wire for set wiring: stranded enameled antenna wire, loop antenna wire, battery cable, and Acme spaghetti.

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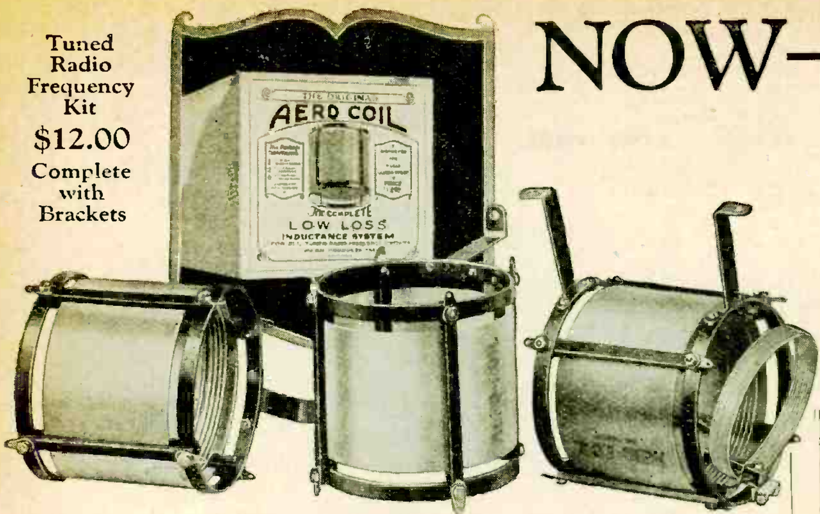
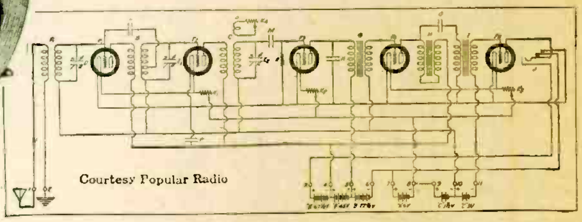
Tuned Radio Frequency Kit
$12.00
Complete with Brackets



The complete Low Loss Inductance System, comprising two tuned circuit transformers and an antennae coupler with a uniquely constructed variable primary for governing the selectivity of the antennae circuit.

NOW—*All the world can have it!*

The sensational favor which Chicago and New York showered upon the AERO COIL has prompted its designers to make it available to every fan in the Nation. Vigorous plans are, therefore, under way to place the Aero Coil where every city and village can see it and witness its markedly superior performance.



Courtesy Popular Radio

Declared by Chicago and New York the most SELECTIVE, *most* POWERFUL *Inductance Ever Designed!*

Enjoy the *"knife-edge" selectivity* with which Aero Coils cut through the tangled mass of Chicago and New York broadcasting *at will!* Enjoy the *uncanny sensitivity* with which sets built of Aero Coils pick up the far off, small, low-wattage stations that you never thought existed! Be thrilled by the *amazing volume* with which Aero Coils amplify for the loud speaker, reception which you have always had to listen to on the head phones! Build a 5-Tube Tuned Radio Frequency Set with Aero Coils . . . . . the true low loss inductance system.

PATENTS PROTECT ITS SUPER-EFFICIENCY

Its *lower* circuit resistance, its *lower* high frequency resistance, its *lower* distributed capacity, and the fact that its dielectric is 95% air are the reasons why the Aero Coil tunes so sharply into resonance—and why it actually uses the energy which other types of inductances waste. Hence, Aero Coil is the inductance of today—and tomorrow, and you can be assured that it is—for the construction which makes it the *ideal* inductance is patented, and no inductance can be made so good as Aero Coil unless in violation of these patents!

> 95% *Air dielectric—No dope on windings—All turns air-spaced—Solonoid (cylindrical) windings—Variable primary*
>
> Engineers recognize cylindrical winding to be superior to any other. The Aero Coil is the only Air dielectric cylindrical inductance with a variable primary. Aero Coil patents prevent imitation.

Build Your Set Now!

The construction which makes possible the far superior results obtained from Aero Coils also makes them cost a bit more—but, performance considered, their price is low. $12.00 for a set of three, complete with nickel plated mounting brackets which fit any condenser. Go to your dealer's today and obtain a set of three.

A circular containing complete hookups for building the most selective, most sensitive, most powerful five-tube receivers ever designed is enclosed in each package.

If your dealer has not yet obtained his stock of Aero Coils, order direct, enclosing price with your order.

Free Booklet showing new circuits and giving full constructional information of help to any fan or set builder—mailed on request. Write for the Aero Booklet.

AERO PRODUCTS, Inc.
217 North Desplaines Street, Chicago, Illinois

Successors to
HENNINGER RADIO MFG. CO.

AERO COIL

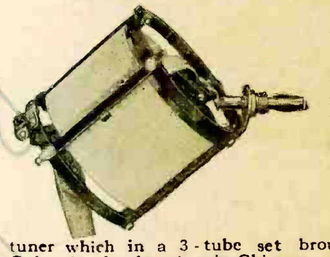
All Aero Coils embrace a patent-protected method of construction which makes possible a far more efficient Inductance performance than is possible with any other type of coil.

Use AERO COILS

Wherever An Inductance Is Required

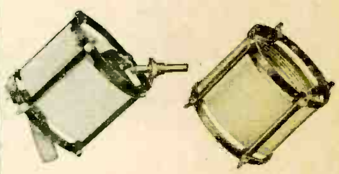
[THE ONLY AIR DIELECTRIC COILS HAVING VARIABLE PRIMARIES IN ANTENNAE CIRCUITS]

The Aero Coil 3-Circuit Tuner



Another adaptation of the patented protected Aero-Coil construction and for that reason the most efficient three-circuit tuner ever offered. More than covers the broadcast wave band when shunted with a good .0005 condenser. This is the tuner which in a 3-tube set brought in Havana, Cuba, in the day-time in Chicago. Price...... **$8.00**

The Aero Coil Radio Frequency Regenerative Kit



Consists of one AERO COIL 3-Circuit Tuner and one AERO COIL Antennae Coupling Transformer. Makes the most powerful, most selective 4-tube, non-radiating set possible to build. Price **$11.00**

The Aero Coil Wave Trap Unit

Also for Crystal Sets

By reason of the characteristics made possible by the Aero Coil construction, this unit makes a very efficient wave trap or crystal set. Price **$4.00**

The Aero Coil Oscillator for Super Heterodynes

The characteristics achieved through the use of the Aero Coil principle make of this instrument the ready means to tremendously increase the efficiency of the oscillator circuit in any Super Heterodyne receiver. Pr. **$5.50**

Prepared by KIRTLAND-ENGEL ADVERTISING COMPANY - CHICAGO

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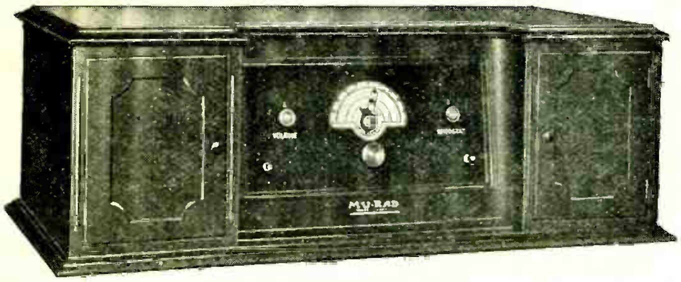
ANNOU

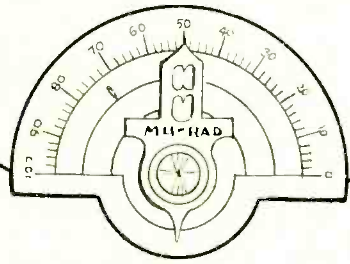
A Sensational New MU-RAD Transcontinental Receiver

THE Receiver that has astonished the entire Radio World! The Receiver that has taken the guess-work out of Radio. The Receiver that makes it possible to tune in stations far and near with but a slight turn of a *Single Knob*. The Receiver that brings all of the glorious pleasure and entertainment of Radio at its Best.

Here, at last, is the Receiver *You* want!



MODEL A---PRICE, $175
Sockets Fit All New Type Tubes



Go to your nearest dealer, see this remarkable receiver, ask him to let you tune it yourself.

MU-RAD RADIO

Factory: Asbury Park, New Jersey

www.americanradiohistory.com

NCING

FAR AHEAD OF THE TIMES

THE new Mu-Rad Transcontinental Receiver is a distinct advance in the art of Radio Reception. It is the evolution of ten years' progress and development in Radio and is the masterpiece of one of Radio's greatest engineers.

One-Dial Control

One Dial setting, the turning of *One* knob, brings in local and distant stations with amazing clearness and volume and absolute selectivity. Once a station is logged it will always come in at the same dial setting. It's so simple a child can operate it.

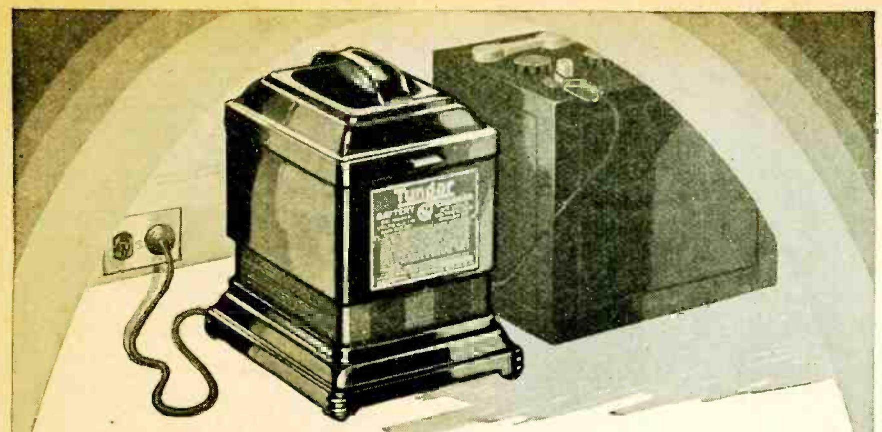
MODEL B---PRICE, $125
Sockets Fit All New Type Tubes

Write Dept. G-2 for handsomely illustrated booklet.

CORPORATION

General Sales Offices: 972 Broad St., New Jersey

www.americanradiohistory.com



Partners for Power

If you want distance and clear tone from your radio set, your storage battery must have its partner—the Tungar Battery Charger.

Two clips and a plug to connect to the house current. That's all there is to it. Or you can make permanent connection and *just throw a switch.*

The Tungar charges while you sleep—it makes no disturbing noise—keeps your batteries at top notch. For power there is nothing like a good storage battery—with a Tungar to keep it good.

The Tungar is a G-E product developed in the great Research Laboratories of General Electric.

The new Tungar charges 2, 4, 6 volt "A" batteries; 24 to 96 volt "B" batteries, in series; and auto batteries, too. No extra attachments needed.

Two ampere size (East of the Rockies) . $18.00

60 cycles—110 volts

Tungar

REG. U. S. PAT. OFF.

BATTERY CHARGER

Tungar—a registered trademark—is found only on the genuine. Look for it on the name plate.

Merchandise Division

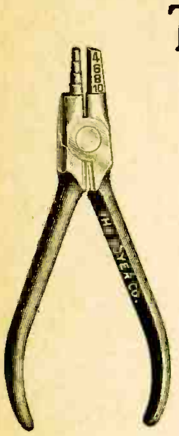
General Electric Company, Bridgeport, Conn.

GENERAL ELECTRIC

The "Windham" Wire Former

A Handy Tool for

Electricians, Radio Fans and Mechanics



This rugged little tool not only makes accurate loops or eyes for No. 4, 6, 8 and 10 screws but will make either sharp or easy radius right angle bends and the sharp cutter will cut the toughest wire as well.

It is drop forged of the very best steel and carefully tempered in oil.

Retails for $1.25

Dealers and Jobbers send for full information. Desirable territory still open.

THE GOYER COMPANY

Willimantic, Conn., U. S. A.

CALLS HEARD

By 2BUY, Bradley Park, N. J.

4au, 4aam, (4ask), 4bq, 4cu, (4du), (4ea), (4er), (4fi), 4jd, (4jr), 4js, (4kw), 4mf, 4mi, 4rm, (4ry), 4sb, 4tv, 4ux, 4vl, 4wk, (4xe), (5ac), 5acz, 5aj, 5agn, 5ail, 5akn, 5akz, 5alj, 5ame, (5auc), 5bg, (5he), (5hi), 5kc, 5lh, 5nj, (5nq), (5ph), (5uk), 5vv, (6agk), 6aji, 6awt, 6bbv, 6bcl, 6bgo, 6bmo, 6bmw, 6bve, (6cah), (6cbb), 6cft, 6cgw, 6crs, 6csw, (6cto), (6cub), (6dah), (6dat), (6fa), 6vc, 7uz, (7fb), qra?, 9aed, 9aii, 9ajn, 9aot, 9ape, 9api, 9apm, 9atq, 9auw, 9axh, (9bbh), (9bbj), 9bby, (9bhz), 9bjl, (9bmv), 9bnd, (9bou), (9bvi), (9cca), 9cip, (9ckb), 9cxw, 9cxx, 9dat, 9dbj, (9dct), 9ddc, 9dfh, 9dhk, 9dka, (9dpr), 9dpv, 9qu, 9dvw, 9dwk, (9dwz), 9dzf, (9eas), 9eak, 9egg (hi), (9eiz), (9cu), 9db, (9fj), 9lq, 9mn, 9uq, 9ut, (9wo), 9zt. Canadian: 1ai, (1am), 1an, (1ar), 1dd, 2cg, 3aa, (3en). (3qs), 3vh, 4gt, 9ch. Bermuda: ber. British: 2sz, (2wj), 5dh. Cuban: (2by), (2mk). Brazilian: 1ba, 2sp (dalite). Holland: pcuu. Porto Rico: 4kt, (4oi), 4rl, 4sa. New Zealand: (2xa), 4ar. Mexican: 1aa, 1af, 1b, 1k, 1n, 1x, (9a). qsl! qra??

By H. C. C. McCabe, 71 Holloway Road, Wellington, New Zealand

1pl, 1yb, 1xav, 1emp, 1are, 1xx, 1ax, 1aao, 1ahl, 1amd, 1anq, 1are, 1aep, 1bgc, 5ael, 5agu, 6awt, 6buc, 6bur, 6cto, 6no, 6chs, 6ut, 6fz, 6csw, 6bcb, 6cwg, 6agk, 6ea, 6eb, 6jp, 6cst, 6vr, 6ts, 6cgo, 6zd, 6age, 6bez, 6biz, 6bhz, 6ahp, 6zac, 6qi, 6acb, 6cms, 6ji, 6chl, 6cub, 6bmw, 6km, 6xap, 6jj, 6age, 6nx, 7ay, 7ya, 8nx, 8byn, 8ry, 8jj, 9cxx, 9dez, 9bmx, 9dfh, 9ado, 9ded, 9hn, 9akf, 9eli, 9uqa, 9cld, 9xa. Canadian: 3co, 4gt, 5bf. British: 2nm. Italian: 1er, German: pox. Miscellaneous: kfuh, nrrl, wiz, npm, npu, npg, nkf, znv.

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

1aao, 1ahl, 1amd, 1anq, 1are, 1aep, 1bgc, 1cmp, 1py, 1qm, 1yb, 1za, 2bbx, 2cty, 2qv, 2ha, 2kr, 2zv, 3cdk, 3ll, 3wo, 4rl, 4rm, 5akn, 5atv, 5mi, 5nj, 5oq, 5ox, 5ph, 5uk, 5wi, 5zai, 6aji, 6awt, 6ajm, 6afg, 6asv, 6agn, 6bur, 6bhz, 6bug, 6cso, 6css, 6cgw, 6cej, 6cnc, 6cix, 6ctn, 6dah, 6eb, 6fa, 6jp, 6km, 6lj, 6nb, 6nx, 6rw, 6vc, 6vr, 6xap, 6xg, 6xad, 6zd, 7ay, 7aek, 7de, 7ij, 7ku, 7ly, 7nt, 7uj, 7uz, 7ya, 8aj, 8apw, 8bgn, 8bkq, 8chk, 8cq, 8cyi, 8gz, 8ks, 8pl, 8sf, 8tx, 8xas, 9akf, 9bn, 9bht, 9cul, 9dhw, 9dfh, 9ek, 9uq, 9xp. Canada: 4gt. Mexico: 1aa. Porto Rico: 401. Brazil: 1ab, 2sp. Chile: 1eg. Argentina: lpz, lpx. England: 2kf, 2lz, 2nm, 2od, 2wj. France: 8bv, 8ct, 8fq, 8qq, 8rdi, 8tok, 8yor. Italy: 1er, 1no, 1rg, 1wb. Sweden: smyy. Hawaii, 6cst, 6dcf, fxi. Samoa: 6zac. Special: aga, nrrl, nkf, npg, npm, wiz, wgh, kfuh. All heard on low waves. All Q.S.L.'s answered promptly.

By U-5, ADW, 223 South 3rd Street, Enid, Oklahoma

A-2ac, 3bq, 4ag, b4rs, cl, dq, 1ei, 2au, 2ax, 2be, 2bn, 3ws, 3aa, 4dy, 5gg, 5go, 9alf, 8sm, g6yn, 2kf, mbx, 9a, 1x, 1aa, 1b, xap, q2by, 3lf, ra8, cb8, mal, bal, z4ak. Specials: wap, wir, wiz, nqw, jaxl, fwx, pox, lpz, knf, nkf, npg, j1aa. Please Q.S.L. card for confirmations. All cards Q.S.L.'d. Qrk 26 watts on 81 meters.

By 6CWP-BUX, 1485 East 5th Avenue, Pomona, California

1cak, 1aep, (1air), 1anq, 1fx, 1rr, 1pl, 1xu, 2ah, 2mu, 2bbx, 2cty, 2brb, 2ss, 2xaf, 3jw, 4gy, 4sa, 4si, 5wi, 5hi, 5he, 5aom, 5oq, 5acd, 5ed, 5ls, 5lg, 5atv, 5alr, 5amd, 7wu, 7dd, (7kg), 7rr, 7lu, 7rl, 7wj, 7uj, 7fd, 7ay, 7ku, 7agz, (7aek), (7ki), (7lj), 7fb, 7uz, 7tq, 7uq, 8dnr, 8cyi, 8djf, 8pl, 8eq, 8kc, 8bce, 8aj, (8ced), 8zg, 8gz, 8brc, 8aul, 9bjp, 9bht, 9cxx, 9wo, 9ecc, 9ces, 9dms, (9ded), 9apm, 9bri, 9dfh, 9amm, 9eak, 9aod, 9oo, 9dac, 9bkb, 9bof, 9ek, 9ell, (9cdv), 9uq, 9aey, 9dfj, 9og, 9xn, 9zaa, 9zt. Canadian: 4gt, 5eu, 9ck. Mexican: 1aa, 9a, (cxi), fxi, nkf, npg, nve, npn, npm, npj, nrrl, wiz, wqn. Reports appreciated on Mi 5 watter. Will Q.S.L. promptly.

(*Continued on Page* 48)

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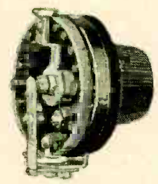
Radio drafted Bakelite

so all could listen-in

"Polyplug"
Polymet Mfg. Co.

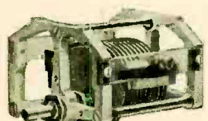
Dial
The Bell Mfg. Co.



Rheostat
Yaxley Mfg. Co.

Aristocrat Dial
Kurz-Kasch Company

Condenser
Sangamo Electric Co.



Condenser
Bremer-Tully Co.

To make available for everyone, everywhere, the marvel of radio reception, radio engineers required an insulating material possessing a unique combination of properties.

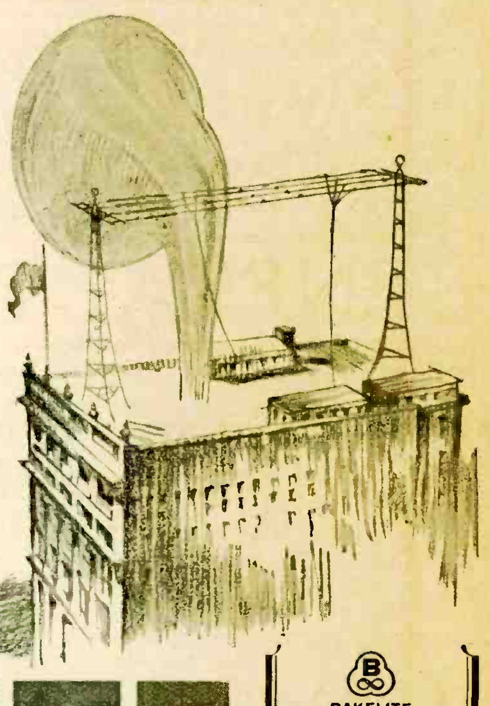
Bakelite alone met the need. It combines high insulation value with strength and light weight. It is easily formed into the many shapes required and will not warp, shrink nor swell. It will not absorb moisture and is unaffected by extremes of heat and cold.

All of these properties and the beautiful color and finish of Bakelite are permanent—unaffected by time, use or climate. So "Radio drafted Bakelite," and today it is used by over 95% of radio set and parts manufacturers.

Make sure that the radio set or parts that you buy are Bakelite insulated, for good insulation is essential to clear reception.

Write for Booklet 30

BAKELITE CORPORATION
247 Park Avenue, New York, N. Y.
Chicago Office: 636 West 22nd St.



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

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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

www.americanradiohistory.com

Perfect Results

in Radio Reception

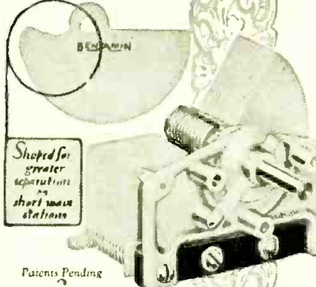
In reproducing the bewitching melody of some famous orchestra, all working parts in the radio set must co-ordinate and harmonize with each other to develop perfect reception. Individually or in combination, Benjamin Super Radio Parts achieve this beautiful tonal perfection by banishing disturbances and distortions, stopping radio losses, properly balancing the tuning range, increasing selectivity, and in making the set neater and better looking.

These unusual advantages increase radio enjoyment. Benjamin Super Radio Parts have become the standard for Perfect Results—just as they have become the standard equipment in many of the finest, factory-made radio sets found in the homes of true music lovers.

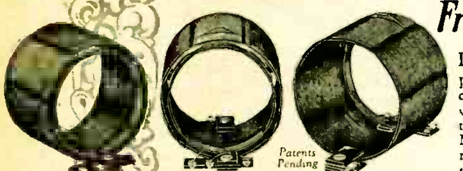
Benjamin Low Loss Long Range Condensers

Straight line type. Spreads the broadcast range on the lower wave lengths, eliminating bunching of stations on the lower side of the dial. The cut-away shape of the rotor blades aids sharp tuning and makes tuning much easier. Minimum insulation is used and leakage must go through long paths outside of strongest field. Unpolished silver plate finish. Small size of condenser makes it adaptable to any set, regardless of crowding of apparatus on subpanel. Friction disc on rotor shaft adjusts turning tension without throwing rotor plates out of alignment.

Drilling template furnished with each condenser. Made in three sizes: 13 plate for .00025 Mfd., 17 plate for .00035 Mfd., and 25 plate for .0005 Mfd.



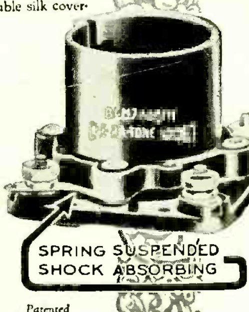
Benjamin Tuned Radio Frequency Transformers



Low Resistance. Low Distributed Capacity. Wires are space wound, adjacent coils are parallel, air insulated and so separated that while capacity is reduced to a minimum, inductance is maintained at a high point of efficiency. Makes any set more selective by enlarging the tuning range. The coils are very uniform, both in inductance and distributed capacity, so that if desired, they may be geared for single control of the tuned stages. A minimum amount of material is used in the field of the coil, and an anti-capacity cement is used only where the wires cross. Coils are coupled so as to reduce capacity of coupling to a minimum. Green double silk covering provides high insulation and gives a fine appearance to the coil.

Benjamin Cle-Ra-Tone Sockets

Benjamin Cle-Ra-Tone Sockets prevent the transmission of outside vibrations into microphonic disturbances. Four delicately adjusted double springs support the socket—"float" it above the base—and absorb all jars and shocks. An absolute necessity in portable sets. Used by leading manufacturers and recommended by radio engineers in the most popular hook ups. There are no rubber parts to deteriorate. Bakelite is used wherever possible to insure sturdiness, long life, and high insulation. Handy lugs make soldering easy. Stiff bus wiring does not affect the flexibility of the Cle-Ra-Tone Springs. Furnished also in gangs on Bakelite sub-panels for compact set building, as when mounted on Benjamin brackets there is plenty of space underneath for mounting accessory equipment.

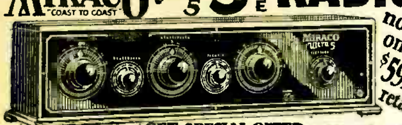


Benjamin Electric Mfg. Co.

247 W. 17th Street, New York — 120-128 So. Sangamon Street, Chicago — 448 Bryant Street, San Francisco

Manufactured in Canada by the Benjamin Electric Mfg. Co. of Canada, Ltd., Toronto, Ontario

NEW BIG POWERFUL MIRACO Ultra 5 "COAST TO COAST" 5 TUBE RADIO now only $59.50 retail



GET SPECIAL OFFER

Factory prices save you 1-3 to 1-2. Users everywhere report Miraco Ultra 5 gets programs coast to coast, Canada to Gulf, loud and clear on speaker; outperforms $100 to $250 sets. Many hear Europe. Marvelous value—let testimony of users convince you. Smaller sets $13.75 up. Write.

AGENTS DEALERS Write!

MIDWEST RADIO CORPORATION
Pioneer Builders of Sets
414-D E. 8th St., Cincinnati, Ohio

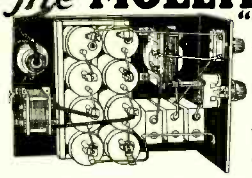
MIRACO RADIO GETS 'EM COAST to COAST

ARE YOU A SUBSCRIBER?

Send for Trial Subscription

$1.00 for Six Months

The MOLLIFORMER "B" UNIT REPLACES "B" BATTERIES



BUILD IT YOURSELF

You can assemble this powerful B Unit in an hour, at a great saving, and use the current from the light socket. Excellent for Supers and all TRF Sets—Noiseless—no Tubes or acid—Utilizes full wave rectification. Guarantees greater Clarity, DX and Volume at cost of 1/10c per hour. Completely eliminates "B" Battery, and is sold with a positive GUARANTEE of satisfaction or money refunded.

Write for descriptive circular.

PRICE

Complete Kit—60 Cycle Unit	$22.50
Complete Kit—25 Cycle Unit	24.50

Kits include Rectifiers.

Parts sold separately if desired.

DEALERS—Write for our proposition.

C. E. JACOBS, Sole Manfr.
2808 N. Kedzie Avenue CHICAGO

CALLS HEARD

(*Continued from Page 46*)

By E. O. Knoch, 6BJX, 2823 East 6th St., Los Angeles, California

1aey, 1ahg, 1amb, 1amd, 1cak, 1cmx, 1iv, 1pm, 1py, 1xam, 2agw, 2bgi, 2br, 2buy, 2byw, 2ch, 2cyu, 2mu, 2xaf, 2xi, 3ef, (3ot), 3vx, 3xan, 4by, 4cu, 4oa, 4rm, 4rr, 4sa, 4tv, 6dcf, (Hawaii), 6zac (Samoa), 8abm, 8aeh, 8afs, 8bf, 8bn, 8bqi, 8brc, 8dme, (8do), 8eb, 8gz, (8jj), 8nk, (8pl), 8sf, a-2bk, a-2yi, (a-3bd), a-3yx, c-4gt, c-5ba, c-5hs, m-1k, m-1la, (pi-1hr), z-1ao, z-4ak, (fx-1), (kfuh), nerk-1, nisv, nkf, npo, (nrrl), nve, wiz, wnp. Anyone heard my W. E. 50 watter? Want a card? You know how to get it.

By Donald Cordray, 8ATX, 5th District, care Gen. Del., Canton, Ohio

(5ar), 5at, (5am), 5bj, (5ce), 5do, 5ek, 5ew, (5gu), 5gw, 5hi, 5hl, (5hh), 5hs, 5ke, 5kq, 5la, 5lc, 5lh, 5ls, (5ma), 5mi, 5mo, 5nx, 5ob, (5ot), 5ox, 5oz, 5qe, 5qy, (5rr), 5rg, 5rw, 5se, (5uf), 5xaa? 5za, (5aai), 5aat, 5abm, 5acm, 5adx, 5aeq, 5aez, 5afm, 5afv, (5agw), 5ali, 5aky, 5alj, 3amh, 5apw, 5aqo, 5arl, 5ast, 5atf, (5atx), 5avl? 5zai, (5zao), 5jau, 5jav, 6ab, 6aw, 6ay, (6bs), 6cc, 6ea, 6eb, 5fa, 6fh, 6ge, 6gw, (6ji), 6kn, 6ru, 6yg, (6zd), (6zh), 6aa, 6aam, 6abl, 6abt, 6adt, 6adx, (6agw), 6age, 6akw, 6arb, (6awt), (6bcp), 6bdh, (6bbv), 6bur, 6jx, (6bqb), ybvd, 6ccc, 6ccp, 6ccy, 6ccf, 6cff, 6cgw, 6chx, (6chl), 6chs, 6cix, (6cka), 6iv, 6cmv, 6cnt, 6cnl, 6cqe, (6cso), 6css, 6ctc, yctz, (6dah), 6dat, 6dhl, 6gu, 6kjb? 6kp, 6lj, 6ms, 6oi, 6op, 6pl, (6ti), (6ts), 6uv, 6xu, 6xp, yzbt? 7ai, (7ab), 7bn, (7cu), 7di, 7dl, (7fs), 7hi, 7ja, 7ki, 7ls, 7mi, 7no, 7si, 7qo, (7op), 7ry, 7ul, (7uj), 7wm, 7zz, 7abb, (7acy), 7adf, 7ago, 7aha, 7aky. Canadian: (1dd), 1ak, 2bn, (2ju), 3fs, (3xx), 4bv, (4aa), 4er, 4hh, 5ab, (5cr), 5gt, 5go. New Zealand: (4aa), 4ak, 2ac. Australia: 2ay, 2cm, 2yi, 3bd. Mexican: 1aa, (9a), 1ak, (bx). English: (2nm), (2od), 5nn, (5xx), 6ya, (6lj), 6nf, 6yu. French: (8dq), 8ssc, 8ae, (8sm). Spanish: (sear2), (ear6). Italian: (iler). Hawaiian: 6asr. Naval: nkf, nrrl, nepq, nerk, npg, kfuh, ket. South American: (cb8), raf2? wjs, 9tc. Will gladly give reports on sigs. Please address cards to Donald Cordray, care of General Delivery, Canton, Ohio.

By 1ABP, 42 Glenwood Ave., Eden Park, Rhode Island

6awt, 6agk, 6bjj, 6bur, 6bwj, 6cgw, 6cig, 6cto, 6ts, 6vc, 7dd, 7lu, 7sf. British: (2cc), 2dx, 2go, 2fu, (2kf), 2kw, 2kz, (2lz), (2nb), (2nm), 2od, 2rb, 2sh, 2sz, 2tf, 2wj, 5ef, 5mo, (5nn), 5pu, 5pz, 5si, 6fg, (6kk), 6nf, 6td, (6tm). French: (8ba), 8ct, 8go, (8pl), (8wag), 8ssm, 8wj, 8qq. Holland: onl, oll, pcl. Denmark: (7ec). Spain: ear2, ear6, ear9. Italy: 1af, 1er, 1gn, 1mt. Brazil: *1-ab. Cuban: 21c, 2mk. Bermuda: (ber). Mexican: 1b, 1aa, 1af, bx. New Zealand: 2ac. Miscellaneous: (wnp), wap, nkf, (nerkl). QRK 1-ABP on 40 meters. Will Q.S.L. all cards.

By 8EQ, J. C. Lisk, 902 S. Elizabeth St., Lima, Ohio.

4fm, 4kt, 4rl, 4sa, 4ux, 4tv, 4xe, 5aqc, 5di, 5ox, 6ajr, 6aiv, 6avj, 6awt, 6bhz, 6bur, 6bve, 6cdy, 6cgw, 6chs, 6chz, 6cix, 6clp, 6cnc, 6crs, 6cto, 6cub, 6dah, 6dg, 6fa, 6jp, 6li, 6lj, 6no, 6xad, 7aek, 7bo, 7fb, 7jh, 7jw, 7mf, 7nt, 7nx, 7sl, 7uz, 7dd, 9aon, 9caa, 9oo, a2DS, a3EF, Z2XA, O1EG, (qra?) BYC (qra?) NRRL, NVE, NAS, WAP, NERK, BER.

Mex.—1AA, 1B, 1X, 9A, BX.

8EQ is on 40 meters and would appreciate reports on his signals.

By 6APK, 1250 West 58th Place, Los Angeles, Calif.

U. S.—1aac, 1aci, 1af, 1anq, 1axa, 1byx, 1cmf, 1pl, 2agb, 2bbx, 2brb, 2lu, 2nf, 2pd, 2xaf, 2xi, 3bva, 3bz, 3hg, 4oa, 4pz, 5acz, 5agn, 5akn, 5akz, 5amr, 5amw, 5aos, 5atv, 5bdn, 5ed, 5he, 5kc, 5ls, 5nq, 5ph, 5se, 5uk, 7ay, 7nh, (7uj), 7uz, 8ajn, 8ayy, 8bn, 8bpk, 8bpl, 8cau, 8ced, 8eq, 8ks, 8nk, 8pl, 8qf, 8ry, 8sf, 8xn, 9adn, (9ado), 9aed, 9aii, 9akk, (9alt), 9amb, 9amm, 9ano, 9aod, 9ap, 9apm, 9bew, 9bez, 9bht, 9bkr, 9bmv, 9bri, 9cjw, 9cto, 9dad, 9ddc, 9ddp, 9dfh, 9dfj, 9dga, 9dic, 9dmj, 9dqx, 9duc, 9dvi, 9ebx, 9ecc, 9efy, 9ek, 9es, 9la, (9oo), 9pb, 9se, 9uq, (9wo), 9xn, 9zk, 9zt.

Canada—1am, 4aa, 4gt, 5ef. Mexico—1aa, 1af, (1k), 1n, (9a). N. Z.—4aa. Miscellaneous fxl, nas, nkf, npm, nrrl, (nve), wiz, wwdo. qrk? Mi five watter on 40 meters. All crds qsl'd.

(*Continued on Page 64*)

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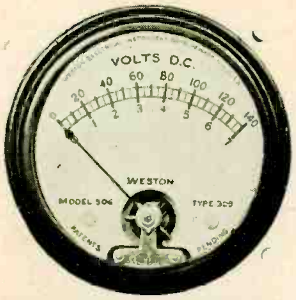

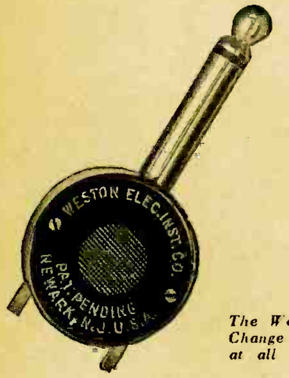

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THE GIRL WITH THE MADONNA VOICE

(*Continued from Page* 23)

listening to this kind of stuff every evening but I know I ain't. That's the Dream Lady from KYTX, but her real name's Nancy Joyce. Just to listen to her, Bub, can't you tell there's something different about her from most girls?"

About this time, I began to be illuminated by the big idea.

"Most every girl's different that way to at least one man, Henry," I said paying him back for this grandfather attitude. "Have you set a date for the happy day?"

"I asked you to be sensible," snaps Henry kind of sore. "Of course we're not engaged. I haven't even met her—not yet. Now look here, Bub, and just consider. You and I never did have the same opinion of girls, I'll admit. Maybe you never thought seriously about them but if you did. I'd bet the clothes I got on you'd never even consider one of those hot mammas you rush to the shows and dances. You'd want a real one hundred per cent girl."

"Listen here, Henry," I says, "Whenever I even consider marrying any girl on the salary I'm getting you rush an alienist around in a hurry."

"You'll fall someday, Bub, you'll fall. You'll wake up and discover this camping out in a room ain't all its cracked up to be and then you'll look around for a woman and a little bungalow all your own. It won't be no cabaret sister you look for either. When you rush a girl to a dance you pick one that looks good and is painted up to look even better. She has bobbed hair, short skirts, socks, a nice figure and she's an intellectual moron. You tell her something pleasant like asking her to eat and she says 'I'm on, sweet paw-paw' or 'Ain't it the cat's meow, though,' or, if she doesn't like the idea 'Aw, applesauce.' But she shakes a wicked hoof and that's all that counts at a dance. At home she couldn't bake a potato wihout looking up how its done in the cook book. Dishwater makes 'em sick and they think a bassinet is some kind of musical instrument. Take it from me, Bub, a swell home they'd make a fellow."

I looked at him shocked. Something had surely made a sudden change in Henry.

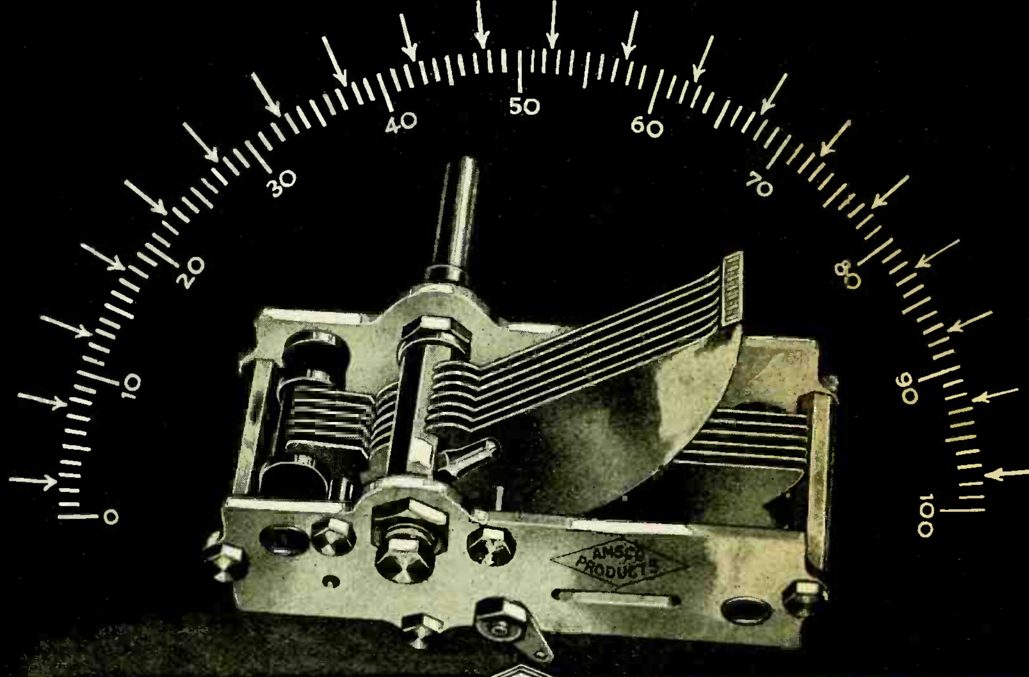
"Why blame it all on me?" I asked. "You didn't always object to 'em wild yourself."

"Sure, I'll admit it," replied Henry. "But since I heard this kid over the radio, I changed my mind. You know Bub—," I could see he blushed a little, "—I've been thinking it must be nice to have a home of your own—that is, with the right woman. No flapper for mine; give me a one hundred per cent American girl and I tell you, Bub, there ain't very many of them left. Take

(*Continued on Page* 52)

The AMSCO ALLOCATING CONDENSER

(STRAIGHT LINE FREQUENCY)



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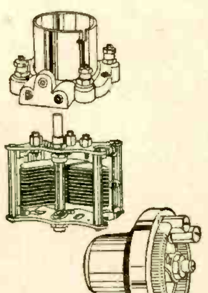

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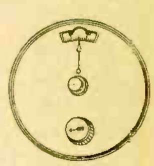

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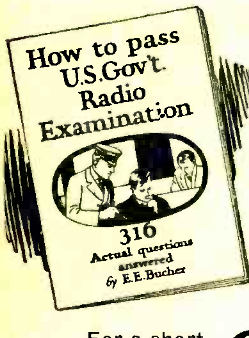

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(*Continued from Page* 50)

this Dream Lady, Nancy Joyce, for instance. She's one if there ever was one and I never met her—yet. You don't have to see her to tell it. Any girl can camouflage her looks so she seems like a million dollars when she ain't a good half dollar after she's opened her mouth unless she's hypnotized you with her good looks first. Without seeing this Nancy Joyce, I can tell a lot about her. All the important characteristics come out in her talk. After all, Bub, looks is only secondary in a woman and, even from her voice, I can tell this Nancy Joyce ain't no mud fence. She's the kind that's got a complexion that don't need paint to make her look alive and I'll bet she wears enough clothes in winter to keep her warm and few enough in the summer to be comfortable without showing everything she's got. If you ask her what she thinks of Voltaire, she wouldn't tell you that she'd never had a ride in one."

The radio on the table was turned on and the voice of this Dream Lady mingled with Henry's.

"Just listen to that!" he exclaimed, while she babbled something about Little Brown Bruin, "Isn't that a voice full of refinement and culture? Can't you just imagine the good, wholsome kind of girl she is. Bub, you know that peculiar Madonna expression that only the great artists can get into their pictures? Well, that same quality can be in their voices too, and here's a girl that got it. The girl with the Madonna voice! Think of the home a girl like this would make a man, Bub, think of it! Here we have an idea we're living when we ain't even camping out in good style compared to a home of our own with a girl like that."

He stopped, all excited and out of breath.

"Great Scott, Henry," I ejaculated, "You ain't changed your mind any lately, have you? Why you never even saw this girl—maybe she isn't white—maybe she weighs 250 in her BVD's. Grab the parachute and come back to earth before the bubble bursts!"

Henry snorted.

"You think I'm wrong, don't you?" he cried, "Well, I'll show you. I'll prove that the voice is mightier than the personal appearance with all its pretty camouflage when it comes to considering a woman as a wife. I'll meet her tonight or die in the attempt."

BEING out of town on business for two weeks after that, I didn't see much of Hen until sometime later. Then, when I would come to the room in the evening he'd be rushing out to take this girl home from the radiocast station. There was no question but that he was all flustered and excited and that he considered the three flights of stairs down from our room as so much air.

(*Continued on Page* 54)

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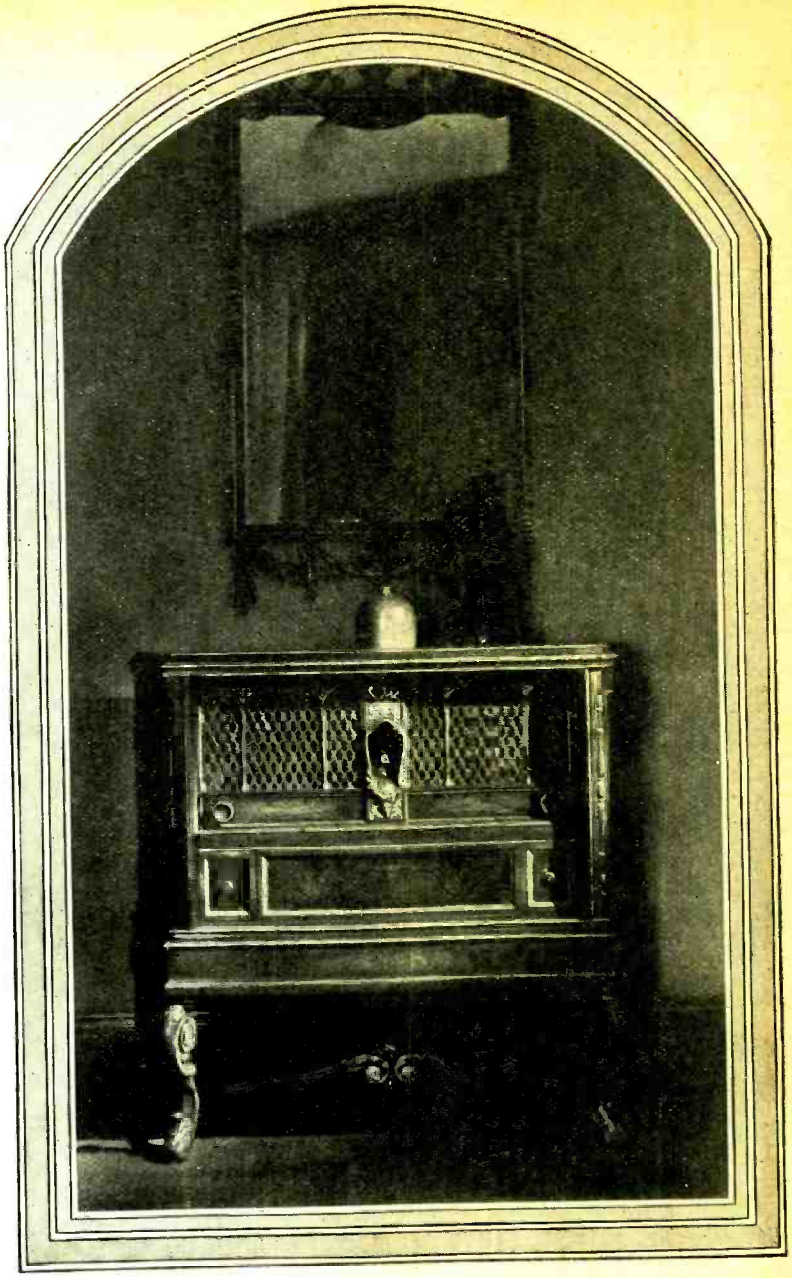

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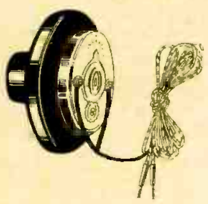

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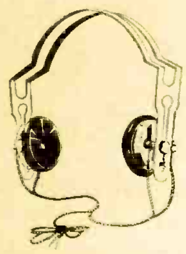

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(*Continued from Page* 52)

But the funny part of it was that every time I came home, no matter if I had only been to a movie, much less a cabaret, he was always in bed sleeping peaceful as a lamb except for the fact he snored. So I took it for granted she sure must be old-fashioned like he expected to send him home that early every night.

I don't know how long I had been asleep one night when I woke up all of a sudden feeling that everything wasn't exactly right. The room was almost as light as day from the moon and I jumped like I was shot when I saw something move. However, when I got clear awake I realized it was only Henry in his pajamas over at the radio set turning the dials and mumbling something in his sleep. Now and then, I could understand something about his "Radio Dream Lady . . . . Madonna voice . . . . little bungalow for two," and all that sort of stuff.

After I had listened long enough to make sure he wasn't going to tell any secrets, I turned on the light and went over and shook him.

"Hen, for the love of Pete, come too," I said, "There isn't anything but bedtime stories for flappers going over that thing now."

Henry woke up with a jump and then, when he recovered, looked at me with sort of an angelic smile.

"She's wonderful, Bub," he muttered, "All I had hoped for and more. I told you I knew a real girl by her voice. She's a revelation, Bub—a real old-fashioned, honest-to-goodness girl, the kind that can make a house a home. Works in an office and sends me home every evening at nine and all of that;" here he rose unsteadily to his feet and took my hand; "Bub, old boy, I've fallen—I've fallen hard. You'll have to be looking around for another bunkie. Nan—Miss Joyce, the Dream Lady from KYTX is going to marry me!"

"What! So soon?" I cried, aghast, "Henry, you're crazy."

"Sure," he admitted, "So'd you be crazy if a girl like that was going to be yours. It's a good excuse. I didn't realize what a fool I'd been parked in a room like this. But I'm through now; through with all the wild ones, cabarets, dancing—everything but Nan. Just a couple weeks more, Bub, and I'll be the happiest man on earth!"

"Henry," I said slowly, "I don't know whether you need sympathy or advice most. But right now you ain't in condition for either, I guess. You go to bed now and see if you don't feel different in the morning."

Hen laid his hand affectionately on my shoulder and grasped my hand with his other. Honest, I did feel a little touched.

"Bub, old man," he said slowly,

(*Continued on Page* 56)

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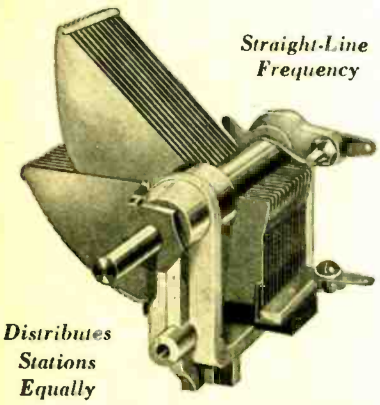

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(*Continued from Page* 54)

"You've been a good pal. I'm sorry, really I am. But some day you'll realize what it all means."

"Yea," I replied sarcastically, "I'm sorry for you too."

And, with that, I went back to bed wondering how under the sun a man could fall for a girl from listening to her tell bedtime stories over the radio.

Next night, Hen made me go along with him to the radiocast station to meet this future of his. I confess I was a little curious to see what she looked like and when she came into the reception room where we were waiting, I gasped. Her dress was modest as one would expect from what Hen said—but her looks! Well, I couldn't help but think there must be some mistake when a queen like this fell for a chap like Henry, who certainly wasn't any collar ad. She looked at me real sweetly and in her smile was something that reminded me of someone I had seen, at least casually, before. Well, as I said, she was good looking, her smile was sweet and her eyes—ah, dark and flashing. Not Madonna eyes, I thought.

But she seemed to think a lot of Henry and as for Hen himself it just sort of made me sick to see how love had affected an otherwise good fellow. So, with the exhibition over, I left them alone to draw the plans for their bungalow.

There was nothing doing that night so I went back to the room, which was unusual. Everything was quiet around the place and with not even Henry there to snore for me the thought of being alone oppressed me and I couldn't help but ruminate over Hen's idea of a little home of one's own. It was the first time, I guess, I had ever thought seriously about the thing and it did make me feel blue for a while.

However, I'll give myself credit with being able to make a decision and right then and there I made one. No married life for mine—give me the fast and furious while I could enjoy it. I'd love them all a lot but none too well. And, slamming my fist on the table to emphasize the fact to myself, I grabbed my hat and left.

On the stairway I met Hen just floating in and it was all of half past nine.

"Come on Hen!" I cried, grabbing him by the arm, "Let's step out with a real good party at a live place. You can celebrate your engagement and I'll give three cheers for my decision to remain happy forever."

"Nothing doing, Bub," replied Hen, pulling loose, "I'm off that kind of life now. It ain't worth it, so count me out. Go to it—and be careful what you drink."

Two hours later I was seeing twenty-

(*Continued on Page* 58)

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Design Patented

The KODEL
MICROPHONE
LOUD SPEAKER

(*Continued from Page* 56)

four or more in the chorus at the Coq d'Or Roof and firmly convinced I had made the happy decision. Four hours after this, Henry obligingly got out of bed and helped me with my clothes with which I might otherwise not have bothered.

"Better cut it out, Bub," he advised, tucking the covers around me, "This sort of stuff ain't getting you anywhere. Better dig round and find a real one hundred per cent girl and be honest-to-goodness happy like me."

And I have a faint recollection of muttering something about waiting and see as I dozed off.

I didn't turn out for work the next morning. Even with my head feeling ten sizes too large, I could have rested easy but I couldn't help worrying about Henry. The whole thing last night had been a sudden shock which the calmer consideration of the morning after emphasized.

The Dream Lady from KYTX, the Girl with the Madonna Voice—all that and more—but she was just Nan Joyce as the big hit of the chorus in the Coq d'Or! Give me credit with brains, though. I told you her eyes didn't fit into this Madonna picture that Hen painted. Now I had seen the proof for myself. Thank God she hadn't recognized me and there was still time to save Hen!

Being from Missouri and stubborn too, I knew that Hen would want to see the facts of this case himself. Otherwise he would want to beat me up for slandering his future's good name. Which Henry probably could do if he tried hard enough.

So that evening I began inoculating him with the idea of at least one grand celebration before he made the big splash.

At first he wouldn't listen and told me I was a horrible example of what big celebrations did to a man. But after I had talked to him like a Dutch uncle for a couple of days I could see he was slipping. Finally he agreed, providing the party wasn't to be too wild and if I would pick a place where he wouldn't likely be known. And there strictly wasn't to be any women so far as he was concerned although, of course, I would take Batty—that is, Miss Beatrice Phillips, whom I occasionally rushed and sort of let him chaperon the affair. Hen never could see how I could get any kick out of Batty but nevertheless the party was arranged for the next night which was all I cared.

WELL, the whole thing went off sort of funny. Hen wasn't very enthusiastic and even after we had reached our table at the Coq d'Or Roof, he made up his mind he was going to be good.

Of course, I had put Batty wise to

(*Continued on Page* 60)

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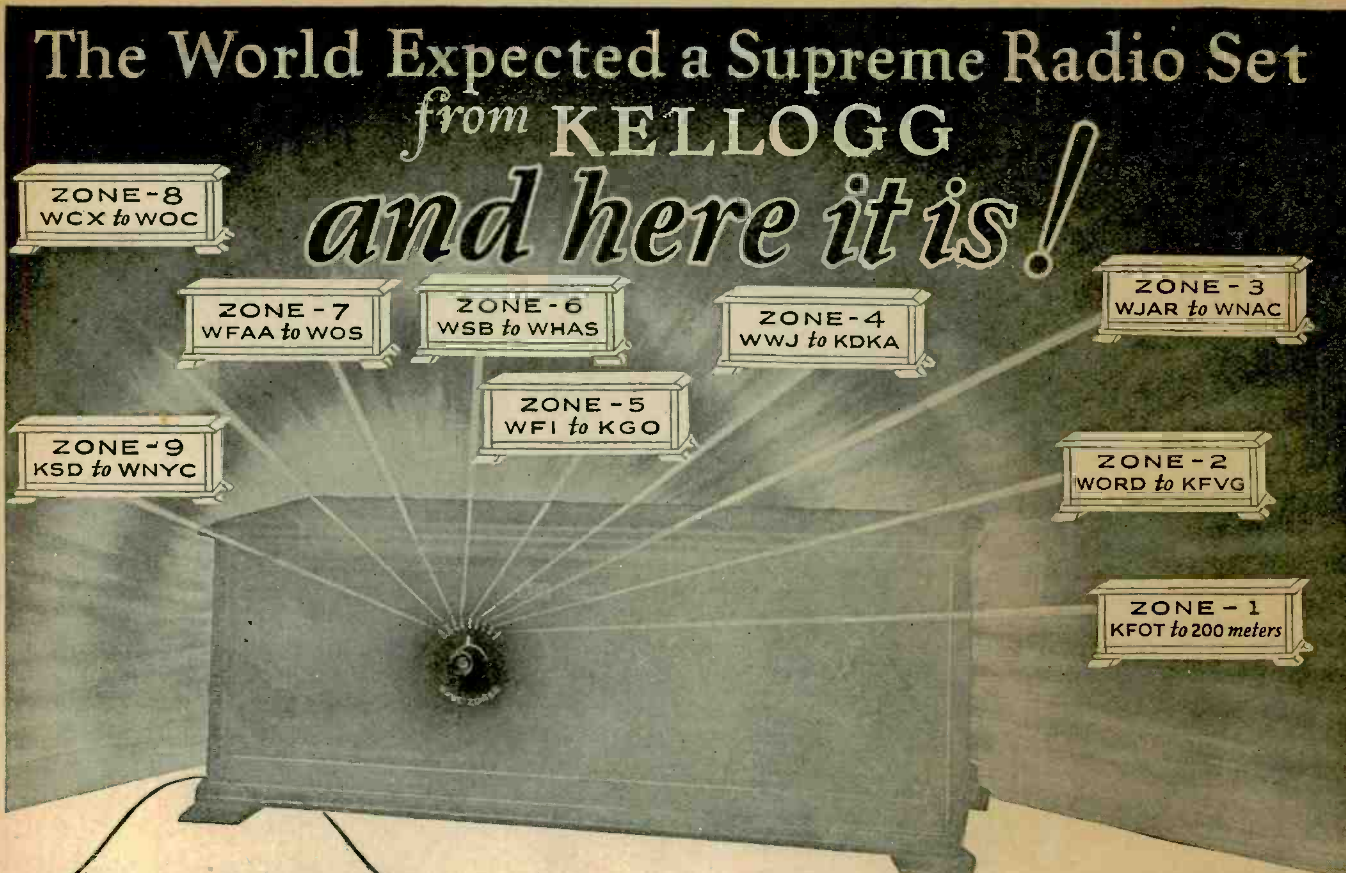

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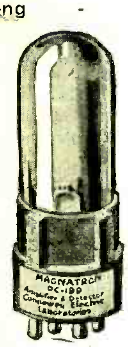

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Pacific Bldg. "RADIO" San Francisco

(*Continued from Page* 58)

the affair and, even now after it is all over, I'll admit she did good. She started vamping poor Henry the minute we sat down and kept him blushing all over. But pretty soon this all wore off and he began to convince me he wasn't clear dead.

"To my last blow-out," he cried and tipped his glass of ginger ale with which, naturally in the Coq d'Or, I had added something which wasn't ginger ale, "And to the best little girl in the world—but Heaven help me if she seen me now." Then he added sort of apologetically, "But this is the last one."

After that things went along smooth as you would want. Henry lectured us on how nice it was to be going to be tied up with a real one hundred per cent girl and while he was telling us it sort of made me sore the way Batty hung her arm around his neck and looked at him like he was a hero. With two more ginger ales, she could have played Cleopatra at the Metropolitan and Hen could have made a piker out of Antony. They both got to playing their parts like they had understudied them for years—but it was all right with me as long as it would be the saving of Henry.

Along about this time, the chorus came stepping out to a blast of lively music from the orchestra. Henry didn't pay much attention to it even after one of the girls got to stepping real lively right in front of our table. I seen it was Nan and I'll swear there wasn't any Madonna in her voice while she was singing that song about her and the boy friend. Most of her costume was entirely natural and I'll hand it to her that she was a knockout, Dream Lady or no.

Back on the farm, you've probably seen a slow-moving cow suddenly realize it had been hit by the local express. Well, that's the way the facts of the case dawned on Henry after a pretty ankle had tilted the paper dunce cap on his head and he looked up at the dancer as though he might be going to bawl her out for disturbing him.

After that, I never seen a man come out from under a couple of drinks half so quick in my life. He knocks off Batty's arm and jumps up like he was stung by a mastodon.

Nancy recognized him and gargled her boy friend just like that.

"Nan—Nan Joyce—for the love of Heaven!" gasped Henry.

"Henry"! hollered the dancer and gave him the once-over like an X-Ray, "Oh, you brute—you brute! You told me you were off this stuff—you said you loved me—that there was no one else—that—!"

"I told you that—sure I did," shouted Henry, "Hellsfire, and what did you tell me? Think of the line you gave me and me bitin' sinker, hook and

(*Continued on Page* 62)

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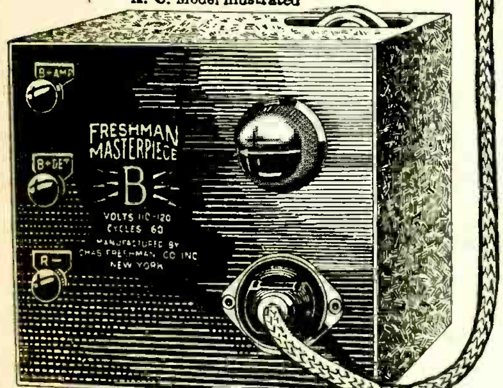

A. C. Model
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Freshman Rectifying Tube is required for operation of the A. C. Model. Price - - $2.50

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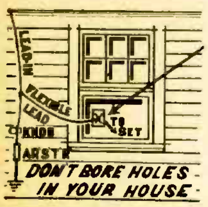

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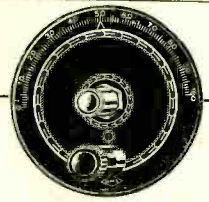

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(*Continued from Page* 60)

fishin' pole. Didn't you send me home every evening at nine so you could go to bed and not annoy your sick mother? Didn't you tell me you worked in an office and told baby stories over the radio at night? And here you are in a place like this dancing without enough clothes on to make a decent girl like I thought you was a respectable shimmy. Ain't you the peach, though?"

"That ain't true," she wailed, "I was quittin' here, leaving them flat so I could be like you thought I was—like I really want to be. I was sick of all this stuff long before I ever saw you but that didn't help none in making a living. Now you find me and condemn me for doing the only thing I know how to make a decent living for mother and me. You blame me for dancing for men like yourself that ain't got brains to be entertained any other way. Think of all you told me about yourself—your ideals of women—a home of our own—all that. Oh, you liar—you liar—you liar—you indescribable liar!"

To prove that she was real serious, she socked down her foot and belted poor Henry across the face a couple of times with her open hand. Mentally, I gave her the cake while I watched. She sure had the old fire and pep and those eyes—those eyes that weren't Madonna eyes, flashed like a blast furnace.

The rest of the folks was enjoying the show a lot and Sam Feldman, who owned the place, came up just as fast as he was able to propel 250 pounds.

"Nanny, Nanny," he protested puffingly, "Cut it out, cut it out. You're ruining the show. Please Nanny, don't."

Like a flash, the girl turned to him. "Tell them the truth, Sam," she cried, "Tell them all of it! Wasn't I quitting for good on Saturday night. Didn't I tell you I was through with this kind of a life, that I was going to be married and start all over again?"

"Sure I'll tell them," agreed Sam wonderingly, when, suddenly, he seemed to take it all in at once. Then he turned to Hen who was wobbling beside his chair, "So you're the kind of a guy as was going to steal our Nanny from us. Ain't you the hell of a feller though? Just the same though she's the biggest hit here I efer had; you ain't a man fit to sweep out her dressing room. She's a good enough girl, Nanny is, and don't need no sucker like you to fill er with a lot of notions that's all bunk. If you was even half so pure like Nanny you'd leave room in your coat for wings. I tell you, don't think because Nanny works here she's a bum—get that, will you? Now get out before I have you bounced."

Of course, Henry was partly drunk and that probably accounted for it mostly for it took a lot to rile him. Anyhow, he turned to Feldman and snapped his fingers in the fat man's face.

"Aw, you go to hell!" he hollered. Then he turned to Nancy, "Go ahead and dance," he yells, "Dance all you damn please and see if I care."

With that he grabs Batty's arm and drags her away. At the door he stops and hollers to the whole bunch:

"From now on I want 'em wild and I'll let the cock-eyed world know it. Eat, drink and be merry for tomorrow we have a big head. Three cheers for songs, women and wine. We're headin' for the Royal Roof and you're all invited to come along!"

And he finishes dragging Batty out, though I sees there wasn't much persuasion necessary.

Well, when I finally came too, the Dream Lady with the Madonna voice was sobbing like she would bust on my shoulder.

"Cut it out, kid," I said, wondering why she had picked on me, but not minding it in particular just the same.

"I did want to be like he thought I was. I was going to be, honest I was," she sobbed.

"Never mind, kid," I told her, "I wouldn't worry none if I was you. There's another one where he came from and personally I don't give a darn if you do tell bedtime stories or dance either. By the way, you've rode in a Voltaire, haven't you?"

"Sure I have," she says, "Why?"

Which proves she wasn't as dumb as Henry thought.

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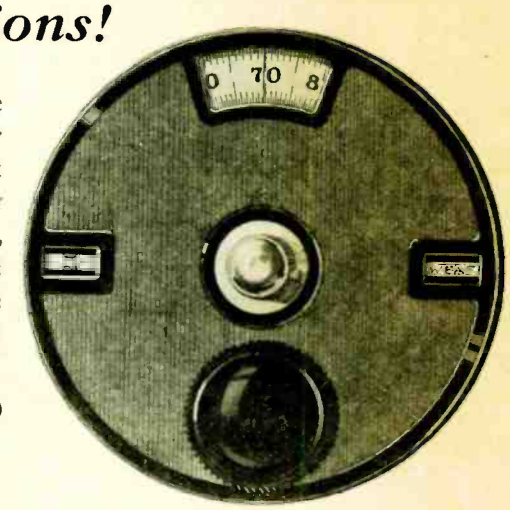

This is the dial specified in the McLaughlin single-control superheterodyne described in this issue.

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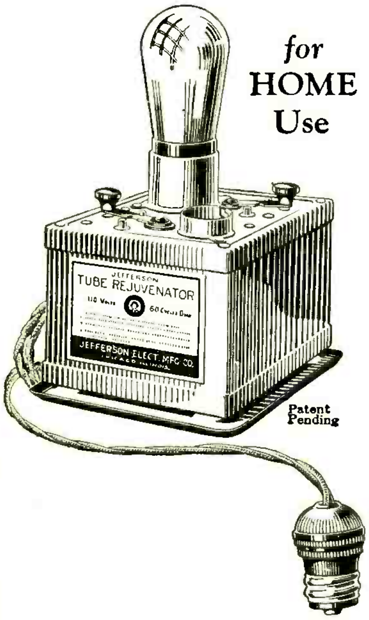

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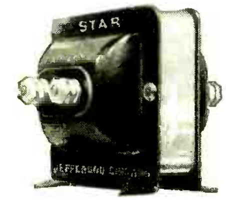

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(*Continued from Page* 48)

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All cards answered. QRK 1PY? one fiver with 35 watts input on 38 meters. 1BNX (portable) all amateur bands. 1 201-A. QRK?

J. Barsby, by 6BBV, 1511½ N. Commonwealth, Hollywood, Calif.

1aep, 1are, 1pl, 1xu, 1za, 2bbx, (2ha), 2lu, 2mu, 2wc, 4af, 4al, 4as, 4hg, 4iv, 4ll, 4rm, 4rr, 4sa, Porto Rico. 4si, 5ac, 5adz, (5agn), (5agu), (5akn), 5alj, (5arn), 5atv, 5ew, 5he, 5ls, 4nw, 5nr, 5ox, 5ph, 5uk, 5wa, 5zl, 5zai, 7adq, (7aek), 7ay, 7dd, 7de, 7do, 7kg, 7ku, 7ly, 7nl, 7nt, 8aj, 8ay, (8ajn), 8bce, (8cnl), 8cau, 8cy, 8dem, (8don), 8eb, 8ko, (8pl), 9abo, (9ado), 9aon, 9bnf, 9but, 9cdv, 9cjw, 9cld, 9cyu, (9dfh), 9dng, 9dvr, 9efs, 9ek, 9no, 9nk, 9oo, 9qr, 9ui, 9uq, (9wo), 9xn, 9zt. Canadian: 4gt, (4bv), 5go. Aust.: (2cm). N. Z.: 2xa, (4ak). Mex.: 9a. Hawaii: FX1. Samoa: (NPU), 6zac. Army: CXI. Navy: (nkf), nve, nof, npg. (nedj off N. Z.), (nqg), nrrl, wap, kfuh.

At 9DPX, St. Paul, Minnesota

1aw, 1hj, 1ii, 1mk, (1my), 1nt, 1rr, (1si), 1sz, 1te, 1ts, (1uw), (1we), (1wl), 1wy, 1xg, (1xu), 1aae, 1aao, 1aap, 1abp, (1aci), (1add), 1aei, (1aep), 1afl, (1ahg), 1ahi, (1ahl), 1aiu, (1ajg), 1aki, 1alp, (1amu), 1aos, (1are), (1arh), 1awy, 1axa, (1axo), (1ayt), (1bal), (1bdh), 1bdx, (1bgc), (1bgw), 1bhs, 1bke, (1bom), (1bqe), 1bqt, (1byx), (1bzc), 1bzp, 1caw, (1ccx), 1cjj, 1ckp, (1cln), (1cmf), (1coe), (1cpc), 1xae, 1zac, (2ax), (2bc), 2bw, 2ch, (2dx), (2ev), 2ff, 2fo, 2gc, (2gy), 2ha, 2kr, (2lu), (2nf), 2wc, 2afn, 2afp, (2agb), 2agt, 2ajx, 2akb, (2amj), 2aof, (2auo), (2bbx), 2bee, (2box), 2bqa, 2bur, 2buy, 2bxj, 2cbg, (2cft), 2cjj, 2crb, (2cub), (2cvj), 2cyw, 2xaf, 3jw, (3kg), (3kq), 3mv, 3nf, (3ot), 3uy, (3zm), 3aak, (3aao), (3acu), (3afq), 3aha, (3auv), 3awh, 3bct, (3bei), 3bgj, 3bmz, 3bnu, 3bof, 3cdk, (3cel), 3cjn, 3ckj, 3cva, 4aj, 4cu, 4eo, 4er, 4fj, 4fl, 4fm, 4iv, (4jj), (4jr), 4js, 4kr, 4kt, (4kw), 4me, 4mi, 4oa, (4oi), 4oy, 4pz, (4rl), 4rm, (4ry), 4rz, 4sa, 4sh, 4si, (4tv), (4uv), 4wp, 4aae, (4aah), 4ask, (5aj), 5eh, (5ew), (5he), (5nr), (5pa), 5qs, 5rg, (5acf), (5ach), 5aej, (5afd), (5agn), (5akn), 5ann, 5aph, (5aqi), 5ask, (5ati), (5atu), 5atv, (6ae), (6bq), 6ct, 6dh, 6ea, 6eb, (6ih), 6js, (6li), 6rw, 6sb, (6sz), 6tq, 6tx, (6vc), 6vr, (6aaf), (6aec), (6aff), 6agk, 6agt, 6aiv, 6aji, (6ake), 6akm, (6apk), 6aqp, 6ase, (6atu), 6aum, 6awj, 6bcq, 6bdn, 6bev, 6bgv, 6bil, (6bjj), (6bkx), 6bmw, 6bqr, 6bqu, 6buc, 6buy, (6bve), 6bvf, 6bvl, 6bvq, 6bvs, 6bwa, (6cah), (6cbb), (6cbj), 6ccv, (6cdy), (6cgc), 6cgo, 6cgw, 6cig, (6ckx), 6cmq, 6cms, (6cpf), 6crs, 6crx, (6csw), 6cto, 6cua, 6cub, (6cuk), (6dab), (6dah), (6dai), 6dam, 6das, 6dat, 6dch, 6dck, 6xad, (6zbe), (7ao), 7au, 7ay, 7dc, (7dd), 7df, 7fl, 7it, (7lu), (7mf), (7ow), (7oz), (7to), 7uv, 7aek, 7aib, 7xaf, a2CM, a2DS, a2IJ, a2YI, a3EF, (a3JU), a3YX, (c1AR), (c1EI), c2BG, c2CG, c3AA, (c4AA), c4AC, c4AX, c4CT, c4GT, c5BA, c5CT, (c5EF), c5HP, ch2LD, (huFX-1), hu6TQ, (hu6AFF), hu6BUC, m1AA, (m1AF), m1AX, m1B, m1G, m1J, m1K, m1N, m1X, m9A, pr4KT, (pr4OI), (pr4RL), pr4SA, q2BY, z1AO, z1AX, z2AC, z2AE, (z2XA), z4AG, (z4AK), z4AL, z4AR, z4AS, BR-7, XA-1, KFUH, MZ, NAS, NEDJ, NERK-1, NISV, NKF, NPG, NPM, NPU, (NRRL), NSF, NUMM, (NVE), (WAP), WGY, WIR, WIZ, WVY.

By 6ASM, R. 2, Box 952N, Inglewood, Calif. C. Nichols, "op."

2bbx, 2kuf, 2xaf, 5akz, 5agn, 5atv, 6ae, 6aqp, 6bvy, 6bur, 6bgo, 6cwl, 6cia, 6cns, 6ct, 6cej, 6cfe, 6che, 6dam, 6dat, 6dai, 6dan, 6ea, 6fa, 6jp, 6js, 6li, 6lj, 6nx, 6oi, 6rw, 6sz, 6ut, 6ws, 6yd, 7ay, 7adm, 7aci, 7dd, 7eo, 7ev, 7fd, 7kg, 7ku, 7lo, 7ly, 7uz, 8nk, 8xn, 9apm, 9akf, 9bkr, 9bht, 9ddp, 9dqu, 9dfh, 9ek, 9oo, 9se, 9wo, 9xi, 9xn. Foreign—Canada: C-4AA, C-4GT, C-5EF. Mexico: M-1AA, M-9A, M-1B. Commercial: nkf, npm, npu, npg, kel, wap, wir, wiz. Miscellaneous: FX-1.

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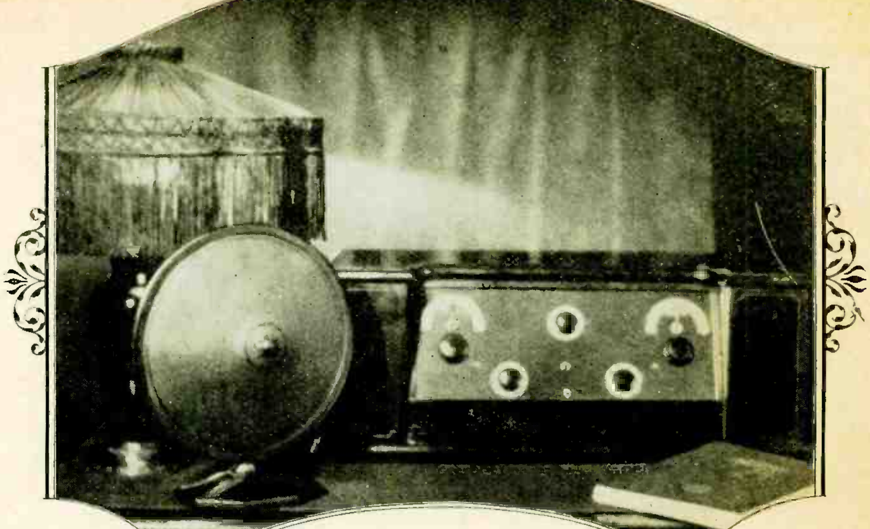
2 TUBE 51 S. D.
Mahogany finished cabinet holds all batteries............$23.50



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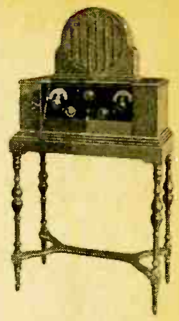

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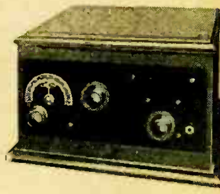

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Yet that is not all. Simplicity of design and fewer parts make manufacturing costs lower and bring about a lower cost to you. This, combined with the economies of gigantic production, makes possible a price of $60.00 on the Super-Trirdyn Special, the most efficient and beautiful of all Crosley receiving sets. For Crosley is the world's largest builder of radio sets—owning and operating parts factories, cabinet woodworking establishments and assembly plants.

Listen to a Crosley Super-Trirdyn under the most exacting conditions. Make an unbiased comparison with the most costly receiver you have ever heard. Forget the radical difference in price.

Then will you understand why the Crosley Super-Trirdyn represents a genuine achievement in radio performance and value which all America was quick to recognize and reward with increasing sales.

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Add 10% to all prices West of Rocky Mountains. Crosley owns and operates WLW, first remote control super-power broadcasting station.

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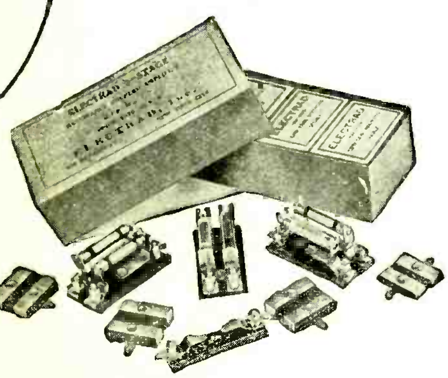

YOU want more from your loud speaker than noise, distortion, howls and squeals. You want pure tones, clear and mellow whether high, low or of medium pitch. You expect faithful reproduction.

Such reproduction is made possible by resistance coupling amplification. Lower initial and operating costs, simpler assembly, and superior results make this method of amplification most popular.

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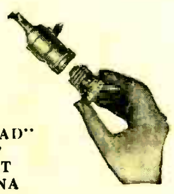

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Plugs in on any light socket. Reduces static and other interference. No outdoor aerial needed.

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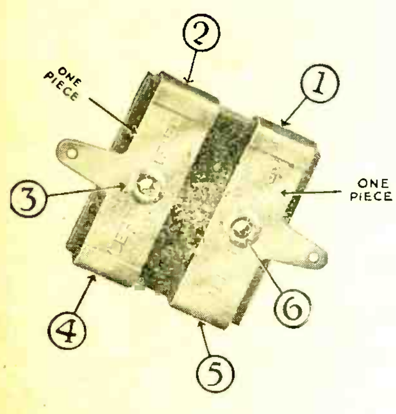

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Variohms, Audiohms, Lightning Arresters, Lead-Ins and many other "Electrad" radio products are on sale at your dealer's. Sent direct if he can't supply.

HOW TO REDUCE INTERFERENCE

(*Continued from Page* 17)

changes the wavelength—affects the tuning—excessively in most cases, too. This can be overcome partially or completely by proper construction of the tickler coil. The cause is clearly explained by mutual inductance which mysterious technical term is discussed at great length in most text books on radio theory.

This correct construction comes in the mechanical dimensions of the tickler more than its electrical. Nevertheless the electrical dimensions do their part. Exact dimensions for the tickler for your set can not be given, for they vary with the secondary, the way the set is wired up, and similar things. The diameter of the tickler can be taken care of by a simple rule: it should be half the diameter of the secondary it tickles, or less. The length of the winding on the tickler

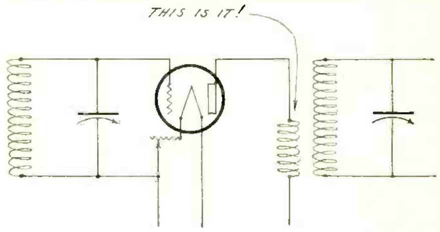

Fig. 3. Primary of Second R. F. Transformer.

needs to be as short as possible. This is easiest achieved with fine wire, so don't use a size greater than 30 d.s.c.

Then there remains a final thing for you, the builder, to do. Make the set complete. Have the tickler with an excessive number of turns—in general, any number of turns greater than 30 is too many. Then go about removing turns until the set will just oscillate at the highest wavelength it will tune to, with the tickler set at maximum or nearly so. Any tickler that will cause oscillation under those conditions will also cause it if the tuner is adjusted to its lowest wavelength, provided the wave tuning ratio is not more than 3 or 4 to 1. After each removal of a turn or two from the tickler, it should be re-connected and tried until the proper condition is reached. This is not as laborious as it sounds and can often be completed within ten or fifteen minutes after starting. Once done you will have a receiver whose secondary log can be depended upon, assuming that a similar record is kept of the primary switch adjustments. A record of the tickler adjustments need not be kept, for it will have little effect on the actual tuning.

All of this will be useless if one other detail is not remembered as a necessary point in the set design. Both the primary coupling coil and the tickler must be mounted at the filament return end of the secondary. This is indicated definitely in Fig. 2 by the schematic arrangement.

Quality Sells Them - Not Price!

Brightson True Blue Radio Tubes

TO THOSE who hold quality above price in making a purchase, True Blue Radio Tubes tell a story of values which continue to mark them The Finest Radio Tube in the World. Evidence of their value is given in their remarkably rapid increase in sales to thousands of radio fans, amateurs and engineers whose friends use and recommend True Blue Tubes.

Exclusive Qualities of True Blue Tubes

1. Every True Blue Tube is like every other True Blue Tube—there is no need of switching tubes to get best results.
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True Blue Tubes are sold with a 60 day written guarantee against defects. Users can return them in 10 days if unsatisfactory. True Blue Tubes are 6 volt ¼ ampere storage battery tubes made with standard base and small base. Ask your dealer to show them to you.

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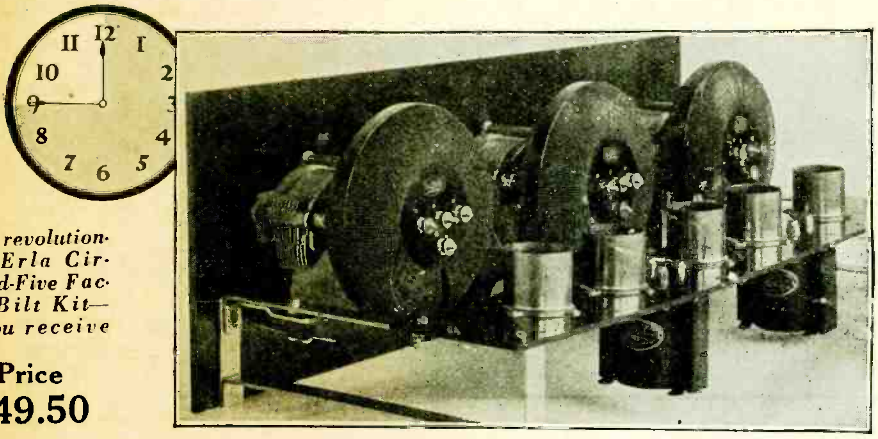

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Price $49.50

This new type kit is factory assembled. Ready cut, flexible, solderless leads make it ridiculously easy to wire. Amazing new inductance principle brings results hardly thought possible. Send for book, *Better Radio Reception.*

NOW anyone can build the finest of receivers in only a few minutes. No more wire bending or soldering. Merely attach a few ready cut, flexible eyeletted leads and the job is done. The finished set is unsurpassed even by the costliest factory-built receiver.

But most amazing is the new inductance principle incorporated in this last word in kits—called the Erla Circloid principle of amplification.

Four vital improvements result from this great discovery, which are not found in ordinary sets.

1. *Greater Distance:* Erla *Balloon *Circloids have no external field, consequently do not affect adjacent coils or wiring circuits. This enables concentration of proportionately higher amplification in each stage, with materially increased sensitivity and range.

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***Write for free information on kit—also book.* See how 45 minutes of fun will give you the newest and most nearly perfected set known to radio science. Easy as A-B-C to finish. Examine it at any Erla dealer's, or send the coupon for full information, illustrations and diagrams *free*. Also ask for remarkable new book, "Better Radio Reception," describing the sensational new Circloid principle. Enclose 10c for mailing and postage on book.**

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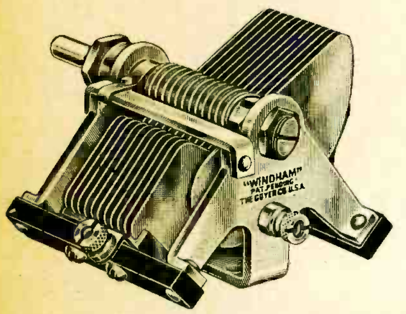
The "Windham" Variable Condenser



A durable, rigid instrument with correct electrical characteristics and made by skilled mechanics. It is provided with adjustable bronze cone bearings, the brake is independent of the bearings and adjustable. The plates are straight line.

It occupies small space, single hole mounting.
The price is right.
Desirable territory open.

The Goyer Company, Willimantic, Conn., U. S. A.

LIMITATIONS OF HORN TYPE LOUD SPEAKERS

(*Continued from Page* 19)

not improve greatly the performance of a poor unit. Apparently that is the trouble here. Unit peaks occur at frequencies of 450, 1100 and 1800 cycles. The unit does not respond with any degree of satisfaction above 2000 cycles, nor below 300 cycles. Even though the horn may be superior, the loud speaker itself cannot give good results unless the unit is a good one. Either unit or horn can spoil a loud speaker, but either one alone cannot make a good speaker.

The horn for Fig. 6 is similar in shape and size to No. 5 but the unit is better so that the response is quite good from 900 to 4000 cycles. There are no sharp peaks over this region. Below 900 cycles we have one peak at 600 cycles, below which the loud speaker does not respond well. The frequency range covered by this loud speaker extends, then, from about 500 to 4000 cycles, whereas for No. 5, the range is 400 to 2100.

The units for Fig. 1 and 6 were almost identical in their construction and operation, but the horns were different. The latter curve indicates much more uniform and intense response than the former. This shows us again the need for both a good horn and an efficient unit if we are to obtain satisfactory results.

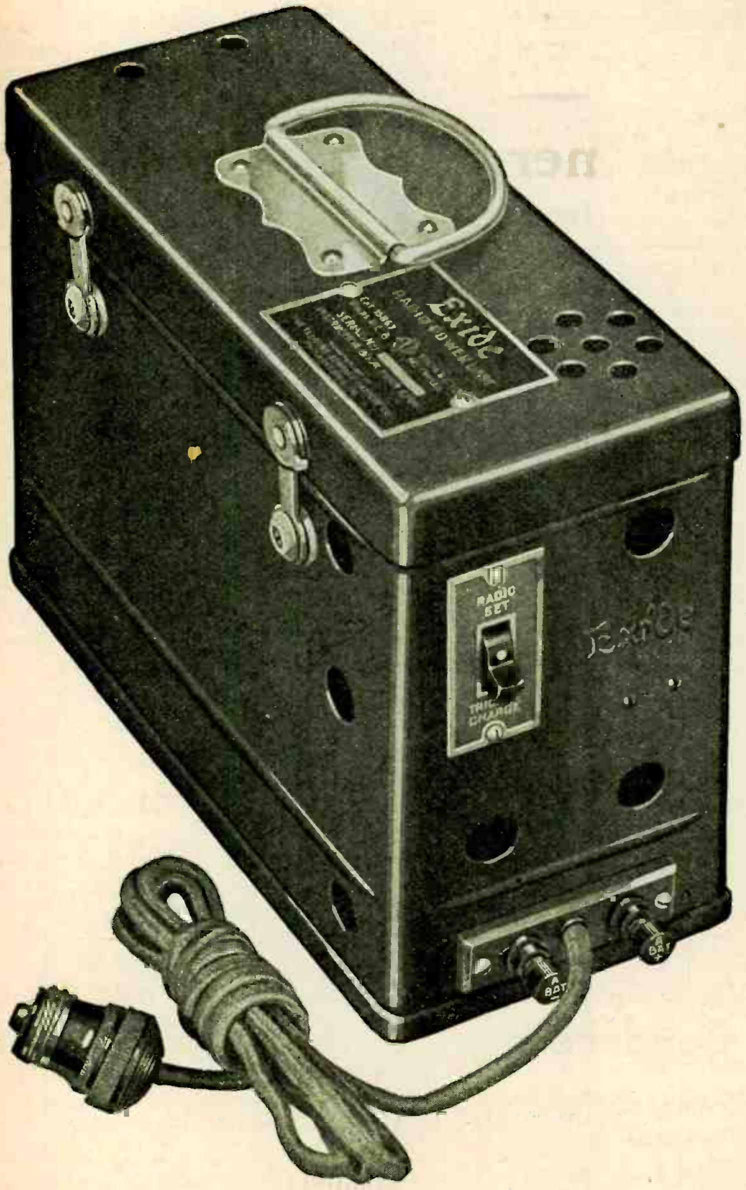
It is apparent that the response-frequency curves should be flat curves parallel to the horizontal zero pressure line. They should be as far as possible above this zero sound pressure, for this height will indicate the efficiency or sensitiveness of the loud speaker. Furthermore, the curve should extend to as low and to as high frequencies as possible. The curve will then indicate the quality or faithfulness of reproduction. If the curve falls off rapidly at low frequencies, as all of them do for short horns, then the loud speaker will have a high pitched, nasal sound. If the higher frequencies (2000 to 5000) are absent, then the reproduction will not be clear and brilliant, but will be muffled and speech would be difficult to understand, and it would sound distinctly high pitched and unnatural if the low frequencies are absent as will always be the case for small, short horns.

The characteristics of various musical instruments and of the human voice include frequencies from well below 100 cycles to well above 6000 cycles. In radio these sounds should all be reproduced by the loud speaker to correspond as nearly as possible to the original. A study of the various loud speakers by means of these curves will be the most certain way to know to what extent a loud speaker is doing this.

In general loud speakers with small horns give incomplete sound reproduction, covering only a small musical range

(*Continued on Page* 70)

Announcing the *New* radio battery that is always charged



HERE is something that will be welcomed by all radio fans—a compact "A" storage battery and charger, known as the Exide Radio Power Unit.

This unit is assembled in an attractive metal case, and is kept at all times connected to the ordinary house current as well as to the radio set.

Upon raising a small switch on the end of the unit, the receiving set is ready for use; by throwing it down, the battery is automatically placed on charge. Thus battery-charging, in its most convenient form, practically becomes a part of set operation.

The battery, of course, is an Exide, specially designed for the unit, and has ample capacity for any receiving set—whether that set uses one tube or ten. As there are no moving parts to wear or get out of order, maintenance cost is low.

Finished in a rich mahogany color, the Exide Radio Power Unit is furnished in two sizes—one, for sets using 4-volt tubes; the other, for sets using 6-volt tubes; retailing at $28 and $38 respectively—slightly higher west of the Rockies.

There are, in addition, Exide "A" and "B" storage batteries for every requirement, and a rectifier for recharging "B" storage batteries. Inquire of any Exide Dealer or at your favorite radio store.

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FOR BETTER RADIO RECEPTION, USE STORAGE BATTERIES

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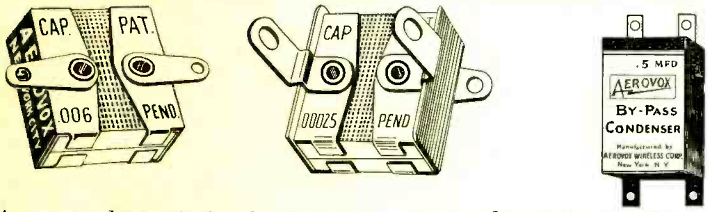

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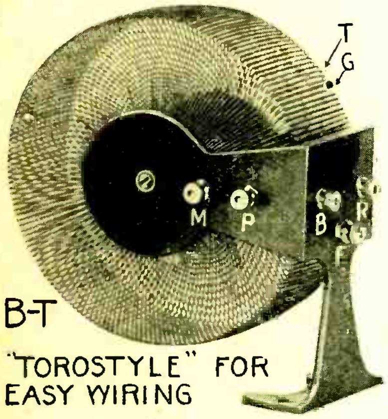
The B-T Torostyle Transformer

A well known principle now applied to radio



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For years telephone engineers have known that "closed" or "toroid style" coils could be used to eliminate "cross talk" between trunk lines.

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Our ambition has been realized. We now offer the B-T Torostyle Transformer with the assurance that its three great characteristics:

Reduction of inter-magnetic-coupling. Nullification of "strong feed-back effects." Elimination of signal pick-up have been obtained without the usual broad tuning and difficult oscillation control.

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Carter "IMP" Pilot Switch

$1.75

Half Size

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Eliminates possibility of going away and leaving tubes burning. Red light shows when filaments are lit. Complete quarter-turn snap switch and light in one. Simple to install. One-hole mounting. Works on 6 or 4½ volts. Current consumption negligible. One of the latest Carter radio achievements.

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MEMBER R.M.A.

(*Continued from Page 68*)

with much irregularity, with non-uniformity and with distortion.

Curves for horns of intermediate lengths, about 28 in. long, cover a wider frequency range, but still with considerable non-uniformity. With a cost ratio of 1½ to 1 a better performance can be purchased at a small increase in price.

Curves for longer horns, 3 to 10 ft., show that the mere bigness of a horn does not insure sucessful reproduction with loud speakers. Four ft. and 6 ft. horns are more sensitive than a 10 ft. horn and give more low frequencies. The 10 ft. horn is deficient above 2800 cycles while the other two continue to radiate sound up to 4000 cycles. The longer horns go to much lower frequencies but do not go into any higher frequencies and have many more peaks due to resonance.

Extensive tests show that a ⅝ in. opening at the small end gives the best results. Smaller openings introduce too much resistance to the sound transmission and larger openings do not allow sufficient pressure variation at the unit diaphragm to cause efficient radiation into the horn.

All curves indicate the marked superiority of exponential as compared to conical horns for the low frequencies, besides the fact that the former can be coiled up into a smaller space without greatly modifying its properties. Resonance effects are equally bad in both.

Many of the defects of the horn type have recently been remedied by means of the cone type loud speaker. Whereas the frequency range of the best commercial single horn type loud speaker is from 400 to 3000 cycles, of the double horn from 200 to 4000 cycles, and of the triple horn from 100 to 5000 cycles; a good cone type effectively covers the range from 100 to 7500 cycles with a nearly flat curve. One manufacturer has developed a cone only 6 in. in diameter which shows this remarkable result.

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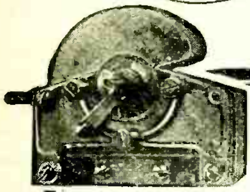
There's a kingdom at your doorway,
  There's a nation at your feet,
There's a world that does you homage,
  Kneels to you upon your seat.
You're the god that stirs our fancies,
  Like Aladdin's lamp of old,
You fulfill the dream of ages,
  Bringing treasures rare as gold.
Like the wise men in the story,
  From the near and distant lands
Thrill our souls with songs of passion
  From the land of desert sands;
Make our pulse rise with emotion
  When we hear Hawaiian strains,
Soothe the babes to rest and slumber
  Where the god of fairies reigns;
You can calm a flaming nation
  Through a subtle silver tongue,
You can rouse a land to glory
  By a noble deed that's done.
You have proven by electrons that
  All the universe is kin,
You have made us vastly wiser,
  Wiser than we would have been.
You can make the whole world better
  By a universal tongue,
By a greater understanding
  You can make the nations one.

—C. L. Parks.

www.americanradiohistory.com

SUPER SM PARTS



New!

Entirely silver-plated! With this unique feature, Silver-Marshall has set a new standard for low-loss condensers. It is only logical that the new S-M straight-line-wavelength condenser should be so built. Their losses are lower than laboratory standards, and the S-L-W plates insure *real* selectivity and separation.

No. 305	.0005	$6.00
No. 306	.00035	5.75
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Send for free circulars of New S-M Parts, and reprints of articles describing the Super-Autodyne and the All-Wave Superheterodyne.

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106 S. Wabash Avenue
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48 Pages of
Programs, Photos, Humor, Musical Reviews, Schedules, Tables, Editorials, Etc.

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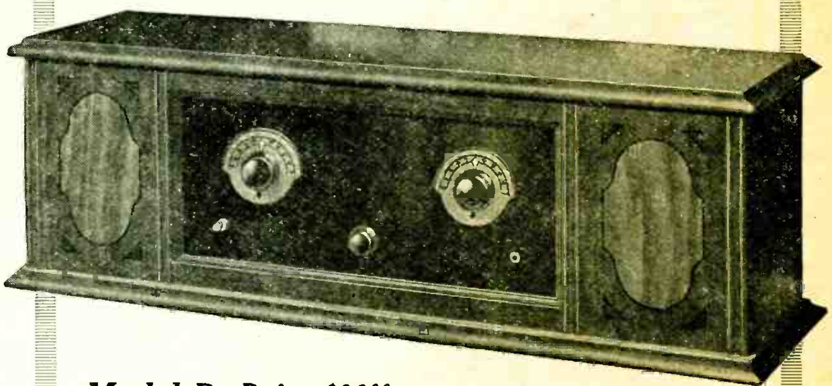
Preliminary Announcement

ALL-AMERICAN RADIO RECEIVERS



Model R: Price $90.00

There will be available this fall a limited number of radio receivers, produced and wired complete in the big, new ALL-AMERICAN factory, and bearing the world-famous name ALL-AMERICAN.

Many hundreds of sets have been constructed in the ALL-AMERICAN laboratories. Most of them have performed in a manner which, in less experienced factories, would have caused joyful excitement. A few of these sets have shown results truly remarkable even when measured by the ALL-AMERICAN standard; but E. N. Rauland, pioneer in radio and severest critic of ALL-AMERICAN products, shook his head and said "Wait."

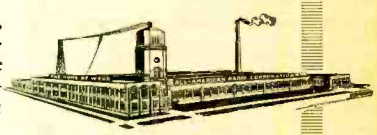
And he was wise. If this achievement had not come until next year, it would still have been worth waiting for. But it is on view at the shows.

Last year it was our pleasure to add to the family of the "World's Largest Selling Transformers" an audio amplifying instrument embodying features hitherto considered impractical, outside the laboratory, on account of their high cost. This new transformer, *Rauland-Lyric*, has in one season revolutionized the tone-amplifying art. And now, in the same spirit, we offer the ALL-AMERICAN Receiver.

ALL-AMERICAN Receivers embody, necessarily, all the genuine improvements of the past year in radio reception—many of them the especial product of the ALL-AMERICAN laboratories. Multistage control through *two* 360° dials, *without gears*, the elimination of "body capacity," the extreme of beauty in tone through *Rauland-Lyric*, and of distance, power and selectivity through ALL-AMERICAN Straight-Line-Frequency TUNING—these are combined with the utmost beauty and permanence in external appointments.

And yet, ALL-AMERICAN Receivers are not high-priced This is due to the fact that, although only a small number will be produced this fall, the price has been set on the basis of next year's extensive production.

Dealers who realize the significance, for future growth, of handling merchandise of this character, are invited to write their jobbers or the factory for full information, or to visit our booth at the Chicago or St. Louis radio shows.



ALL-AMERICAN RADIO CORPORATION
E. N. Rauland, President
4209 Belmont Avenue — Chicago

OWNING AND OPERATING STATION WENR — 266 METERS

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Pioneers in the Radio Industry

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CLARITY

THE OBEDIENT SLAVE TO YOUR DESIRES

FROM the mellow depth to the highest pitch of harmony—the improved APEX Receiving Sets bring in, with startling clarity and naturalness, all of the delicate gradations of the entire range of sound—whether the highest soprano or the deepest of bassos profundo.

The charm of naturalness, combined with greater distance getting ability, positive selectivity and full volume, plus the enchanting elegance of design and finish, present radio receiving sets that are most satisfactory in every element of operation and a real delight to all whose choice of home furnishings is guided by true appreciation of artistic and refined beauty.

Only a dependable merchant is given the APEX dealer franchise. *Your* APEX dealer will gladly make personal demonstration of APEX Quality Radio Apparatus.

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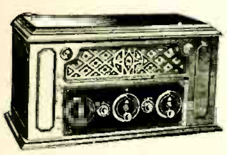
Chicago

Also makers of the famous APEX Vernier Dials and APEX Rheostats, which are sold by every good dealer in Radio.

Quality Radio Apparatus

Apex Entertainer
Price $22.50

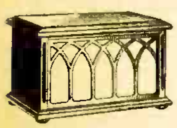
Apex Super Five
Price $95
without accessories



Apex De Luxe
Price $135

Apex
Baby Grand Console
Price $225

Apex Utility
Radio Table
Price $75



Apex Console Entertainer
Price $27.50

Prices West of Rockies slightly higher. Canadian prices approximately 40% higher.

Upon request, we will gladly mail you descriptive folder.

Western Representative:
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Seattle, Portland, Los Angeles and Salt Lake City

Northern California Distributor:
UNITED RADIO SUPPLIES COMPANY
San Francisco California

PIERCING NEPTUNE'S SHROUD

(*Continued from Page* 13)

in the other. Confusion may also arise in some cases when taking bearings on shore beacons. It was an 180-degree error of this sort that two years ago at Point Arguello, California, wrecked an entire fleet of United States naval destroyers which were proceeding at high speed in a dense fog.

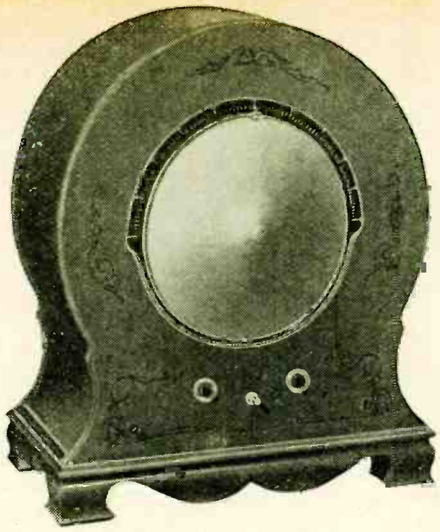
This defect of the earlier compasses has also now been completely overcome in a very interesting manner. In Fig. 5 (a) a loop is shown turned edgewise toward an advancing radio wave, the same as in Fig. 1; but here we have a single wire antenna connected to one side of the loop—in this case to the rear side, *r*. This antenna is of such length that it will pick up just about enough energy—combined with the energy induced in *r*—to neutralize the energy induced in *f*. The loop alone would have a current flowing in it, owing to the difference in potential of the radio wave at *f* and *r*, as already explained, but by using the antenna the difference is nullified.

Now if this loop, with its attached aerial, is rotated half a turn, as shown in Fig. 5 (b), the conditions of Fig. 5 (a) will be reversed. What was the rear edge of the loop, with respect to the advancing radio wave, is now the front edge; and its increased current by virtue of this new position will be augmented by the energy brought in by the connected aerial. The combined currents will greatly overbalance the feeble current in what is now the rear side of the loop. In one edgewise position of the loop, the energy brought in by the aerial is added to the low potential side of the loop and therefore counterbalances the greater energy in the high potential side, with resultant zero current in the wire; when the loop is turned around the energy brought in by the aerial is added to the high potential side of the loop, which now completely overbalances the unaided low-potential side, and a comparatively large current flows in the wire. When the edge of the loop with the aerial attached is toward the distant transmitter, signals are heard; when the other edge is foremost, the signals vanish, or at least they are greatly weakened.

In the actual operation of the compass, therefore, the loop is used both edgewise and flatwise, first edgewise with the antenna switched on to get the general direction of the distant station; then flatwise with the antenna switched off to get the exact direction.

AS TO practical details of construction: The loop of the modern compass consists of a rugged oaken frame frame 4 ft. square, upon which are wound 12 turns of Litz wire consisting of 270 strands of wire formed into a strong weatherproof cable. The loop,

(*Continued on Page* 74)



THOMPSON MINUET. A 5-tube dry cell Thompson Neutrodyne receiver combined with improved cone-shaped speaker. Unique "apartment house special" for use where space is at a premium. All batteries self-contained. Does not use a storage battery. Operates on dry cell tubes. If necessary, will operate on a wire around the picture moulding. Size—21½ inches high, 18½ inches wide, 10½ inches deep. Price, $150. (Slightly higher west of the Rocky Mountains and in Canada).

LICENSED BY INDEPENDENT RADIO MANUFACTURERS, INC. NEUTRODYNE REG. U.S. PAT. OFF. HAZELTINE PATS. NOS. 1450 080 AND 1489 228 PAT. MARCH 27, 1923 AND APRIL 1, 1924 OTHER PATENTS PENDING R.E. THOMPSON MFG. CO. 30 CHURCH ST. N.Y.C.

Hear this extraordinary Thompson Receiver

NEW in appearance — the Thompson Minuet. New in operation — the Thompson Minuet. New in performance—the Thompson Minuet. You have never seen, used or heard so supreme a receiver as this.

The beautiful mahogany cabinet is unique in shape. It incorporates the acoustic principles of the violin and 'cello. And such quality! Rich, resonant tones fill the room. The rolling thunder of the kettle-drums, the rumble of the bass viols come to you as well as the high-pitched violins and piccolo. Bass, baritone, tenor, contralto, soprano, with marvelous naturalness.

The single tuning control lever moves over the long scale covering half the circumference of the speaker. It is a new sensation in radio to operate the Minuet. Simply swing the control lever over the scale and the stations come in one following the other. Two verniers are provided, for those who wish hair-line tuning on distant stations. All batteries, "A," "B," and "C," are contained within the case, and the only external connections needed are to antenna and ground.

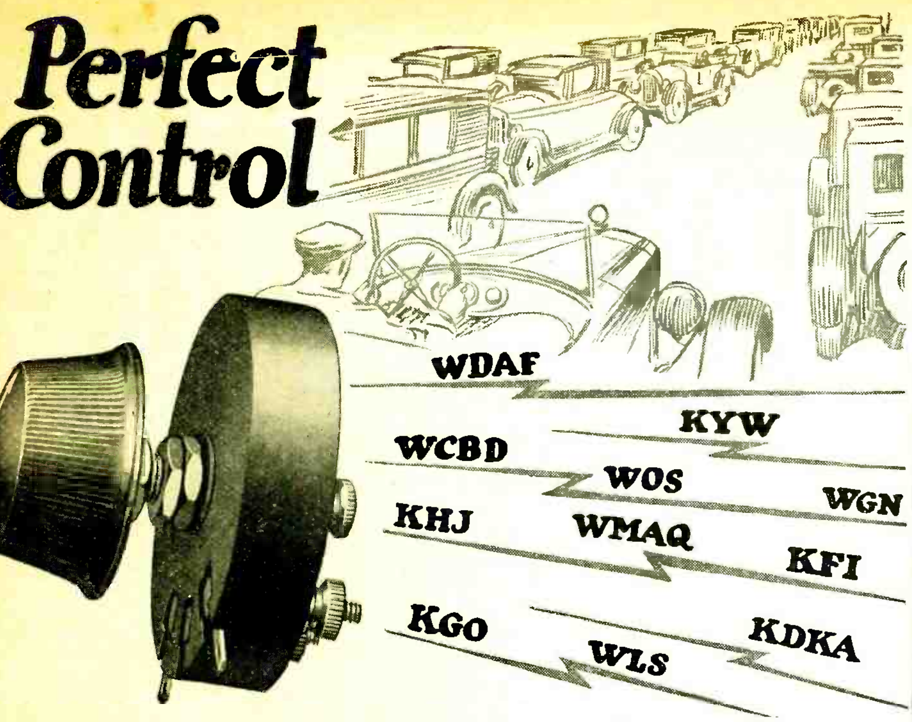
The long, unexcelled radio experience of the Thompson Company is yours when you buy the Minuet. It is your absolute assurance that in design, manufacture, and performance, you are buying the best.

The Thompson Minuet is sold by the better dealers everywhere. They are glad to let you see it, operate it, hear it. Investigate this instrument, the product of fifteen years' radio experience. The R. E. Thompson Manufacturing Company, 30 Church Street, New York City.

THOMPSON RADIO

www.americanradiohistory.com

Perfect Control



CAN you handle your radio set as easily as your automobile? Slip through radio traffic without bumping into unwanted stations, throttle down on the locals, or speed up to full volume on distant stations?

Control your radio receiver with a Centralab Radiohm for greatest flexibility and power. Gives smooth variation of resistance from zero to 200,000 ohms. Ideal for plate circuit control of oscillation. Now used as a standard unit by more than a score of prominent radio manufacturers.

$2.00 at your dealer, or mailed direct. Write for literature and circuits describing this and other Centralab patented controls.

CENTRAL RADIO LABORATORIES
14 Keefe Avenue Milwaukee, Wisconsin

Centralab

(*Continued from Page 72*)

which turns on ball bearings, has a heavy shaft extending downward into the ship's chart-room or wheel-house below. On this shaft a large polished hand-wheel is mounted for rotating the heavy loop, below that is the mechanical compensating device for absorbing errors, and still below that are mounted the two sight-wires, one above the other and about an inch apart, which swing over the face of a compass or dial.

The sight-wire system and dial, the general construction of the loop and its supports, and of the apparatus on the loop shaft below is clearly shown in the accompanying pictures. Nearest the ceiling is the automatic condenser device shunted across the loop, for balancing out the interfering capacity effects of the ship's funnels, ventilators, and so forth. The two loop wires may be seen running thence to the radio receiver, a six-tube tuned-frequency instrument comprising two stages of radio frequency —using ultra-permeable iron-core transformers—detector, and three stages of audio. The ends of the loop wires are shunted by a tuning condenser of about .001 mfd. capacity, and the independent loop system is inductively coupled to the first radio frequency tube by means of a transformer. In the very latest installations, the receiver is incorporated in a weatherproof metal compartment below the compass itself.

The radio compass has supplied the final "missing link" in the art of ocean navigation. By the aid of a single shore beacon, and her own log, a vessel can in the thickest fog determine her position and distance from land; taking bearings upon two or more beacons she can quickly and safely enter the most dangerous harbor in the thickest weather. The time of a ten thousand-ton steel freighter is conservatively worth one hundred dollars an hour; that of a large liner often a thousand dollars an hour or more; therefore the radio compass often saves enough in one short voyage to more than equal the cost of its installation. This, however, is of comparatively little importance as compared to the safety it affords to lives and to costly ships and cargoes.

The radio compass, by its annihilation of the perils of the fog, removes the last element of uncertainty at sea. It sets at naught the damp shrouds of Neptune, and leaves the hoary old sea-king little recourse but that of stirring up terrific storms and gales with his trident, whereby he may perhaps occasionally founder some of the older out-worn iron nags still wandering about the seven seas, but with which he can inflict no great injury upon the modern high-powered steel steamship. The radio compass has indeed made travel on the deep considerably safer than any form of travel on land—except perhaps that obtainable in a Chinese wheelbarrow.

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GOSILCO SUPER WIRE

Heavy silver plate on No. 14 copper with sheath of 24 karat gold.

Sets rewired with GOSILCO show 35% increase in volume and range (Official KNX Laboratories test). Aerials permanently efficient. Out-distance all others.

75-foot aerial, $4.50; 100, $6.00. Round bus wire, 15c per length, postpaid. C.O.D. orders filled.

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CARDWELL TORO-TRAN
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Super

AMPLIFYING TRANSFORMERS

Standard on the majority of quality sets

KENNEDY

The Royalty of Radio

Writes: "We are cranks on audio-frequency transformers and our engineers are constantly running comparative tests on them. The fact that we continue to use Thordarsons exclusively, in ever increasing numbers, simply means that we believe that it is the best available at this time."

Thordarsons are Absolutely Uniform!

They always "match up" perfectly

One reason that leading builders of fine sets use *more* Thordarsons than all competitive transformers combined is because Thordarsons run *absolutely alike, absolutely uniform;* always "match up" perfectly.

Daily we hear from fans who paid high prices for musically named, fancy-looking transformers, only to discover that their old standbys — Thordarsons — were the *real* musical instruments. For the benefit of others, we therefore repeat: "when better transformers can be bought they will be Thordarsons."

Few, if any, transformers actually cost as much to make as Thordarsons. Why, then, pay more? Follow the lead of the leaders—build or replace with Thordarsons. Any store can supply you. If dealer is sold out, order from us.

ZENITH
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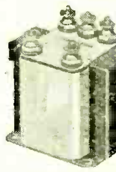
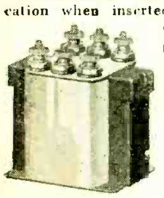
KUSTOMBILT *and many others*

THORDARSON TYPES AND PRICES

Thordarson Super Audio Frequency Transformers, sub-panel or top mounting types: 2-1, $5; 3½-1, $4; 6-1, $4.50.



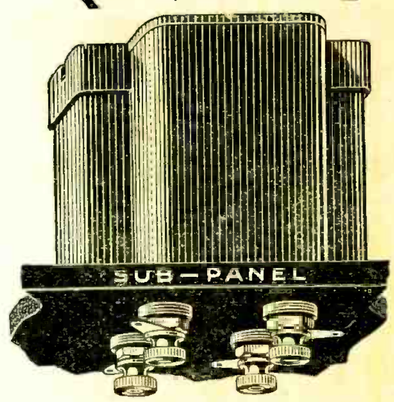
Thordarson Power Amplifying Transformers give best results when preceded by two stages using 3½-1 Thordarson A. F. Transformers. Pair, $13.



The Thordarson INTER-STAGE Power Amplifying Transformer provides two stages of POWER amplification when inserted in circuit between Input and Output Power Amplifying transformers. Four tubes are required, but the quality of the reception more than repays you. Only Thordarson builds a transformer of this type. Each, $8.00.

Thordarson AUTOFORMER, the All Frequency Amplifier, amplifies clearly the *lowest* notes of any instrument as perfectly as the highest notes. Autoformer amplification is an adaptation of impedances, resistances and capacities — developed and perfected by Thordarson. Write for the Autoformer Hook-up Bulletin. Autoformers are $5.00 each.

Write for the latest Thordarson bulletins on amplification.
Thordarson dealers everywhere.



SUB-PANEL MOUNTING THORDARSONS ON SALE!

They permit a neater assembly, the shortening of leads and the concealing of wiring—as in factory built sets. Same ratios—same prices—as standard type Thordarsons. If dealer cannot supply, order from us.

Super-Het Builders

For the "Best" 45,000 Cycle Super-Heterodyne, "Radio" and other leading authorities recommend in highest terms the Thordarson 2-1 Ratio Transformers. Take no others.

THORDARSON ELECTRIC MANUFACTURING CO.
Transformer specialists since 1895
WORLD'S OLDEST AND LARGEST EXCLUSIVE TRANSFORMER MAKERS
Chicago, U.S.A.

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Who Built That Fine Set?

Dear Mr. Radio-Shop Owner and Mr. Set-Builder:

How many times are your customers asked the above question by their friends? And how often the answer is, "A fellow over in town." Why not have your name and address in fine, attractive engraving on every panel? We will put it there for you for from 25 to 50 cents per panel. Then the receiver is not an unknown job; it is your set.

BAKELITE ENGRAVING COSTS SMASHED! With newest types of high-speed engraving machines, imported from Germany, we have halved the costs of bakelite engraving. Even if you are already using engraving, get our prices.

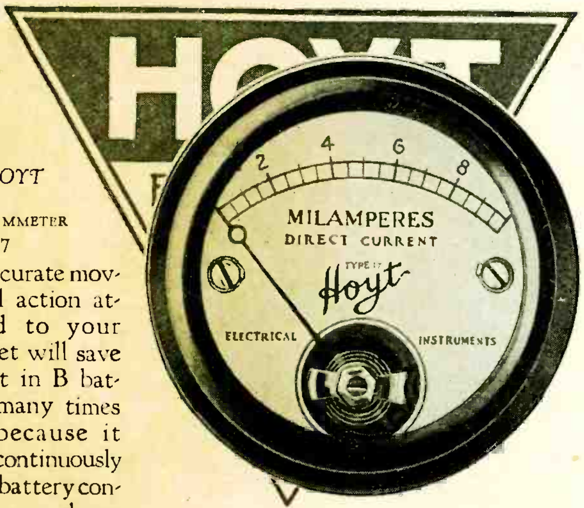
HIGH-QUALITY CELERON BAKELITE PANELS AND TUBING. Cut any size, to order. Panels, list price, 1/8 inch thick, 1½ cents per square inch; 3/16 inch thick, 2 1/3 cents per square inch, including smooth-sawing, waxing, and polishing. Standard wholesale discounts, with extra 5% for orders of over $25.00. We drill panels.

Get our discount sheets. Wholesale only.

660 Twelfth St. **Volney G. Mathison & Co.** Oakland, Calif.

Distributor of Engraving Machines, $525.00, and up.

HOYT METERS *Insure Reliable Radio Reception*



This HOYT 2 INCH MILLIAMMETER TYPE 17 *with* accurate moving-coil action attached to your radio set will save its cost in B batteries many times over because it checks continuously your B battery consumption; and possible short circuits.

HOYT builds a full line of Radio Meters in all sizes and types. These are described in our book *"Hoyt Meters for Radio."* A request will bring it to you.

BURTON-ROGERS COMPANY
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Notice to our Readers

We have a few copies of the August, 1925 issue of "RADIO" on hand. This issue contains Best's Super-Heterodyne feature.

Send 25c for a Copy

Pacific Building "RADIO" San Francisco

L-C CIRCUIT

(*Continued from Page* 16)

by means of a small screw mounted in the center of the condenser, a rough adjustment being made by turning this screw until oscillation ceases, or is reduced to a very small part of the condenser scale. Then remove the r.f. amplifier tube from its socket and place a piece of paper on top of the positive filament spring, replacing the tube in the socket. The local station will no doubt be heard faintly, and the neutralizing condenser can now be adjusted until no signal is heard, as is customary in the adjustment of neutrodyne receivers. One make of vacuum tube has such a low interelectrode capacity that the neutralizing condenser is not needed, and may be omitted.

After the neutralizing condenser is in order, the piece of paper on the socket spring contact can be removed and the tube filament lighted. If oscillation still persists, the antenna coil and r.f. transformer may be closer than is desirable, and the coils should be separated further, if such a procedure is possible.

Ordinarily, the volume control of this set can be obtained by changing the tuning of either of the variable condensers slightly, but many prefer a separate volume control, and in this case, it will be advisable to mount a 25 ohm wire type rheostat on the panel, between the two tuning condensers and underneath the feedback condenser to replace the automatic filament cartridge in the r.f. amplifier tube positive lead. The position of this rheostat in the circuit is shown in Fig. 1, and in dotted lines in Figs. 2 and 3. This rheostat was not used in the experimental layout, as it was desired to make the set as simple as possible in regard to controls.

If more volume is required, for loud speaker operation in a large room, one of the new UX-112 power tubes, which draw .5 amperes at 6 volts, can be placed in the last audio stage, the *B* battery for that tube being increased to 135 volts, and the *C* battery to minus 9 volts. A type 112 Amperite should be used in that case, to control the filament current.

With an average antenna having a total length of 75 feet, including lead-in, the range of this receiver at night is very great, stations 1000 miles distant being brought in with ease, through powerful locals. For those luckless individuals who reside a few rods from one of the high powered stations, a suggestion about shielding will be in order. Shield the inside of the cabinet, and the back of the panel, with a fairly heavy grade of sheet brass, such as No. 16 gauge, drilling holes in the brass to clear the panel apparatus. As there are relatively few parts on the panel, this will be an easy job. Connect the shielding to the ground terminal, and little difficulty will be experienced with interference from local stations.

www.americanradiohistory.com

What Do You Know About

Short Wave Broadcasting?

¶ Do you know that Station KDKA has been heard in Spain, England, France and even South Africa on Low Waves?

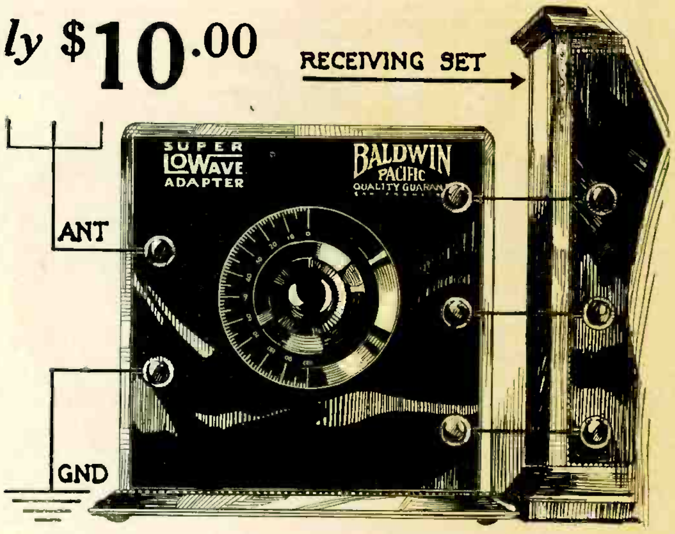
¶ Do you know that short waves point the way for future international broadcasts and rebroadcasts of foreign programmes?

¶ Do you know that high frequency broadcasting requires special and absolute precision in its application as a means of communication?

Within the last few weeks radio listeners on four continents have become aware of a new phase in the development of radio broadcasting, namely, the use of short wave lengths in the transmission of radio broadcasting programs. A quick succession of spectacular accomplishments in radio broadcasting and rebroadcasting has brought this system of transmission prominently to the attention of the public. The successful reception and repeating in England of programs from KDKA at Pittsburgh, Pa., the reception of this same station by the ship Arctic, while lying in the frozen North, only 11 degrees from the North Pole; then the successful reception of the Wills-Firpo boxing match in Argentine; and finally the consistent reception of Station KDKA in England, France, Germany, Spain and South Africa during the recent international tests, have made it evident that something different was being introduced in broadcasting which has pushed the limits for successful reception out to much greater distances.

NEW!

Only $10.00



Super LoWave Adapter

Attach to Any Superheterodyne

Receive

KDKA - WGY - KFKX

and other Radiocasting stations on their Powerful Low Wave Programs

SIMPLE AND EASY TO USE

The Baldwin-Pacific "Super LoWave Adapter" is designed to cover a wave length from 40 to 125 meters so as to enable reception of various radiocasting stations operating from 62 to 100 meters such as KDKA, WGY and KFKX.
Just connect the adapter to the Super-Heterodyne receiver so that the three terminals ordinarily connected to the three tap loop antenna are connected to the three binding posts at the right of the adapter. In case the receiving set uses a two tap loop, connect the receiver to the upper and lower binding posts, or when used with Radiola and similar Super-Heterodyne receivers, ABANDON THE CENTER POST ON THE ADAPTER. The antenna and ground are connected to the binding posts so marked on the adapter. Complete and simple directions accompany each adapter.

Send for your Super LoWave Adapter today. Order from your regular dealer. If he cannot supply you, shipment will be made direct upon receipt of remittance or via Parcel Post or Express C. O. D.

Dealers and Jobbers:
write for attractive proposition

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St. Louis: 1724 Olive Street
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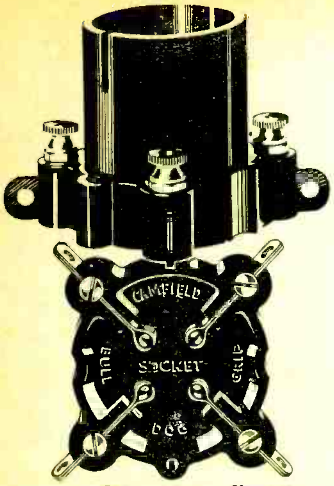


Side and Bottom View of Camfield Bull Dog Grip Socket

The NEW

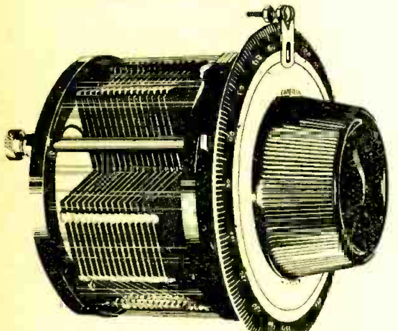
CAMFIELD

Bull Dog Grip Socket

Fits Every Type of Tube!

The Camfield *Universal* Bull Dog Grip Socket—like all other Camfield products—has *utility features* that place it in the lead:

1. It fits all types of tubes, including the new X Type.
2. It grips the tube prongs on all sides, assuring a solid contact.
3. Contacts are made of heavy phosphor bronze.
4. Flanges on prong grips allow tubes to slip into socket easily.
5. And the price—65c each.



CAMFIELD STRAIGHT LINE LOW LOSS CONDENSER

"In the transparent dust-proof case"

This condenser embodies a new principle of construction, combining every essential and desirable feature in a single unit. Its straight-line action, together with the 360° dial, absolutely eliminates the necessity of a vernier.

The Camfield Condenser is enclosed in a transparent Dust-Proof Case, which prevents the accumulation of dust between the plates, thus making it PERMANENTLY LOW-LOSS. Sold in three sizes, as follows:

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

CAMFIELD RADIO MANUFACTURING CO.

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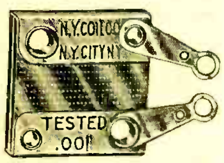

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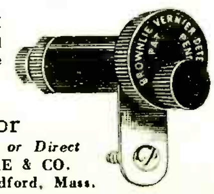

ANTENNA CHARACTERISTICS

(*Continued from Page 21*)

rather pronounced directional properties. Thus the directional effect of the antenna itself should not be given any particular thought or worry, but instead, consideration should be given to keeping it away from intervening objects, particularly metal obstructions.

Effective height is a gage of the amount of energy intercepted from the electro-static or electro-magnetic component of the wave front. Effective height is, of necessity, less than the actual height, although the ratio of effective to actual height is an extremely variable quantity. An antenna only 20 ft. above the ground may have a greater effective height than one 10 ft. above a grounded metal roof on a high building. Effective height is increased by placing the receiving set close to the ground. In general, the greater the effective height of an antenna the better the results, assuming no interference. However, an excessively high antenna, especially one having many wires, gives a considerable increase in static to signal ratio. This idea is not imaginary for it may be verified by actual experiment. To illustrate, a test made by the writer will be described.

A large multi-wire antenna having a horizontal portion 90 ft. above the ground was used with a regenerative receiving set and audio amplifier. On a certain night static was so severe as to prevent reception from any station from a greater distance than 100 miles. The receiving set was then disconnected from the outside antenna and an improvised single-wire antenna was erected inside the building. Understandable reception was then obtained from stations three or four hundred miles distant. From this one must not assume that an inside antenna is to be recommended. This test, while showing the disadvantage of too large an antenna, was made under unusually severe static conditions.

One frequently hears the remark concerning the antenna—"The higher the better." The basis of this statement is undoubtedly the greater effective height which may result by suspending an antenna from tall supports. However the single objection of an increase in static to signal ratio usually places a fairly definite limit to the size and height of the antenna. In general, if the antenna is erected in a locality which is free from obstructions, it should not be more than 50 ft. above the ground nor more than 100 ft. long. In most cases the limiting values of capacities previously specified will satisfactorily determine the size of the antenna.

Study the characteristics of your antenna and you will not only add to your knowledge of radio principles but you will be able to obtain improved re-

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sults. Remember that the antenna is not merely a wire stuck up in the air for the purpose of "catching" radio waves, but like other parts of the receiving circuit, it behaves according to certain well-defined laws. Before placing too much belief in claims made for a particular type of antenna or for a particular kind of antenna conductor, let these claims be brought before the tribunal of antenna characteristics and in many cases they will be found wanting.

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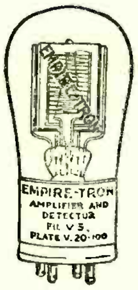

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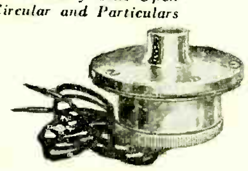

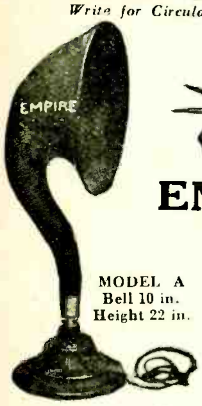

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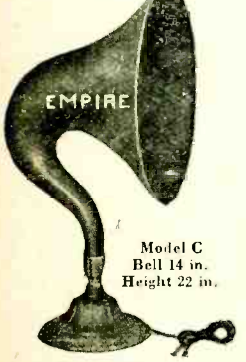

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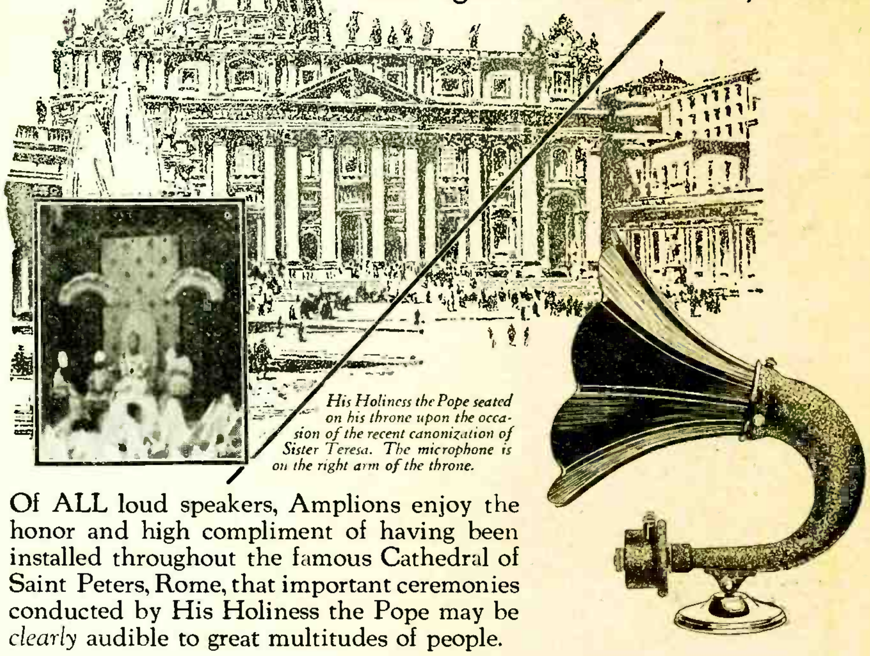

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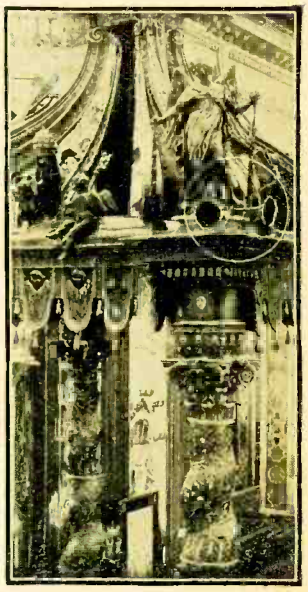

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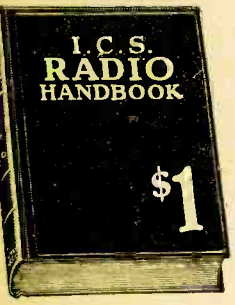

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ELIMINATION OF OSCILLATIONS

(*Continued from Page 22*)

to reduce stray fields several principles are utilized. To reduce electrostatic coupling the different radio frequency stages may be placed in separate screened compartments. Such amplifiers have been made commercially, although they are not popular in radiocast receivers.

The coils may also be wound so as to reduce electrostatic and magnetic coupling while placing each condenser in a metal grounded case. It was known long ago that if a winding be added to any single layer coil of the same number of turns as the coil and closely superimposed but oppositely wound, then by connecting one end of the superimposed coil to the main coil and leaving the other end free, we will get a marked screening effect and the main coil will have little external electrostatic field.

The geometric form of winding will also greatly influence both fields. Thus a toroidal coil has a much smaller external magnetic field than a simple cylindrical coil. Similarly the "figure eight" coil has a reduced external field. Many variations of these principles are conceivable and used in modern receivers, all of which have the advantage of retaining selectivity and sensitivity while still ridding themselves of the undesired oscillation feature.

In our third group of methods we include those wherein an attempt is made to balance out or neutralize whatever electrostatic couplings exist in the tubes themselves, a type of coupling which we have not yet discussed. It will be found that when all coupling between coils, condensers and wiring has been eliminated there still may remain a tendency to oscillate, especially at the lower wavelengths. Such a tendency can be explained only when we look into the vacuum tubes themselves. Each vacuum tube consists of three elements, the plate, grid and filament. There is some slight electrostatic capacity between the plate and grid as shown in Fig. 2. Any current variation in the plate circuit will cause the potential of that electrode to rise and fall correspondingly. As the plate voltage fluctuates it tends to force a current across the minute plate-to-grid capacity C_1, thence through the condenser circuit back to the filament. In this way any radio current in the plate will tend to cause a minute grid current which will *reinforce* the original plate current. Thus any slight accidental oscillation in the second stage of amplification will tend to perpetuate itself in this way and build up a continuous oscillation of the whole system.

What steps can we take to reduce this unavoidable capacity between grid and plate? First, obviously by making the plate and grid as small, geometrically,

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as possible. Small tubes should therefore show less of this effect than larger ones, which is a fact. The other method is typified by the principle of the neutrodyne receiver, where we neutralize instead of reduce the tube capacity. The capacity is neutralized by artificially introducing a potential which will be opposite in effect to the potential causing the oscillation.

How the result is obtained may be seen by the circuits in Fig. 2. C_1 represents the disturbing plate and grid capacity, C_2 is the capacity of the neutralizing device. To cause a grid current

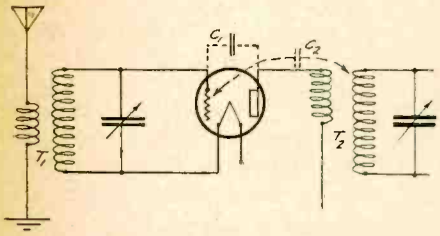

Fig. 2. Circuit Showing Tube Capacity and Neutralizing Capacity.

equal and *opposite* to the one flowing as a result of C_1, use is made of the transformer T_2. The voltage of the secondary of this transformer is *opposite* in phase to that across the primary, because its windings are purposely made opposite. Hence if a tap be made at some point in the secondary and led through a small neutralizing capacity C_2 to the grid, then we will have the condition of an *opposite* voltage being impressed on the grid through this new agency. By proper choice of the tapping point and by adjusting C_2 we can get an *equal* as well as *opposite* voltage. Thus the disturbing current due to C_1 is always opposed and neutralized by a current through C_2. Each stage of the neutrodyne receiver is neutralized in this manner. The advantages of receivers working under this principle are these: selectivity and sensitivity, no tendency to oscillate when each stage is properly balanced, and large tubes may be used because the minute tube capacities play no part after being neutralized.

The soft white cotton sold in drug stores as "absorbent cotton" makes a very good shock-absorber for tube bases. It should be kept well away from the metal terminals, however, as it usually will absorb some water in damp weather, and may cause trouble.

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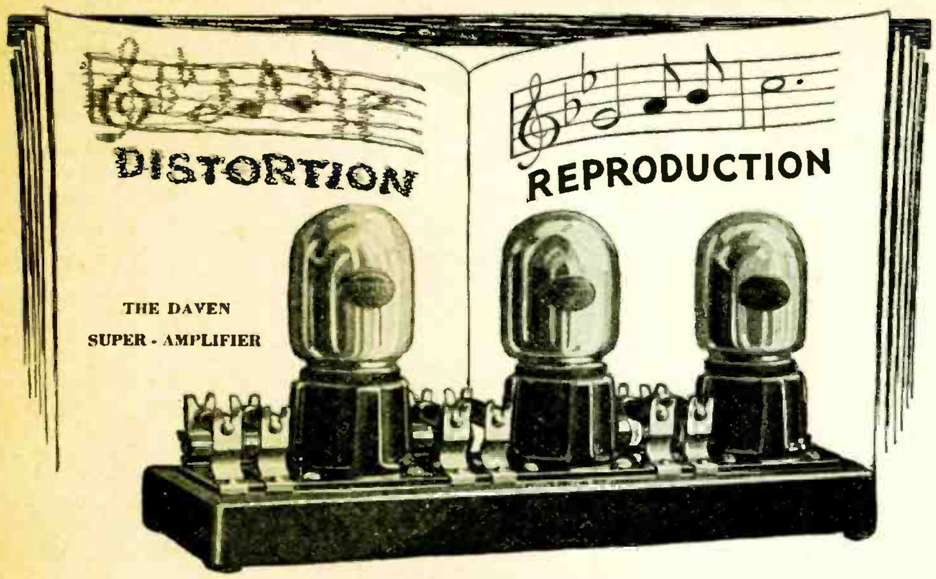

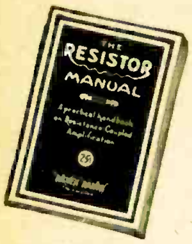

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(*Continued from Page* 28)

meter indication to 1/10 scale. This makes the 10 ampere range.

If the work has been carefully done you will now have a fairly accurate universal meter with which you can measure any voltage from 1/1000 to 200 volts and any current from 1/1000 to 10 amperes. For anyone having ready access to a variety of meters much of this work can be eliminated. Instead of stepping up from one range to the next, as we have described here, it would be possible to calibrate all the ranges from a standard in the same manner as was described for the initial ranges of this meter.

Also if it was not desired to bother with adjusting each range to an even value on the scale by means of extra resistance in series with the regular resistors, one could put in standard ready-made resistors of any desired value and then, noting from the standard meter what the full scale value was with any given resistor, straight line curves could be plotted and used with the meter.

If each of the ranges is made a divisor or multiple of 100 as described herein, and the meter is equipped with a 0-100 scale, a table showing the ranges obtainable on each point may be made and fastened in the cover of the instrument. An example of such a chart is shown herewith.

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Voltage Range		*Current Range*	
Point 1	.050 Volt	Point 1	.020 Amp.
Point 2	.100 Volt	Point 2	.040 Amp.
Point 3	1.000 Volt	Point 3	.100 Amp.
Point 4	10. Volts	Point 4	.500 Amp.
Point 5	20. Volts	Point 5	1.000 Amp.
Point 6	200. Volts	Point 6	10. Amps.

HOW RADIO CIRCUITS WORK

(*Continued from Page* 25)

better than words how the opposition to currents of resonate frequency is extremely high. So far as reactance is concerned, this opposition is infinite. This is desirable, for the greater the opposition, the greater will be the voltage drop across the combination, and consequently more voltage will be impressed on the detector. The opposition cannot approach infinity, however, because of the resistance in the circuit.

The grid circuit of the amplifier tube has its source of voltage in the secondary coil, where it is induced by currents flowing in the antenna coil. The secondary coil, with the condenser, may be considered in series, with the induced secondary voltage across them, as in Fig. 4. The reactance diagram is then similar to that for the antenna circuit. The reactance diagrams are simple to

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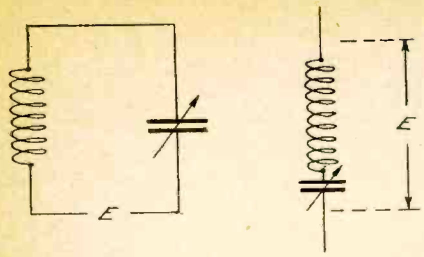

Fig. 4. Equivalent of Amplifier Grid Circuit.

use, and are extremely helpful in the cases of complex and coupled circuits. By drawing the simplified, equivalent circuit, combining susceptances for parallel connections, and reactances for series connections, the total reactance curve will be obtained, which will give a perspective of the action of the circuit as a whole.

Resistance has no part in the determination of resonance conditions, as can be seen from inspection of the formula for resonate frequency—resistance does not enter. However, when the resonate condition is reached, resistance becomes the all-important factor. It alone determines what current will flow, and what energy will be lost. The less the resistance in a series circuit, the greater will be the flow of current; the less the resistance in a parallel circuit, the greater will be the voltage drop across the combination. That is the reason for the "low-loss" products of today.

The grid condenser, the leak, the batteries, rheostats, etc., are not strictly parts of radio circuits. They are auxiliaries in the functioning of the tube, helping to convert the radio-frequency energy delivered by the radio circuits, into audible sound. The capacity of the tube, and its accessories, are small enough to have negligible effect, at broadcast frequencies, on the radio circuits.

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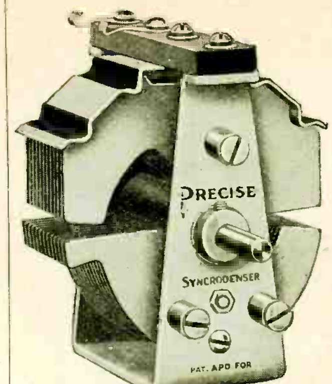

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With a coil of proper inductance, the Syncrodenser produces straight line frequency characteristics from 0 to 50 on the dial and capacity characteristics from 50 to 100. This allows ideal separation of stations on the dial. The lower half of the dial, which normally has most broadcast stations, now has fewer, while the upper half has more than on ordinary condensers. This permits much finer tuning for every station on broadcast wave lengths.

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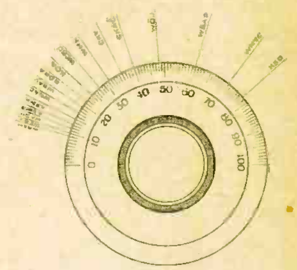
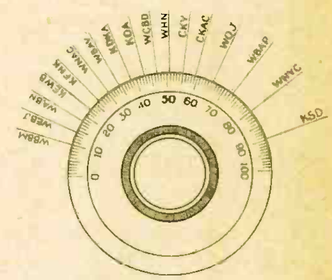


How broadcast stations are spaced on the ordinary condenser



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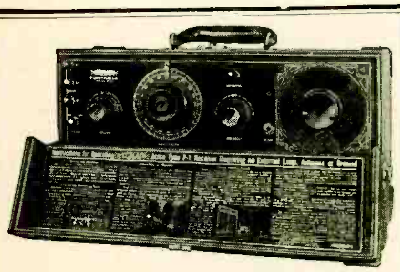

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FROST-RADIO PAN-TAB JACKS ARE BEST *for* YOUR RADIO SET

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Through the air of the evening, calm and sweet comes a cradle song from a distant city. Then, as never before, we feel the need of radio amplifiers which will bring out, strong and clear, just the pure beauty of music. For such moments is the joy of owning the one amplifying instrument selected by world-famed musical authorities for the purity of its tone: Rauland-Lyric.

Rauland-Lyric is a laboratory-grade audio transformer designed especially for music lovers. The price is nine dollars. Descriptive circular with amplification curve will be mailed on request. All-American Radio Corporation, 4201 Belmont Ave., Chicago.

Rauland-Lyric
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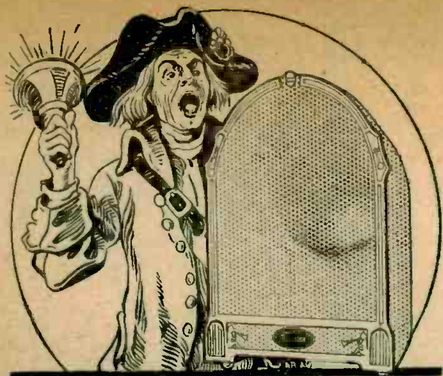
The Choice of Noted Music Critics



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SUPERTRAN
REGISTERED U.S. PATENT OFFICE
AUDIO TRANSFORMER

A DETECTING, OSCILLATING AND MODULATING RADIOCAST WAVEMETER

(*Continued from Page* 30)

of the panel, front and left side of the cabinet. Such shielding was found unnecessary in the instrument illustrated.

Test of the modulator buzzer can also be made at this time. The regenerative receiver is set at a non-oscillating point, as is customary in ordinary reception; and our wavemeter buzzer switched on. The distance between the wavemeter and receiver is then gradually reduced until the modulated wave becomes audible in the loudspeaker or phones of the receiver. The phones of the wavemeter may be left in circuit, but much stronger modulation of its wave will be obtained when they are disconnected, as the plate current of the tube is thus considerably increased. It must also be remembered that the inductance coil of the wavemeter is lying on its side and the waves from it are propagated bilaterally, being somewhat analogous to reception on a loop. The wavemeter is, in fact a miniature loop transmitter, and our receiver must be somewhat in the direction of the plane of its coil for maximum energy transfer.

Calibration

ROUGH calibration of the completed instrument may be made from reception of available radiocast stations. The instrument is very loosely coupled (2 or 3 ft.) either to a coil composed of a few turns of wire which is connected to an antenna and ground; or to a standard receiver, which at the same time will be helpful in determining the identity of each station tuned in. A calibration chart or graph for the instrument is prepared, giving dial settings on the lower horizontal scale and wavelengths in meters on the left hand vertical. Ordinary cross-section paper may be used, or a chart of special size so as to fit the cover of the cabinet may be formulated, as illustrated in Fig. 1. Headphones are plugged in, and the regenerative coil set on the point of maximum coupling, as indicated by the *Oscl* marker, and the tube switched on. Stations whose wavelengths are definitely known are first tuned in on the receiver; then on the wavemeter and by fine adjustment of the vernier knob the point of zero beat reception is noted (the middle of the squeal). In this condition the wavelength of our wavemeter circuit is the same as that of the transmitting station, and a dot is placed on our chart at the point where this wavelength in meters and dial setting of the instrument cross. Stations of other wavelengths are tuned in similarly, corresponding dots being placed on the chart, until a continuous row is formed, through which may be drawn a line,

(*Continued on Page* 86)

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Price **$5.50**

COCKADAY COIL

Because the success of his 4-circuit tuner so largely depended on the efficiency of the coil, Cockaday in specifying the Precision Cockaday Coil, paid a great compliment to the marked accuracy and efficiency of Precision Coils.

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PRECISION R-F COUPLERS

This highly efficient coil is one of the finest radio frequency coils on the market. The hard rubber core is octagonal in shape, with the sides concave, permitting the wire to touch at only eight points. This gives a coil that is 90% air core and yet having the rigidity of one wound on a solid surface cylinder.

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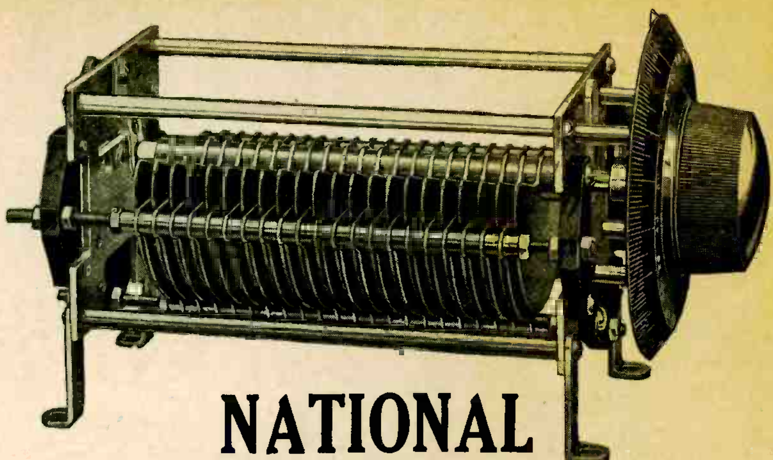
Built to Amateur Specifications for the Amateur



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IDEAL for Short-Wave Experimentation. Used by Lieutenant Frederick H. Schnell, Traffic Manager, American Radio Relay League, for communication with amateurs during the Pacific Fleet cruise in Australian waters.

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Type 150—3000 150 MMFd. (.00015 MF). 3/16" spacing (ordinarily known as double spacing), 3000 volt flashover. Fine for 5W and normal 50W sets. Proper size for Primary circuits. Price, $7.50.

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Type 100—6000 100 MMF. (.0001 MF). 3/8" spacing, 6000 volt flashover, for the overloaded "50" and the "250" W. Plenty big enough for the primary, too. All prices include 4" Velvet Vernier Dial. Price, $12.50.

"NATIONAL" can furnish you with 5 or 3 plate Receiving Variables for that short wave receiver. Send for Bulletin 106 R. B.

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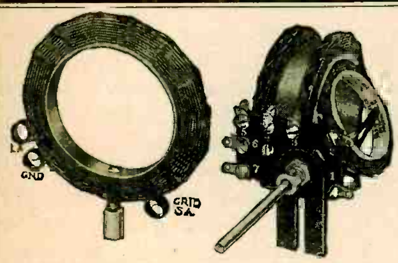

Coil Set No. 24 for Browning-Drake Circuit

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For Browning-Drake Roberts, Craig and Hoyt Circuits
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Sickles Coils for the famous Browning-Drake Circuit are the latest Sickles achievement in efficient design for a particular use. They are priced at $7.50 a set.

The New No. 18A Coils for any Roberts Circuit are absolutely standard equipment. They are priced at $8.00 per set.

Coil Set No. 20, at $4.50, is for use sepcifically with the New Reflex Receiver designed by Albert G. Craig using the Sodion detector.

Coils for the Hoyt Circuit at $10.00 a set for the Knockout Reflex Circuit at $4.00 a pair, and the Tuned Radio Frequency coils at $2.00 each are other standard Sickles Coils. We manufacture also for manufacturers special requirements.

Send for descriptive catalog

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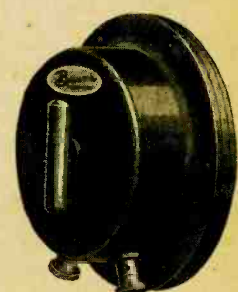

The large size of this Unit gives great range with tone of most pleasing quality, which, combined with the special amplifying properties of the Burns horn, produces remarkable results. A speaker that will add to the enjoyment of any receiving set. Pleases the eye as well as the ear.

Horn is of a distinctive design with pyralin flare in several handsome finishes.

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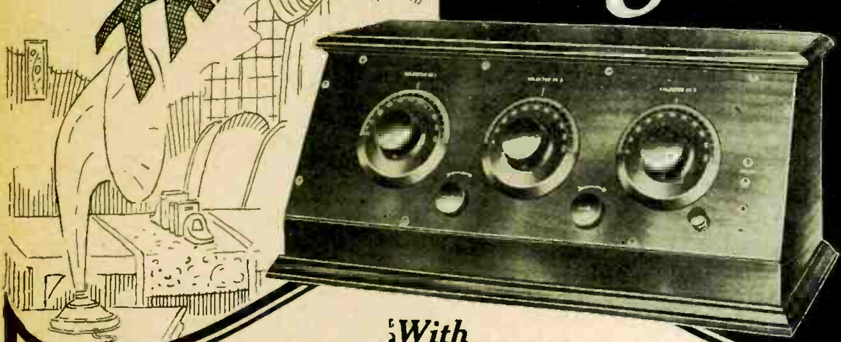
(*Continued from Page 84*)

Again Chelsea Triumphs

New CHELSEA Super Five

$50.00



With Added Features

These new models defy comparison, possessing all the refinements and efficiency of the highest priced sets. The ultimate in selectivity and volume, yet a child can get results.

The Super-Five, with its beautiful mahogany cabinet, rugged bus wiring, hand-soldered connections, no unsightly binding posts, and other advanced features, meets the popular demand for a moderately priced Receiver of highest quality.

$26.00 Three Tube Receiver

Licensed Under Armstrong Patent No. 1113149

The only genuine Armstrong circuit 3-Tube Receiver with a dust-proof, fool-proof inside panel protecting the "vitals." Cord connections to batteries and many other refinements. For distance and real tone quality, the equal of many $100 Sets. See it at your Dealer's.

Other Chelsea Models include the Super-Six, $60, and the Super-Five with fine Built-in Speaker, $125.

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thus filling in the blank spaces, and giving us a complete calibration curve.

As before stated, no antenna and ground connection is made to the instrument, and its coupling to the coil or receiver used in connection with its calibration is very loose, a matter of several feet. No closer coupling is necessary, in fact too close coupling will give false readings and also interfere with our neighbor, since the instrument is oscillating. Thus by observing the golden rule we attain accuracy.

The foregoing is considered the most continuously available means of calibration. The simplest method is by comparison with a commercial wavemeter, determining resonance by the click method, which will be subsequently discussed. Calibration may also be effected by using honeycomb or duo-lateral coils, their natural period being given by the manufacturers. Of these three the first is considered the most reliable, provided you know accurately the wavelengths of the various stations. Commercial wavemeters having good accuracy on the lower wavelengths are seldom available, and coils even of the same manufacture are found to vary.

Final calibration should be made from either one of the Standard Frequency Stations. One of these is located at Washington, D. C., and the other at Palo Alto, California, and of such power that practically the entire United States is covered in their combined transmissions. For those residing within about 500 miles of either of these stations, calibration may be obtained by loosely coupling the wavemeter to a small coil in series with an antenna and ground, as described. Use of a receiver will be unnecessary except at greater distances, where some form of tuned pickup may be employed. At the extreme limits a regenerative receiver may be first tuned to either WWV's or 6XBM's wave by the zero beat reception method; then the wavemeter tuned to the receiver in like manner, thus giving an accurate point for our chart. The constructor of this instrument is urged to take advantage of these transmissions, as accuracy in the finished product is thus assured. These transmissions are bi-monthly, announcements of which, including time, wavelength, etc., appear in the Monthly Radio Service Bulletin and most radio publications.

The determination of resonance, and,

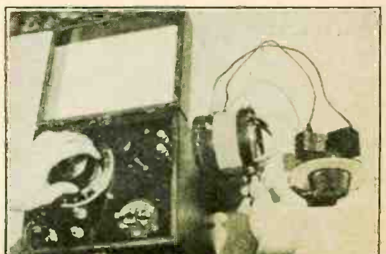

Fig. 5. Determination of Resonance and Wavelength by the Click Method.

(*Continued on Page 88*)

HOOKUPS! HOOKUPS! HOOKUPS!

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The first national illustrated radio weekly.

Other features: Diamond of the Air Circuit, by Herman Bernard, which has swept the country; a somewhat different Question and Answer Department; seven days of programs; list of broadcasting stations; latest developments in the art and science of radio, weeks ahead of other publications; technical and human-interest pictures.

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CALIBRATION FEES

WAVEMETERS:	$1.00 for first two coils, $.35 for each additional coil; $.50 extra for each curve. For buzzer type the calibration covers 100-3000 meters; for vacuum tube type 25-25,000 meters; tube type to be accompanied by actual tube and statement of filament, plate and grid voltage to be used and anticipated range of each coil.
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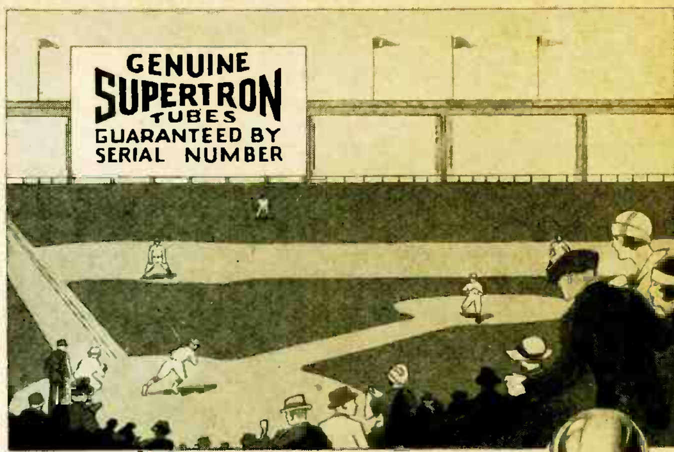

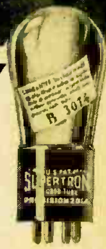

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THE last inning — tie score — and the bases are full—you hear the crowd yelling!!!—then you hold your breath, for that moment—Alas! You are disappointed, reception has Ceased, due to faulty tubes.

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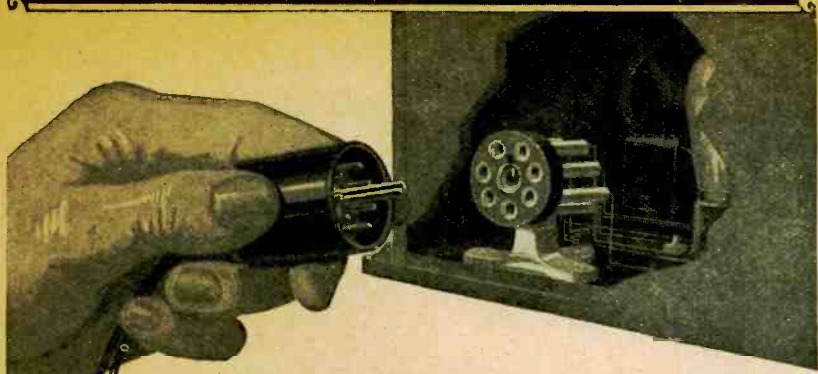

Affording a plug and socket connection between the radio set and all outside connections, Jones Multi-Plug is as essential to the radio as a cord and socket to the electric iron. For safety and convenience, leading set manufacturers have adopted this item as standard equipment. You, too, need a Multi-Plug for the set you are building or the set you now have. See your dealer or write direct for descriptive folder A.

Type BM-For set building $4.50
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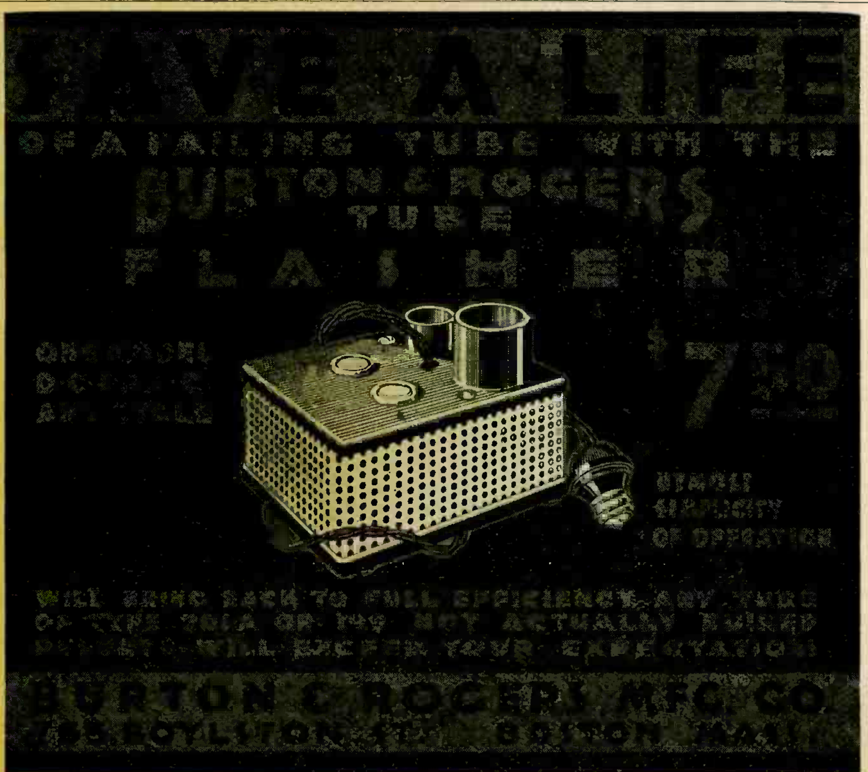
MULTI-PLUG
THE STANDARD SET CONNECTOR



(*Continued from Page* 86)

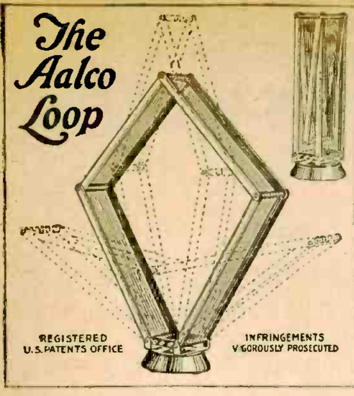
if our instrument is properly calibrated, the measurement of wavelengths is simplicity to the *n*th degree. We simply hold the coil or circuit whose wavelength is to be measured close to the instrument and slowly rotate the 4 in. dial, as illustrated in Fig. 5. When the wavelength of our wavemeter circuit coincides with that of the unknown coil or circuit, a sharp click is heard in the wavemeter phones. This click denotes the point of resonance, and by referring to our calibration chart we find the wavelength of the circuit under test.

If you are the owner of a regenerative receiver, this determination of resonance by the click method may be demonstrated to your own satisfaction on your own set. Cause the detector tube to oscillate and place a 150 turn honeycomb coil near the coil of the detector circuit. The inductance and distributed capacity of a 150 turn honeycomb coil is such that its natural wavelength, with the ends free is approximately 281 meters, and when we tune our oscillating detector circuit past this wavelength setting, a sharp click will be heard in the phones or loudspeaker. In the absence of a coil, a wavetrap may be used. When the wavelength of the trap and detector circuit coincide, we obtain the same results, provided the coupling is close.

This last procedure is also an excellent method for determining which is the oscillating tube in an unbalanced neutrodyne or defective tuned R. F. receiver. Since the wavelength of the trap is variable, a tube's oscillation may be detected on any wave setting. Such experiments on a receiver should be performed with antenna and ground disconnected, better still, outside of radiocast hours, since it is necessary to have an oscillating circuit.

The explanation of this click phenomenon is quite simple. In our wavemeter we have an oscillating circuit which is radiating energy at a constant rate. Thus the current in the headphones is constant. When a second circuit is magnetically coupled to the wavemeter and the two circuits brought in tune, the oscillations in the first circuit suddenly disappear when the point of resonance is reached. Their disappearance is caused by the greater amount of energy absorption from the wavemeter at exact resonance, less amount being transferred between the two circuits at points near resonance, and practically none when the wavelengths of the two differ by any appreciable amount. Disappearance of oscillations in our wavemeter causes a sharp change in the tube's plate current, thus giving rise to the click, which is quite similar to the click produced in any regenerative receiver when changed from the oscillating to the non-oscillating state by varying the regeneration.

(*Continued on Page* 90)



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Wiring Always Taut

GUARANTEED FOR LIFE

THE AALCO—the lowest resistance loop made—assures maximum selectivity and range---Perfect dial matching made possible by variable inductance. Constructed of the finest materials throughout in new and masterly fashion.

SPECIFICATIONS: Length, 24 in.---Normal Ht., 30 in.---Wavelength range 120-600 meters. Laboratory test results sent upon request.

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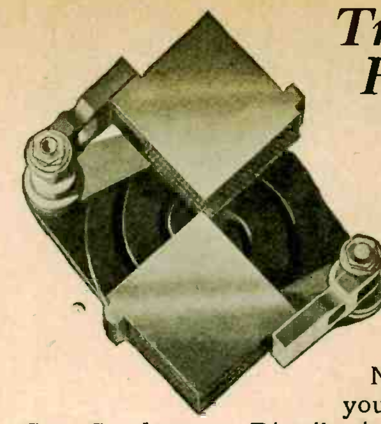

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The Signal Spiral Cam Condenser

No more "bunched up" stations when you equip your sets with Signal Spiral Cam Condensers. Distribution over the 360° of the dial makes tuning simple. Ten more points of superiority are as follows:

1. Concentration of electrostatic field in center of condenser.
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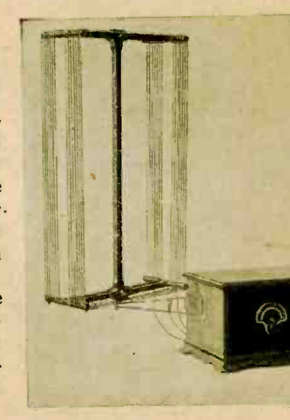
10. Design which permits mounting air core transformers directly on the condenser.

The Signal Spiral Cam Condenser is built in three capacities—all one price. See one at your dealer's. Write us for a chart that proves the efficiency of this unit. It's conclusive evidence!

This Loop Attaches to Your Cabinet



Solves the problem of using a loop in close quarters. It is designed with a special bracket to be mounted on the end of the radio cabinet. This does away with "that extra piece of apparatus." At the same time, the aerial may be easily disconnected for moving about without unmounting the bracket. It can be turned a full 360° in a space no greater than the width of the average cabinet.

The Signal Bracket Type Loop Aerial has all the advantages of the famous Signal Table Type Loop Aerial illustrated at the left. Built of solid walnut with extra tap for super-heterodynes and other circuits requiring a shorter aerial. See both types at your dealers. They are built for results.

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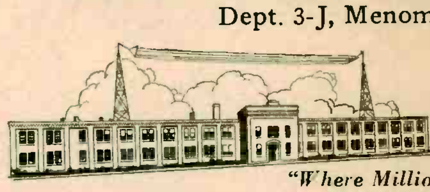

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Audio Transformers and Voltmeters

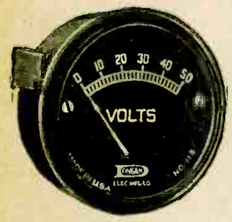
42 Set Mfgrs. Use Them

Type S
Audio Transformer
Special quality in this handsome mounted transformer.
Attractive prices.

It is only natural that Dongan can continue to manufacture Audio Transformers that suit the requirements of the great majority of receiving set manufacturers. Many of the men in today's organization have been designing and building Dongan Transformers for fifteen years.

Better Audio Transformers priced specially for set manufacturers; a reputation for quality always maintained; deliveries when you need them—all are assured Dongan customers.

This year many sets achieve a new sales appeal by the use of Dongan Voltmeters. Built into the set, Dongan Voltmeters become most essential to fans who like to keep performance up to par. Accuracy throughout the scale is a dependable feature of Dongan Voltmeters.



Type N
Voltmeter
One of 5 types. Range 0-7, 0-50, 0-100 volts. A guaranteed high-grade instrument

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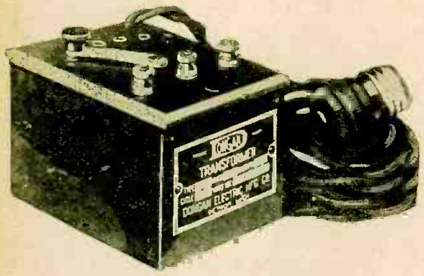
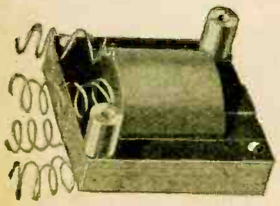
The Radio Public is demanding reliable merchandise like Dongan Transformers and Voltmeters. You will find Dongan parts the last word in design, construction and appearance. Our discounts allow you a generous profit—Dongan Repeat Sales assure it.



Type B. A. C. Tube Transformer



For B-Eliminators Use Dongan Transformers and Chokes

Type CSB
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One of 35 types exclusively for set mfgrs. Performance equal to any.

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Mocking Bird Unit

Patented

$7.50 List

All fans remember the pioneer of adjustment units—Morrison Model C. For 3 years this unit was a standard of comparison. In trend with radio's great growth, Morrison now offers the Mocking Bird Unit, the peer of all units.

You cannot equal the tone reproduction of the Mocking Bird Unit attached to the phonograph. Radio assumes new delights—purity of tone and the remarkable volume (adjustable) are marvelous.

The Handsome Mocking Bird Cabinet at $30 list is a real musical masterpiece. Morrison Mocking Bird Cabinets and Units at most good dealers or send your order to factory. Absolute money-back guarantee if not satisfied.

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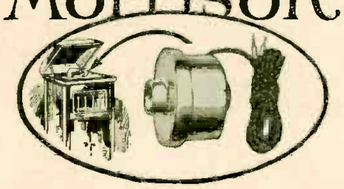

Loud Speaker

(*Continued from Page* 88)

By varying the coupling between these two resonant circuits, the degree of sharpness of this click may be changed, the smaller the coupling the sharper the click, until a point is found where a barely perceptible movement of the dial is all that is necessary. Thus accuracy of resonance observation is obtainable within less than 0.1 degree on our wavemeter dial. Just so, when determining the wavelength of a circuit, we first couple it close to the wavemeter and determine its approximate resonant point; then by gradually increasing the distance and at the same time varying the wavemeter setting in slight amounts across this click point, we attain accuracy in a high degree.

Uses and Refinements

THE wavemeter as thus far described is considered as an all purpose testing instrument. Its first obvious use is as a receiver. In the experimenter's or constructor's laboratory, or in the radio shop its uses are manifold. As an oscillator, regenerative receivers may be calibrated with great accuracy; and when the buzzer is used in conjunction, any non-regenerative set may be calibrated. With such an instrument it is not necessary to wait for a radiocast station of sufficient strength to come on the air, when it is desired to test a receiver, balance a neutrodyne or tuned radio frequency outfit. In use, the stability of adjustment and sharpness of its wave is practically a duplicate of the wave emitted by any transmitting station, thus being superior to the customary buzzer circuit.

In the balancing of a tuned R.F. receiver it is invaluable, as it enables exact balancing or testing on any or all waves. In neutralizing by the unlit tube method, if sufficient strength of signal is not obtained, a connection between one binding post of the wavemeter and the ground post of the receiver will suffice. Still greater volume may be obtained by connecting the remaining post through a small condenser to the antenna post of the receiver, and if this condenser has a capacity approximating the average antenna's capacity, we have in effect a dummy antenna circuit. Such a connection will not be required, nor should it be used in calibrating, as our wavemeter settings will be in error.

The approximate natural period of an antenna may be determined by the click method by simply coupling the wavemeter to the antenna coil in a connected receiver. In the absence of a receiver, the antenna and ground may be connected direct to the wavemeter, but such measurement will be rough, since the coupling cannot be reduced so as to obtain a sharp click. Swinging connections and grounds will be audible.

With a well constructed and accurately calibrated instrument the determina-

(*Continued on Page* 92)

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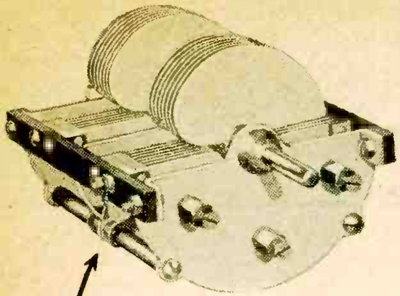
What You Save on Condensers You Lose in Reception!



The set builder who shops around for cheap parts is always the one to offer alibis for his receiver's performance. Especially is this true when "bargain" condensers are used for they are the heart of the set; and its value as a fine instrument depends on the electrical and mechanical prrfection of these devices.

Continental LoLoss Condensers

are used and approved by many of the biggest names in radio. Their extremely low dielectric losses, exact capacities, and mechanical precision make them invaluable to fine reception in high-grade sets. Most reliable radio stores carry the complete line. If not, write us direct.

UNITROL

Made Under Hogan Pat. No. 1,014,012

The new UNITROL is a Straight Line wave length double condenser that is designed to separate low wave length stations and simplify the operation of quality receiving sets. *It will operate a four-tube set with one control.*

Notice the patented balancing plate feature illustrated above. The ingenious device is found only in Continental Unitrols.

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14 Plate .00025 Capacity	$7.00
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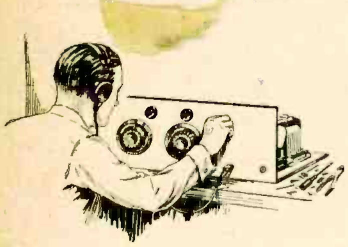
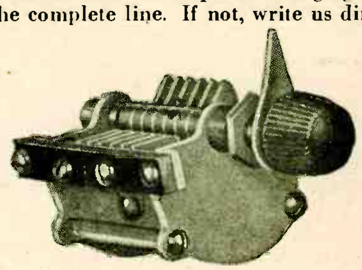
25 Plate .0005 Capacity	8.00





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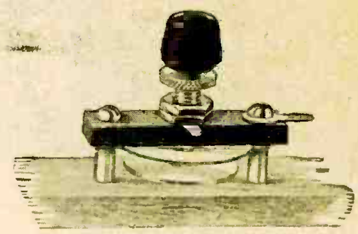
The Perfect Vernier

Continental "Lo Loss" Junior does away with all friction and geared vernier devices. It is a miniature condenser designed with exactly the same low loss, rigid construction and precision workmanship as all Continental Condensers.

Shunted across standard condensers, this little Junior gives amazing results.

Price $1.25



CONDENESERETTE

The Neutralizing Condenser has a minimum capacity slightly less than the internal capacity of a vacuum tube and a maximum equal to twice or three times its internal capacity.

It is an excellent neutralizer—taking the squeal out of the Neutrodyne, Superheterodyne and other high frequency circuits.

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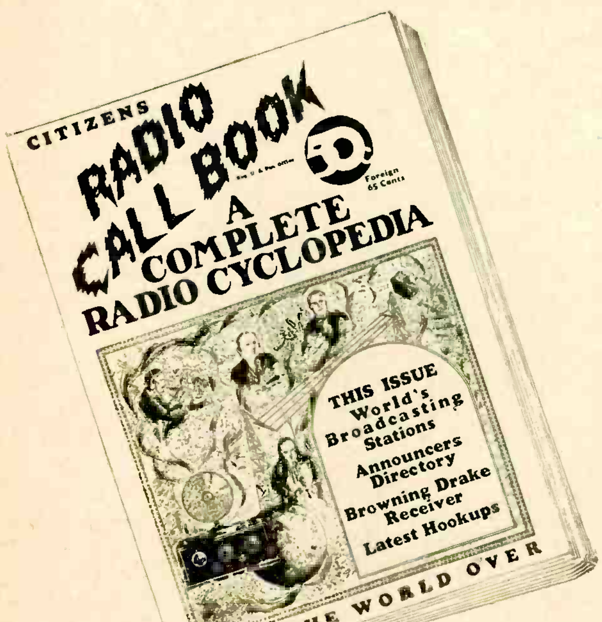

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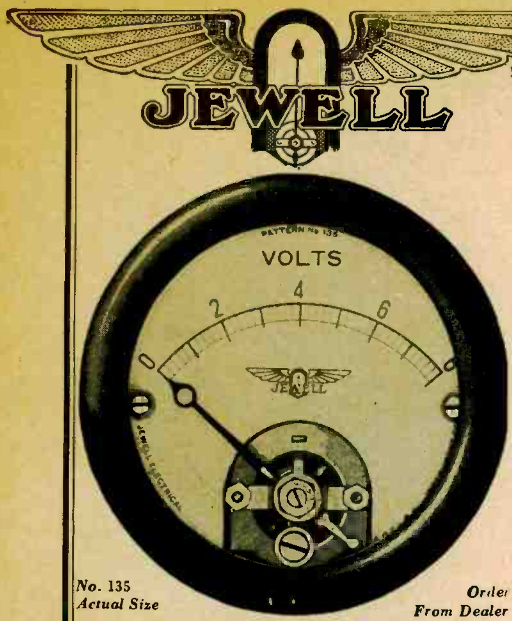

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CELESTO RUBBER CO.

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(*Continued from Page* 90)

tion of wavelength is simple; and with a large variable condenser and a few inductance coils of known value for use as standards, the determination of unknown capacity and inductance is but a few moment's work. Honeycomb coils are catalogued with distributed capacity, pure inductance and natural wavelength. Thus using these as a base, any large variable may be calibrated, and with the addition of a few sheets of cross-section paper and such a chart as given in the June issue of this magazine, the experimenter is well equipped to design and formulate any circuit used in receivers.

In the case of binocular and toroidal coils, the wavelength, capacity and inductance may be determined by coupling the wavemeter through an intermediate circuit. The two binding posts of the wavemeter are connected to a few turns of wire closely wound around the coil under test, thus giving an untuned coupling circuit. Readings obtained by this method will be in slight error, but much less than it is possible to determine by physical measurements. The amount of this error can be approximately determined by first measuring the wavelength of a circuit containing the customary tubular coil in the regular manner, then measuring the same circuit through the intermediate coupling. The difference between the two readings on any particular portion of the scale may be taken to represent the approximate amount of error in the measurement of toroidal or binocular coils. Torotrans or R.F. transformers constructed along binocular lines can thus be measured by connecting their untuned primary direct to the wavemeter bindingposts.

For high accuracy in measurements, an instrument constructed along the foregoing lines should be shielded and the shielding grounded. A straight line frequency condenser could then be used so as to give finer readings on the lower dial settings, and a chart, either in meters or kilocycles, preferably both, plotted on logarithmic scale paper, thus enabling ease of reading at the high frequencies. The instrument would warrant the use of a vernier scale as illustrated in Fig. 6. Such a scale is also a valuable addition to the portable instrument, also to any sharp tuning receiver. A piece of metal or bakelite conforming closely to the curvature of the dial is marked off into ten equal divisions in the space required for only nine divisions of the dial. The zero mark of the vernier scale is then placed to correspond with the dial marker; the whole numbers being read from the dial at the point of the marker, and tenths of divisions read from the vernier scale at the point where the two scales coincide. Thus the reading of the illustration is 26.6.

Using the small tube in the portable instrument, the strength of its oscillations is such that measurements of in-

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ductances and capacities ordinarily used in receivers is quite fairly balanced. Using a six volt tube, the portability is lost, but at a gain in accuracy and a strength of oscillation to enable much more latitude in measurements. At the time of calibration from a Standard Frequency Station, it is well to have prepared two stable circuits, which may consist of honeycomb coils shunted by small condensers; one of short wavelength and one of long, to be used as a check against the wavemeter at future times. Immediately upon calibration of the instrument, the wavelength of these two circuits should be measured, such measurement and wavemeter dial setting being marked upon the coils. They should then be put by and used only for checking the instrument. Using such check methods, on an instrument using the standard 6 volt tube and hand rheostat, it is found that by slight adjustments of the regenerative coupling and rheostat, compensation for varying voltage and circuit dearrangements may be had, so it is possible to maintain accurate calibration under all conditions. Accuracy in the portable instrument may be checked in like manner, but so long as the tube will oscillate it will be found sufficient for its purposes; variations being much less than one degree

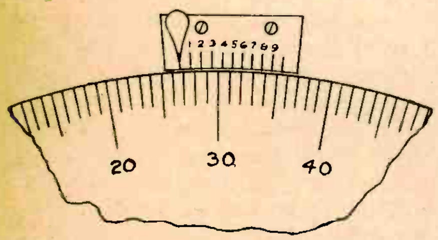
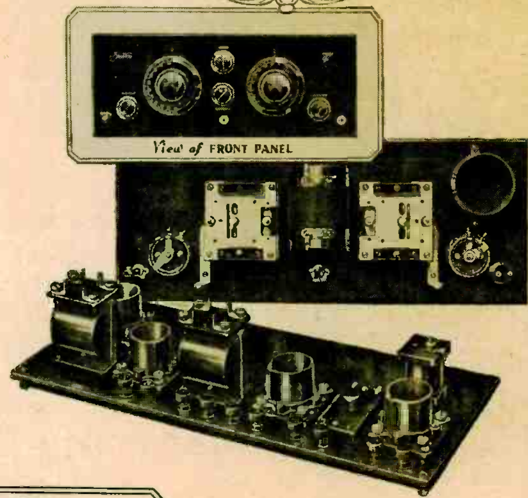


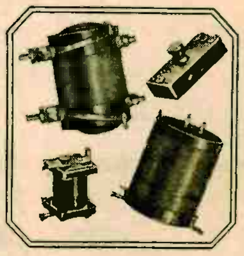
Fig. 6. Vernier Scale.

even on the lower dial settings. Obviously, the remedy is renewal of batteries.

With a low reading milliammeter used in place of the phones, much greater accuracy of observation may be obtained than is possible by the click method. Using the same amount of coupling as is necessary in the click method, the direct current measurement will give a reading of approximately ¾ milliampere, and as resonance is closely approached this reading rises slightly until at the point of non-oscillation it jumps to 3 or 4. Adjusting slowly out of resonance, the reverse conditions take place. Reducing the coupling between the two circuits beyond the point necessary for good click readings, we find that the tube continues oscillation, even though the circuits are in tune, such resonance being indicated by a sharp rise in plate current. Thus we may have stable visible observation, greater separation between circuits, and with attendant increase in accuracy and precision of adjustment.

Samson TC Assembly





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Your Confidence is Deserved

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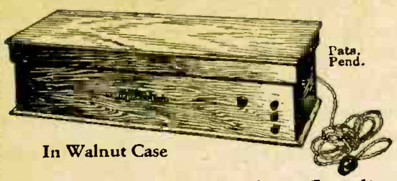
The Wilson "B" Radiopower-Unit



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No acid to spill. No moving parts to get out of order. Requires no attention. As easy to operate as switching on a light. Convenient and dependable. The least expensive plate current supply because of its long life. *In handsome walnut case. Price complete, $35.*

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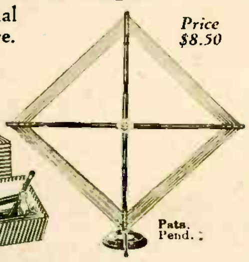

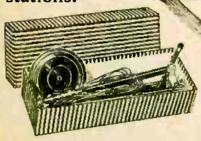

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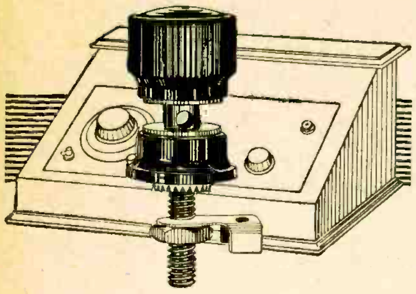

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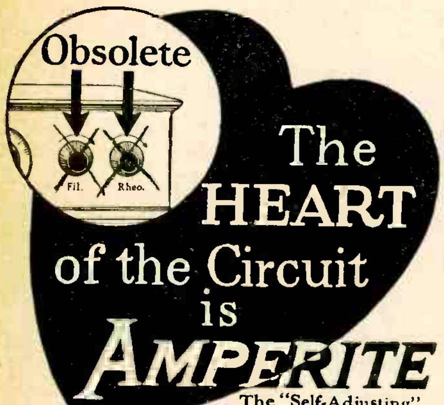

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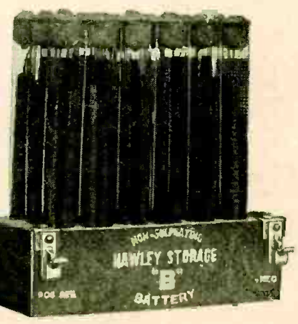

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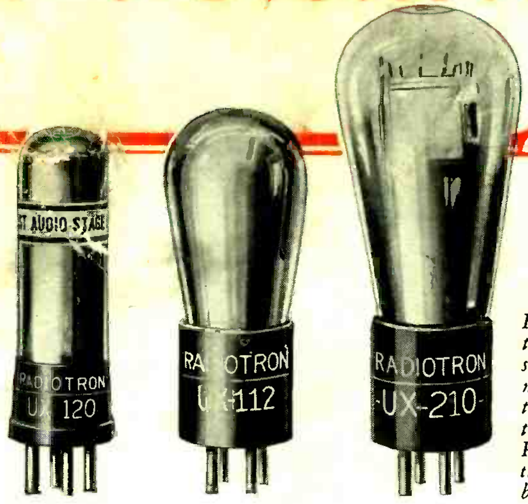

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