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RADIO

Established 1917

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Forecast of Contributions for June Issue

A. J. Haynes has redesigned his DeLuxe Super for the use of large tubes throughout. He gives special directions for stabilizing the stage of tuned radio frequency ahead of the simplified superheterodyne.

Volney G. Mathison describes the construction and application of diamond-weave coils to the Browning-Drake circuit.

A strong series of arguments in favor of tuning in terms of kilocycles rather than in terms of wavelength are advanced by E. E. Griffin.

In "Canned Audio" W. H. Wenstrom tells how to satisfactorily reproduce and amplify phonograph music through a radio loudspeaker.

A. H. Vance initiates you into the secret of adapting Round's Circuit for short wave reception.

H. Diamond describes a method of dual reception whereby two operators, using the same aerial and the same simple tuning arrangement, may simultaneously listen to two stations of different wavelengths without interfering with each other.

G. F. Lampkin has developed a lower-loss receiver for 15-200 meter reception whose construction he describes in detail.

D. B. McGown recounts his success in making and using a quartz crystal oscillator to control the frequency of a tube oscillator and as a standard wavemeter.

J. E. Anderson discusses selectivity and interference during the first of a series of valuable articles showing the inter-dependence of selectivity and distortion in a radio receiver.

"The Toroidal Coil, Its Advantages and Application," is the subject of a helpful contribution by E. C. Nichols.

C. William Rados gives some practical suggestions for the betterment of home-built receiving sets, telling, among things, how to incorporate fieldless coils and single control.

L. R. Felder presents some simple theory on "Coupling." "Impedance Coupling" is the subject of the fourth article in the series on audio frequency amplification by G. M. Best.

E. T. Jones has a timely article on static.

The fiction feature is a story of a ship operator, "The Removal of Jasper Holmes," by H. A. Highstone.

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5-Volt Tubes	1	UV-200	1	69 WHR or 67 WHR	22 / 16
	2	UV-201A	½	67 WHR	33
	2	1 UV-200 1 UV-201A	1¼	611 WHR or 69 WHR	22 / 17
	3	UV-201A	¾	69 WHR or 67 WHR	29 / 22
	3	1 UV-200 2 UV-201A	1½	611 RHR or 69 WHR	21 / 14
	4	UV-201A	1	69 WHR or 67 WHR	22 / 16
	4	1 UV-200 3 UV-201A	1¾	613 RHR or 611 WHR	22 / 15
	5	UV-201A	1¼	611 WHR or 69 WHR	22 / 17
	5	1 UV-200 4 UV-201A	2	613 RHR or 611 WHR	19 / 13
	6	UV-201A	1½	611 RHR or 69 WHR	21 / 14
	8	UV-201A	2	69 KPR or 67 KPR	21 / 15
	For sets using current at a rate higher than 2 amperes.		2¼	69 KRL or 67 KPR	22 / 13
			2½	69 KRL or 69 KPR	19 / 16

C-300 and UV-200 are interchangeable

C-301A, DV-2 and UV-201A are interchangeable

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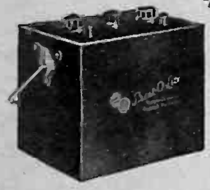
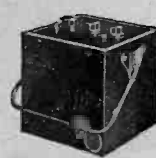

69 KPR "A" BATTERY


69 WHR "A" BATTERY


23 MRR TWIN "A" BATTERY


48 LRR "A" BATTERY

How often should you recharge radio storage batteries?

Don't wait until you've bought batteries and then learn by bitter experience that they are running down every few days.

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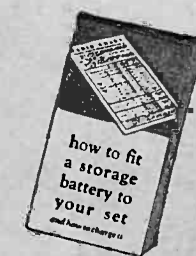

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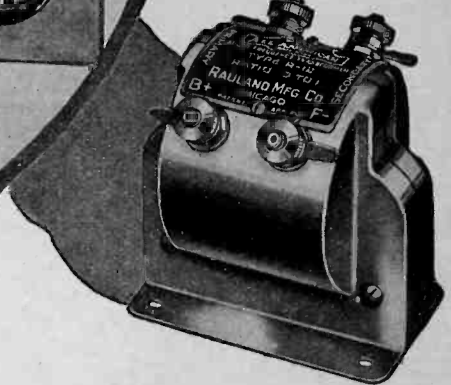

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MEMBER R.M.A.

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Fada Neutrola-Grand $270. Adapted for dry cell or storage battery

RADIO

Established 1917

Volume VII | JUNE, 1925 | No. 6

Radiotorial Comment

MANY radio owners have been needlessly alarmed by the fear that the non-compliance of their radio installations with all the requirements of the National Electrical Code invalidated their fire insurance. While this may be technically so, especially in the case of *A* and *B* battery eliminators which have not been approved by the Underwriters' Laboratories, no insurance company is known to have refused payment when the fire was definitely proven to have started from some cause other than the radio installation.

Radio cannot be singled out as a target any more than any other current-consuming device which is not installed or operated in accordance with code rules. There are probably many more violations in ordinary lamp-cord extensions for electric lights or irons than for radio current supply sets.

Nevertheless great care should be exercised in putting in and using these devices. Many fires have been traced to the carelessness of the handy-man type of wiring, which ignores the commonsense safety precautions provided by the code. The same familiarity with electrical principles given by radio should be extended to a knowledge of its dangers.

The purpose of the code rulings is to prevent the possibility of accident due to the entrance of high voltage current into the home. This is more likely to be due to contact of an aerial with power or lighting or signal circuits than from lightning, yet the code provides against both contingencies.

The code rules as regards both receiving and transmitting equipment should be familiar to everyone making a radio installation. These have been printed many times, but as their interpretation is not always clear, a detailed statement will be published in our next issue.

Particularly pertinent to safety are the rules regarding inside jobs:

"Wires inside buildings shall be securely fastened in a workmanlike manner and shall not come nearer than 2 inches to any electric light or power wire not in conduit unless separated therefrom by some continuous and firmly fixed non-conductor, such as porcelain tubes or approved flexible tubing, making a permanent separation. This non-conductor shall be in addition to any regular insulating covering on the wire. Storage battery leads shall consist of conductors having approved rubber insulation. (The circuit from the storage battery shall be protected by a fuse of not more than 15 amperes capacity)."

The word "approved" means approved by the Underwriters' Laboratories and applies also to attachment plugs, fuses, switches, lightning arresters and power transformers, as well as to battery chargers and *B* battery eliminators. All supplies, so approved, bear a readily recognized stamp. From time to time, furthermore, the Laboratories publish lists of inspected apparatus.

It will be noted that these requirements preclude the safe use of any unapproved home-made rectifying devices. However, if the transformers and other equipment are constructed in accordance with the usual factor of safety no danger attends their use. But to employ audio-frequency transformers, with exposed terminals for connection to the 110 volt lighting circuit is courting danger of shock and even of fire. 'Tis safest to have the completed job approved by the local electrical inspector just as should be done with all transmitting equipment.

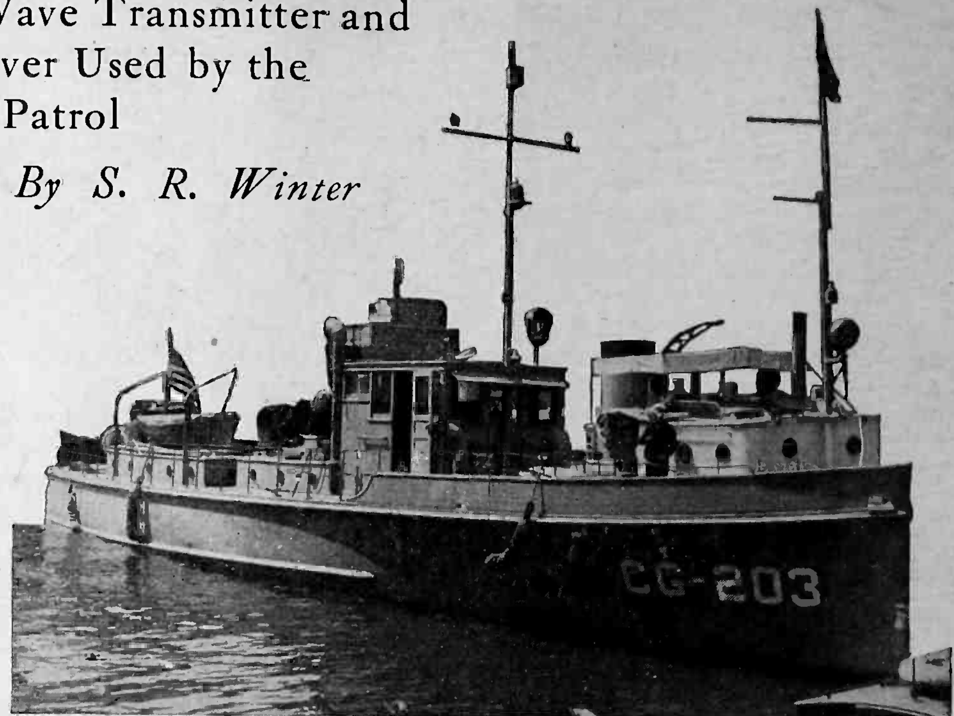
A receiving set, by itself, needs no approval. The hazards are associated only with the wires leading to it. For instance, a loop receiver with dry batteries is an independent unit which would be incapable of starting a fire under any ordinary conditions.

The rules are not arbitrary. They represent common sense precautions against the danger of fires. They would be followed by any cautious person alive to their beneficial effect even if no insurance were carried.

Raiding the Rum Runners with Radio

A Description of the Short Wave Transmitter and Superheterodyne Receiver Used by the Coast Guard Patrol

By S. R. Winter



Coast Guard Patrol

THE possible uses of radio in the activities of the rum-running fleets which hover off our coasts has stirred the imagination of the radio public and many are the weird stories that have been woven about the activities of the bootleggers in this direction. They are portrayed as using radiocasting stations for the transmission of code words, as well as the ordinary telegraph transmitter, in order to convey information to the rum fleet.

As might well be assumed, the United States Coast Guard has made use of radio in every way possible to aid in preventing liquor smuggling and it is of particular interest at this time to know that the new 75 foot patrol boats recently built for the Coast Guard, as well as the older units of the patrol, are to be equipped with radio transmitting and receiving sets which will surpass in performance any of the marine radio equipment heretofore used in commercial service.

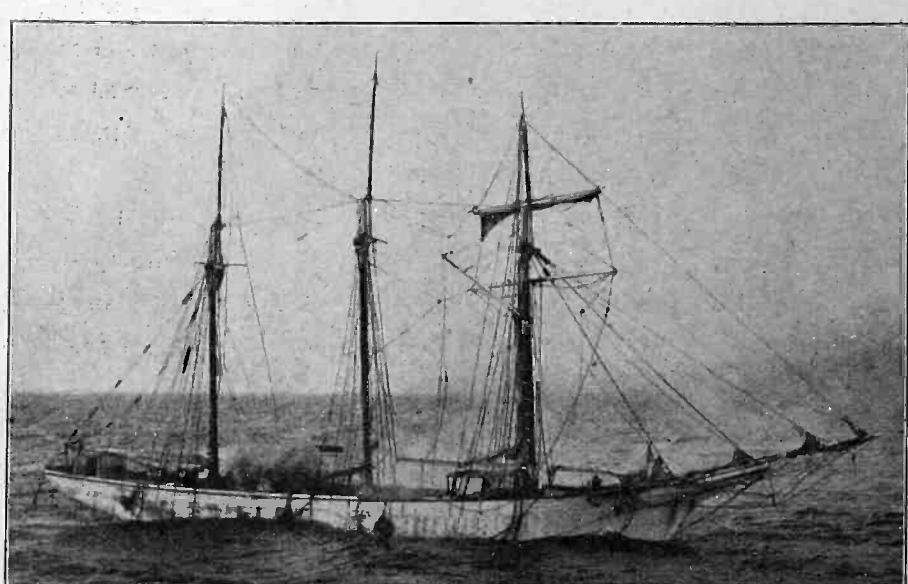
Realizing that the short waves offered a better opportunity for operating a number of transmitters in a narrow band of wavelengths, the Western Electric Company, which manufactured the equipments, designed them to operate between 100 and 200 meters, representing the first commercial application of the short waves on a large scale. The transmitter will be of particular interest to the amateur, since it is arranged for operation on waves within the amateur band.

It is composed of three major parts—oscillator circuit, modulator circuit, and speech input circuit. The transmitter in its entirety represents a single unit brass frame, 35 in. high, 16½ in. wide, and 18 in. deep. The upper part of the front panel includes all the meters for automatically observing the behavior of the circuit, the switches for controlling the filaments of the vacuum tubes and motor generator being at the bottom of the front panel. The required connections to the transmitting device are made to a terminal strip, which is accessible through a door at the bottom of the transmitter.

The equipment in the transmitter resolves itself into three distinct sections. In the first compartment are mounted the audio-frequency coils and resistance units for the speech input and modulator circuits. The second section from the bottom of the transmitter is composed of two compartments—the front containing the two power tubes as well as the speech amplifier tube, with accessories. The back compartment of the second section is shielded from adjoining sections and contains the primary tuning condenser and the grid coupling condensers. The third section, located at the top of the outfit, also resolves itself into two compartments—the front holding the plate-voltage motor resistor and the antenna relay, while the second compartment contains the antenna loading coil and the antenna coupling condensers. This compartment is likewise shielded.

The control switch for the sending of telephone or interrupted-continuous-wave telegraph messages is mounted in the center of the front panel. When the apparatus is functioning as a telephone transmitter a push button is provided for connecting the transmitter to the antenna, thus starting the oscillations when this button is pressed. Similarly, with this control switch in the interrupted-continuous-wave position, the telegraph key is connected in the circuit and oscillations begin when the telegraph key is depressed. The filament elements of the vacuum tubes are governed by means of a conventional snap switch. A second switch of this type controls the plate dynamotor which supplies the voltage to the plates of the vacuum tubes, only after the filaments have been lighted. A rheostat is used in adjusting the current of the filaments.

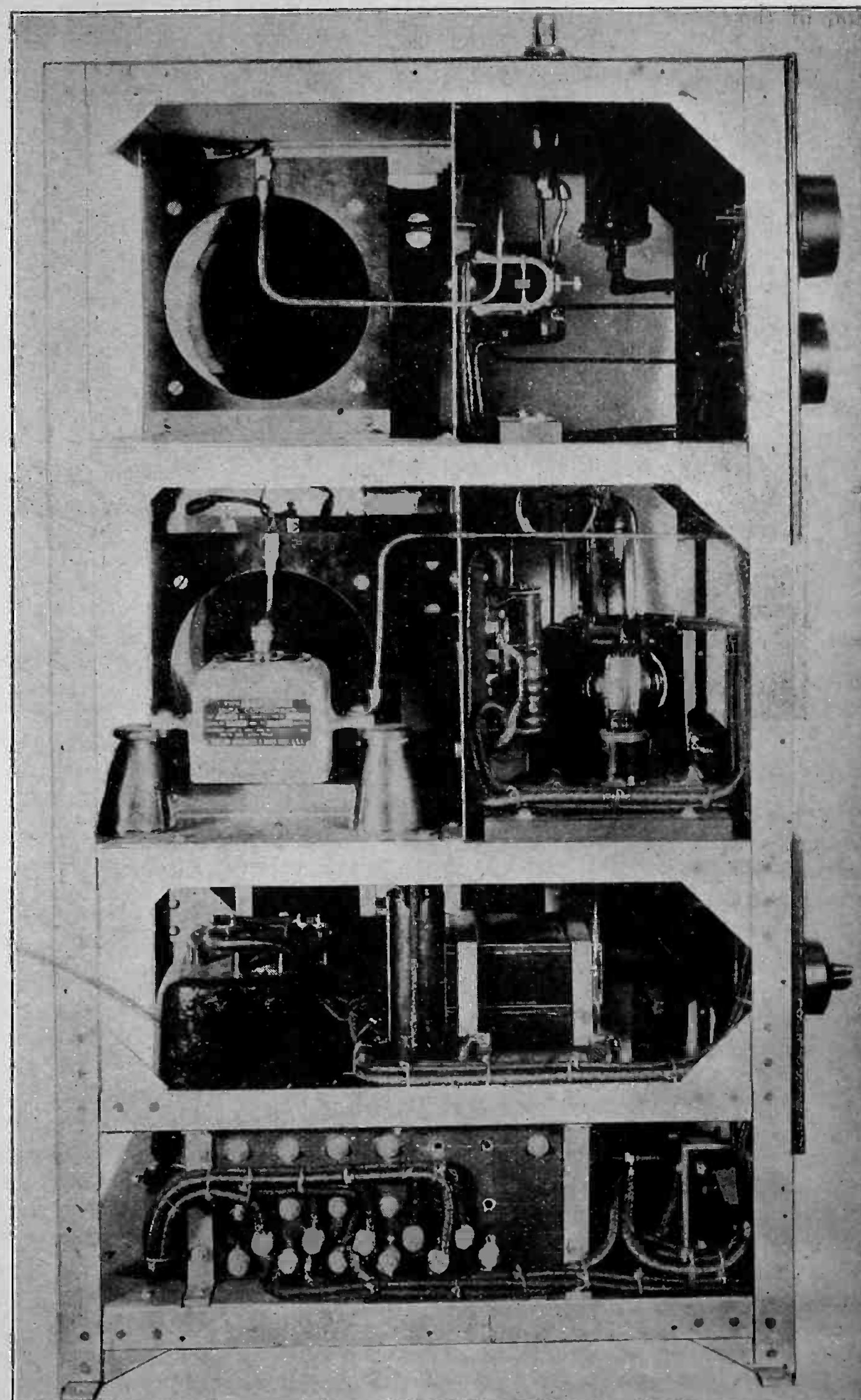
The antenna and primary coils are provided with a fine continuous adjustment of their inductance so that the circuits may be fixed at any wavelength between 100 and 200 meters. This precise adjustment is effected by use of a sliding contact on the last turn of wire of the inductance coil. It can be set in

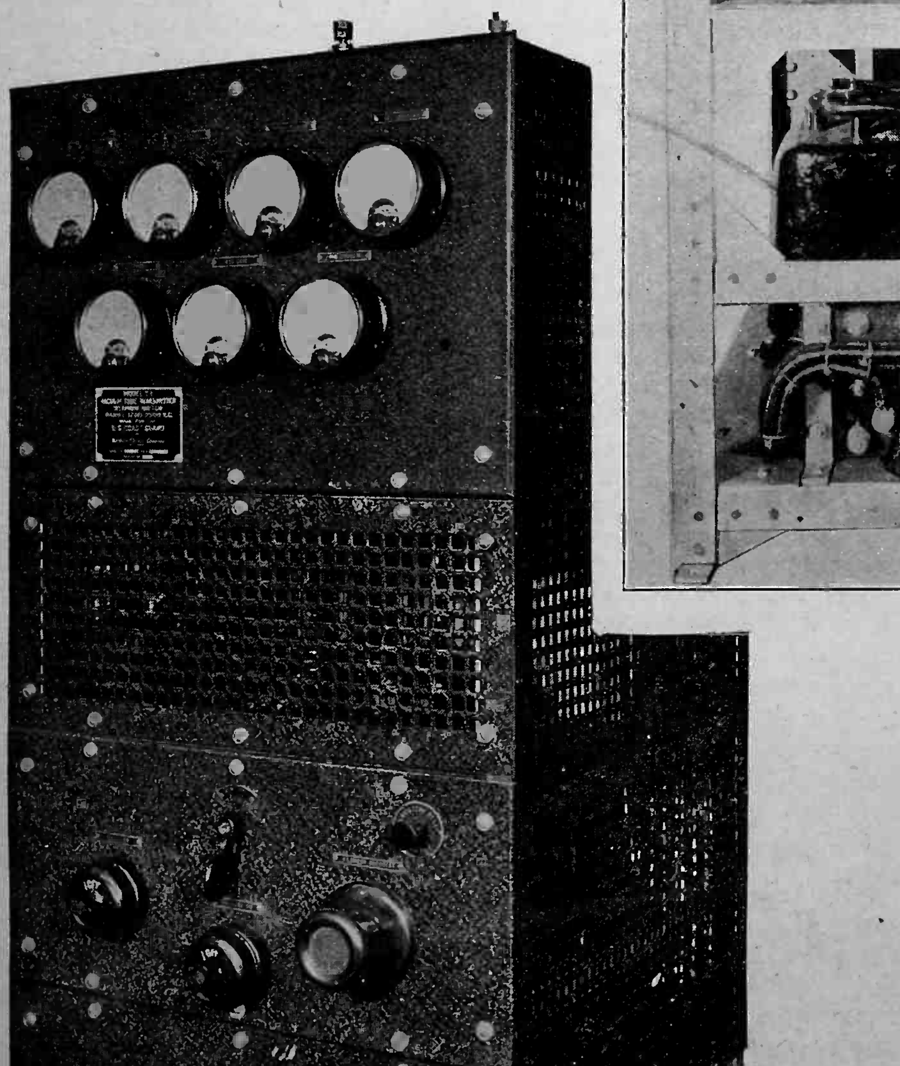

Typical Rum Runner

any position from the outside of the transmitter by using a screwdriver. There is an absence of fine-adjustment knobs, commonly found on radio apparatus, as the set may be adjusted at the desired frequency with the assurance that it will remain in a fixed position for a considerable period. This is accomplished by means of a specially designed coupling circuit which is not affected by a change in antenna capacity due to the roll of the boats.

The simple type of oscillator, failing to qualify with respect to the exacting stability requirements, was discarded in favor of the capacity coupled oscillator circuit. This, too, does not radiate harmonic frequencies. Subsequently, this short-wave transmitter was tested for frequency stability with its relation to variations in plate voltage supply and change in capacity of antenna.

The results obtained were: In the case of a variation in plate voltage by a change in storage battery (fully charged) at 33 volts to 28 volts (nearly discharged) with the brilliancy of the filament constant, the change in frequency was of the order of .007 per cent. This



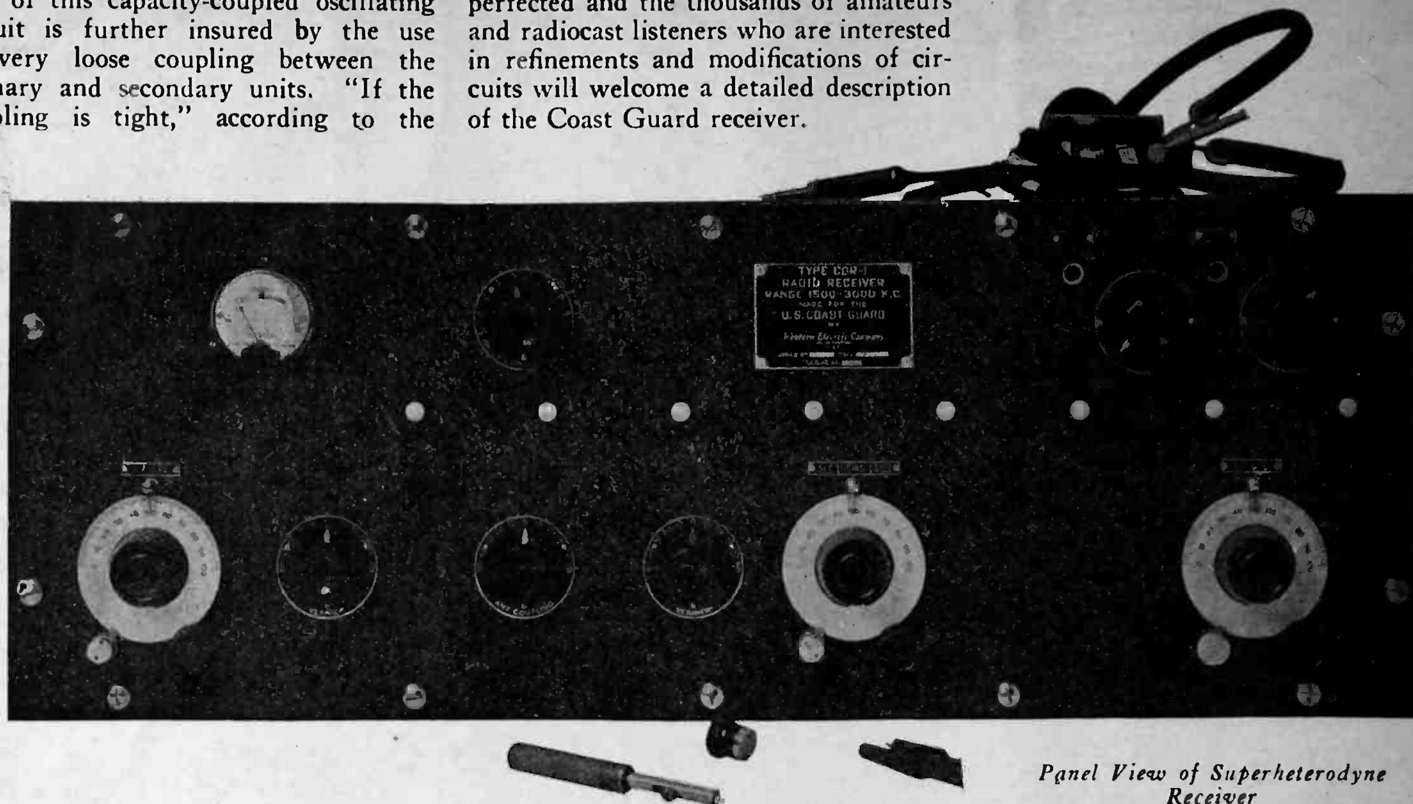


Short Wave Transmitter on Coast Guard Patrol

slight variation is responsible for the conclusion that under operating conditions the frequency of this transmitter is independent of plate voltage and storage battery voltage.

The double-tuned self-excited oscillator output circuit consists of a closed inductance capacity oscillating circuit coupled to the antenna circuit by use of a large capacity which is common to both circuits. The direct-current plate voltage is applied to the oscillating vacuum tube through the primary inductance as a means of eliminating a high-frequency plate-feed choke coil. The energy delivered by the vacuum tube to the primary circuit is controlled by means of the plate tap. The antenna circuit is composed of an antenna loading coil, variable by taps, and is in series with the antenna ammeter and the antenna coupling condenser. The stable operation of this capacity-coupled oscillating circuit is further insured by the use of very loose coupling between the primary and secondary units. "If the coupling is tight," according to the

perfected and the thousands of amateurs and radiocast listeners who are interested in refinements and modifications of circuits will welcome a detailed description of the Coast Guard receiver.



Panel View of Superheterodyne Receiver

designing engineers, "there are two frequencies at which this kind of circuit may oscillate, one which is determined by the primary and the other by the secondary. The circuit should always be operated at or near the critical coupling value."

A 200-ampere-hour storage battery is the primary source of power for energizing the filament elements of this transmitter and as a power supply for the plate circuit dynamotor. Simplicity in operation, ruggedness in service, and efficiency in action, were among the requirements imposed upon the designing engineers, to say nothing of the exacting constancy of frequency. All of these requirements seem to have been met when we are told that a person unfamiliar with radio can operate this transmitter. In a word, this 50-watt transmitting device is adjusted to a single wavelength and it remains there with an unyielding attitude like the laws of the Medes and Persians.

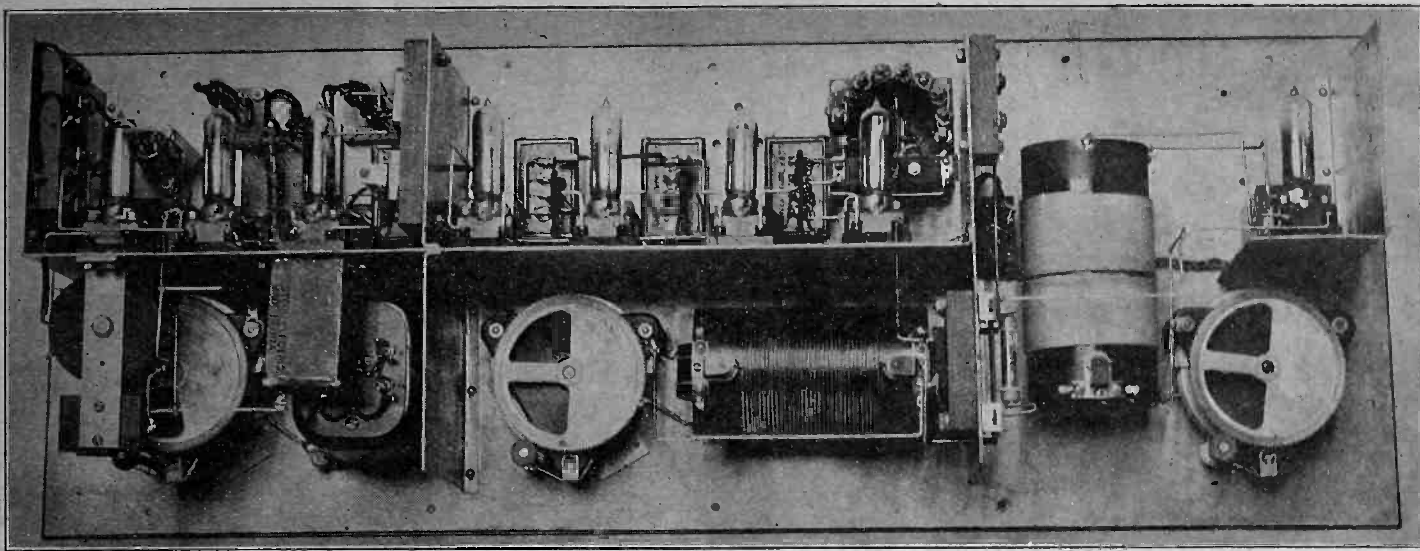
Users of superheterodyne radio receiving sets, who are prone to classify this type of outfit as the Rolls-Royce of radio, will find further justification for their claim in the knowledge that the superheterodyne has been selected as the receiver for the Coast Guard patrol boats. In fact, "the double detection (superheterodyne) type of receiver is used because the required sensitivity and selectivity could be obtained only with this type of receiver," to quote the engineers of the Bell Telephone Laboratories. However, the radio receiver used on the vessels of this Government was subjected to more exacting requirements than are imposed on superheterodyne receiving sets employed for radiocast reception. In a word, a special design was

This superheterodyne equipment, like the transmitter, operates on a frequency range between 100 and 200 meters. This, too, will receive signals by means of radio telephone and interrupted-continuous-wave telegraphy. So sensitive must this receiver be that it can separate signals from transmitting stations that are operating at frequencies of only five kilocycles apart, compared to the present 10 kilocycle separation of radiocast stations. Simplicity is required, so that it may be operated by a person unfamiliar with radio. Thus, locks are provided so that it can be maintained in a fixed position and the set can be placed in operation by simply turning of a filament switch. The outfit is shielded and consists of the radio-frequency input circuit, high-frequency oscillator circuit, modulator or first detector circuit, intermediate-frequency amplifier circuit, second detector and audio-frequency circuits, and intermediate-frequency oscillator circuit.

In justification of their decision of a choice of intermediate frequency, the designers tell us, "Taking into consideration the fact that the intermediate frequency selectivity is of no value in differentiating between two signals whose carrier frequencies differ by twice the intermediate frequency, a moderately high intermediate frequency would naturally be chosen. With too high an intermediate frequency the amplification obtainable is considerably reduced and the regenerative effects due to interstage coupling of one form or another are greatly increased. If too low a frequency is used the tuning of the secondary circuit and that of the oscillator will differ by only a small percentage of the carrier frequency and the tuning of the two circuits will not be independent of each other. The 50-kilocycle frequency used was chosen because satisfactory intermediate frequency transformers had been developed for this frequency, the required amplification could readily be obtained, and such an amplifier requires no stabilizing adjustment in order to prevent a tendency toward internal oscillation."

This superheterodyne receiver is designed to operate in conjunction with an overhead antenna but it was deemed advisable not to tune the antenna circuit, thus eliminating the additional tuning control. In the radio-frequency input circuit a small coupling coil is placed directly between the antenna and ground, the mutual inductance between this coil and the secondary circuit being adjustable. In deference to the engineering principle that if more than critical coupling is employed no additional signal strength is available and the selectivity of the secondary circuit is appreciably impaired, this coupling coil conforms to a size so as to insure the condition that the maximum coupling between the antenna and the secondary circuit would not greatly exceed critical coupling. The coupling coil is placed at the low potential end of the secondary coil, and since one end of each is connected to the ground, the capacity coupling between them remains at a minimum. As a means of insuring an extremely low high-frequency resistance, the secondary coil is composed of bare copper wire, spaced by its own diameter on a thin-walled tube.

A vernier adjustment is afforded by use of a small coil mounted at the opposite end of the secondary circuit from the antenna coupling coil; however, it is connected in the low potential side of the tuned circuit in order to have one terminal of the vernier coil at ground



Rear View of Superheterodyne on Coast Guard Patrol

potential. The use of the inductance vernier has decided advantages over the use of a separate plate on the variable condenser. In the case of the latter, the capacity of the separate plate may be one-tenth or one-twentieth of the total capacity of the condenser but when the latter is adjusted to a point near its minimum capacity, the capacity of the vernier may be appreciably greater than that of the condenser. The result is a critical adjustment. Where an inductance vernier is employed the percentage change in inductance and in the tuned frequency is about constant over the whole range of frequencies embraced by this superheterodyne. This particular vernier was constructed so that the total variation is equivalent to only 10 per cent of the condenser setting for the major portion of its range. This type of vernier is no more critical at high than at low frequencies.

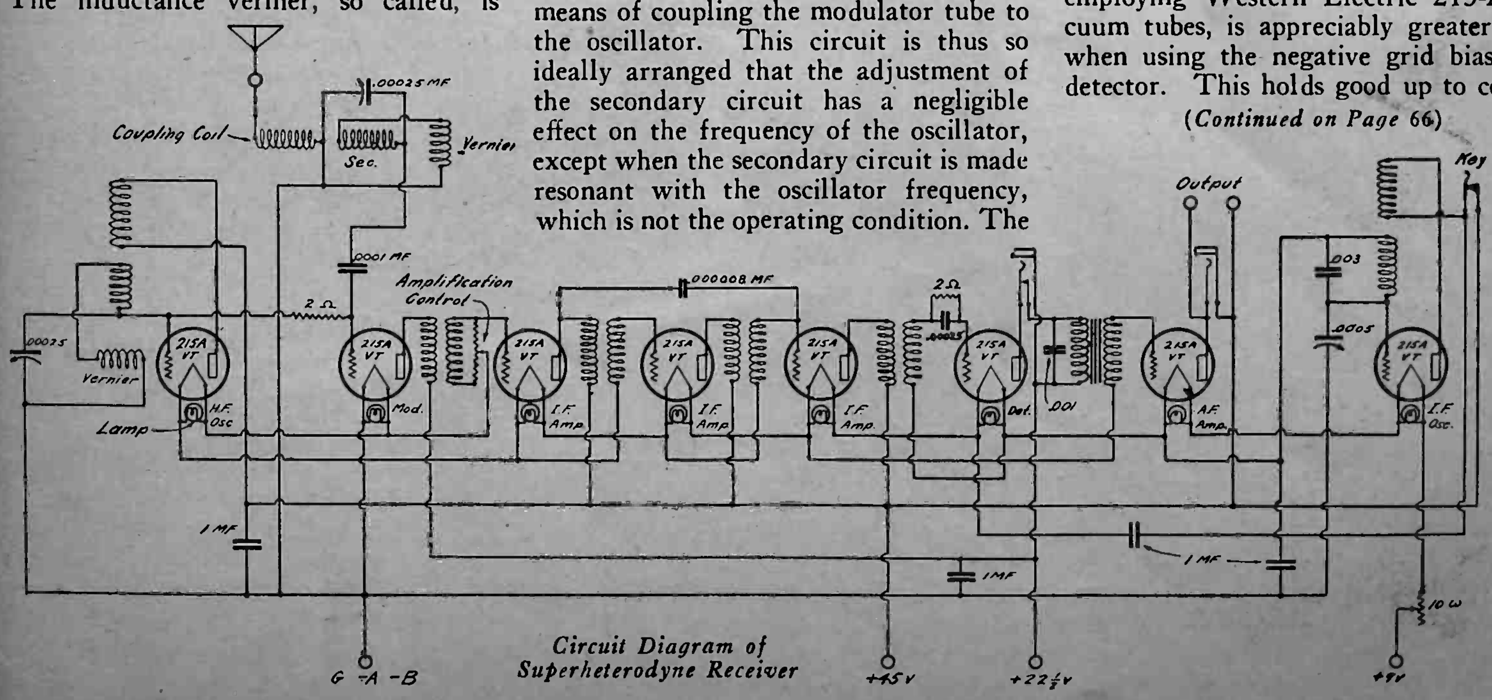
A tuned grid inductively coupled oscillator circuit is used, thus permitting the tuning condenser to be placed across only the grid coil. One side of it is thus at filament or ground potential, with the resultant elimination of hand or body capacity on the frequency of the oscillator. The inductance vernier, so called, is operative in series with the grid coil and is mounted at the high potential end of the coil. The oscillating coils are so designed that the reading of the scale of the oscillator condenser for a frequency of 50 kilocycles below that of the incoming signal is virtually identical with the scale reading of the secondary circuit of the superheterodyne receiver over the operating range between 100 and 200 meters.

Owing to the fact that the grid condenser and grid leak type of modulator requires an appreciably smaller input on the grid, for maximum efficiency, than the negative grid bias type of detector, the former is employed in this receiving set. The circuits used for the frequency changing system, consisting of the oscillator and modulator, are illustrated in the schematic diagram reproduced with this article. The condenser and grid leak combination was selected with the view of obtaining maximum efficiency, which is secured with a capacity of 100 micromicro-farads and a 2-megohm resistance unit. This grid leak acts in a dual capacity—as a leakage for the electrons of the modulating vacuum tube and as a means of coupling the modulator tube to the oscillator. This circuit is thus so ideally arranged that the adjustment of the secondary circuit has a negligible effect on the frequency of the oscillator, except when the secondary circuit is made resonant with the oscillator frequency, which is not the operating condition. The oscillator is completely shielded from other parts of this radio receiver, thus obviating any inter-play between the oscillator and the secondary circuit.

Each of the eight vacuum tubes employed requires a filament current of 250 milliamperes at about one volt. The use of a number of this particular kind of vacuum tube makes it advisable to connect the filament elements in series, so that grid biasing potentials may be obtained by the drop in potential across certain portions of the filament circuit. However, a receiver of this type, having great amplification, offers certain difficulties because of the coupling thus made between the grid circuits of the various vacuum tubes. This coupling problem was minimized in this receiver by use of a number of high capacity by-pass condensers, properly placed. The filament circuit was planned from the viewpoint of securing the desired grid biasing potentials with the simplest possible filament circuit.

The second detector is of the grid leak and grid condenser type. The reason influencing this choice is that the efficiency of this type of detector, when employing Western Electric 215-A vacuum tubes, is appreciably greater than when using the negative grid bias type detector. This holds good up to certain

(*Continued on Page 66*)



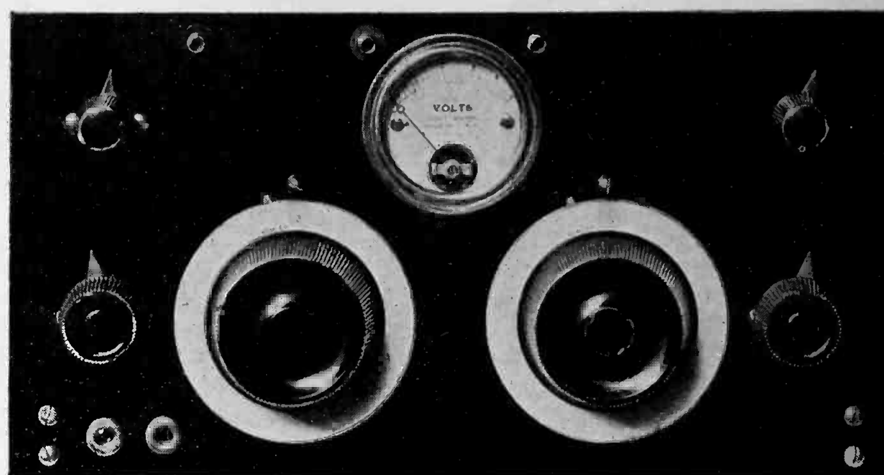
Circuit Diagram of Superheterodyne Receiver

The Midget Super

A 7-Tube 45,000 Cycle Superheterodyne in Kodak Size

By Clinton Osborne

THE average conception of a superheterodyne receiver pictures an outfit 2 ft. long, 7 or more inches in height and at least 8 in. deep. We have been told that to cram all the parts of so elaborate a circuit as the super into a smaller space than the conventional arrangement would be to invite all kinds of trouble, from howling due to coupling between transformers to broad tuning resulting from the feeding of oscillator current through the various wires of the set.



Panel of Midget Super (About 2-5 Actual Size.)

While this claim is true to a certain extent, much of the apparatus can be placed in very close proximity if care is taken in shielding the intermediate transformer group and in keeping the field of the oscillator coil at a considerable distance from the intermediate amplifier.

With the latter idea in mind, Mr. W. P. Brush, who has built a number of models of the Best 45,000 cycle superheterodyne, has constructed a portable set which occupies a minimum of space, weighs only 7½ lbs. with the vacuum tubes, and yet does not have any of the troubles predicted. Only the pictures of the actual receiver are shown, the set being mounted in a leather carrying case complete with collapsible loop, 4-volt midget storage battery, *B* batteries and loud-speaker, the entire outfit weighing about 25 pounds.

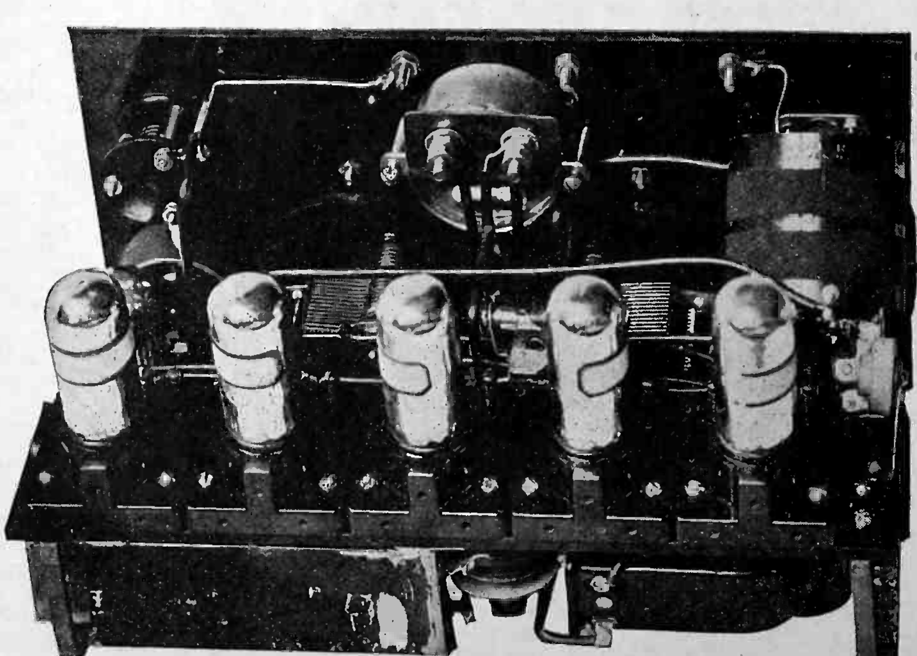
The standard arrangement being too large for a suitcase set, a 3/16 in. panel of bakelite 5¾ in. by 11 in., on which all of the necessary panel apparatus could be crowded, was selected, and the arrangement of the rest of the equipment was made to conform with the size of the panel. The illustrations give an accurate picture of the compactness and excellent arrangement of the various sockets, transformers and condensers, the vacuum tubes showing admirably the relative size of the set. Two Remler condensers are mounted at 90 degrees from their usual position, in order to take up as little room as possible when at their minimum capacity position. As the dials furnished with the condensers are 4 in. in diameter, it was necessary to cut them down to 2½ in. each, the cut being made with a hack saw in order to retain the small piece of metal used on each dial as a stop. The voltmeter was selected because of its small size, fitting above and between the two air condensers. On each side of the condenser group is a small rheostat, each condenser end plate being filed away for ⅛ in. in order to make room for the rheostats.

The oscillator coupler is mounted at the upper left end of the panel and the feedback condenser at the upper right end. The loop terminals are brought out at the top of the panel at points where the connecting wires would be shortest.

The secret of success in the compact arrangement is the placing of the oscilator and first detector tubes at opposite ends of the panel. The oscillator tube is mounted directly underneath the oscillator coil and adjacent to the oscillator condenser. The first detector tube is mounted under the main filament rheostat.

A pair of brackets made from flat brass strip, as shown in Fig. 1, support the bakelite shelf at the rear of the set, on which are mounted the remaining five tube sockets, the transformers and miscellaneous apparatus. The oscillator and first detector sockets are fastened to the bottom of the brackets at each end of the panel. The bakelite shelf is 2¼x 11 in., of 3/16 in. bakelite, the five sockets completely covering the top of the shelf. Underneath the shelf are mounted the three intermediate frequency transformers, crowded together and shielded from each other by a copper sheet, all shields being tied to the negative *A* battery.

The tuned transformer was removed from its bakelite case and mounted between the intermediate group and the audio transformer, which can be seen clearly in the illustration. Back of the intermediate transformers is mounted a 1 mfd. by-pass condenser, of the ultra-thin type.



Rear View of Midget Super, Showing Compact Arrangement

The schematic circuit diagram is shown in Fig. 2, the circuit not differing materially from that described in January, 1925, RADIO, except that the last stage of audio frequency amplification is omitted. A 6 to 1 ratio transformer of unusual excellence was used, in order to obtain as much voltage amplification in the audio stage as is consistent with fair quality.

In order to localize the oscillator current as much as practicable, a small radio frequency choke is placed in the oscillator plate battery lead, between the oscillator coil and the point in the *B* battery lead where battery voltage is supplied to the other parts of the set. This choke may be made by winding 250 turns of No. 32 cotton covered wire on an ordinary wooden spool such as is supplied with sewing thread. The wire may be wound jumble fashion, and the spool can be mounted next the audio amplifier tube, as is shown in the picture.

Looking at the rear of the set, the tubes mounted on the shelf are as follows, reading left to right; 1st, 2nd and 3rd intermediate amplifiers, 2nd detector and audio amplifier. This method brings the output of the set to a pair of phone tip jacks mounted on the front of the panel, there being no arrangement for plugging in on the detector tube.

The panel layout is shown in Fig. 3, the voltmeter hole being cut for a Hoyt instrument. No drilling holes are shown for the mounting screws of the rheostats, as apparatus other than that shown in the pictures may be used.

Some difficulty will be experienced in wiring the set, as the arrangement of parts is very cramped. It is well to wire up the vacuum tube circuit, including the oscillator and 1st detector tubes, before fastening the shelf and bracket assembly to the panel. The final connections to the panel apparatus can then be made without much trouble. Anyone never having built a multi-tube set before would do well to try something else first, as full detailed working drawings of the set cannot be furnished here, and the successful construction of the outfit rests with the mechanical ability of the worker.

No claims for great selectivity or distance are made for this outfit, and for city use, the larger layout is more desirable, but for reception in the country, where powerful stations are somewhat distant, it has no peer. Successful reception of stations on the loudspeaker, over a distance of 2000 miles at night, using a portable loop antenna, has been had with this set and there is every reason to believe that anyone handy with tools and familiar with common radio circuits can do as well.

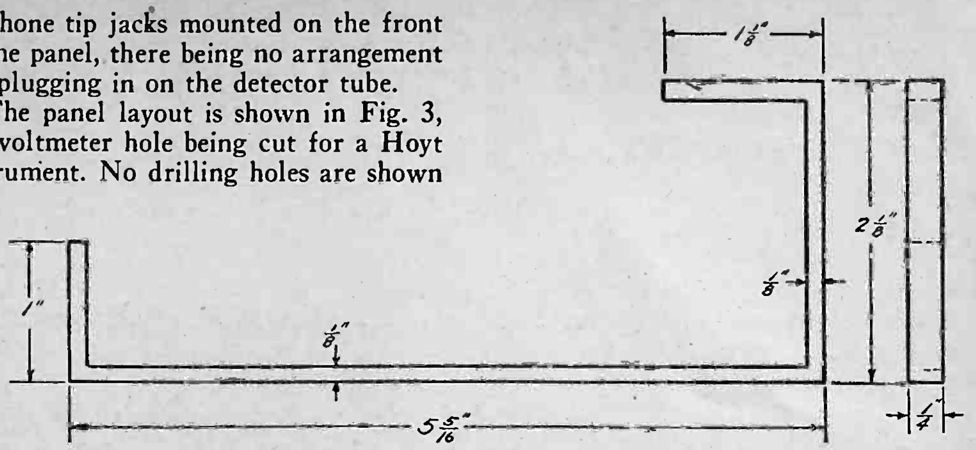


Fig. 1. Bracket Detail.

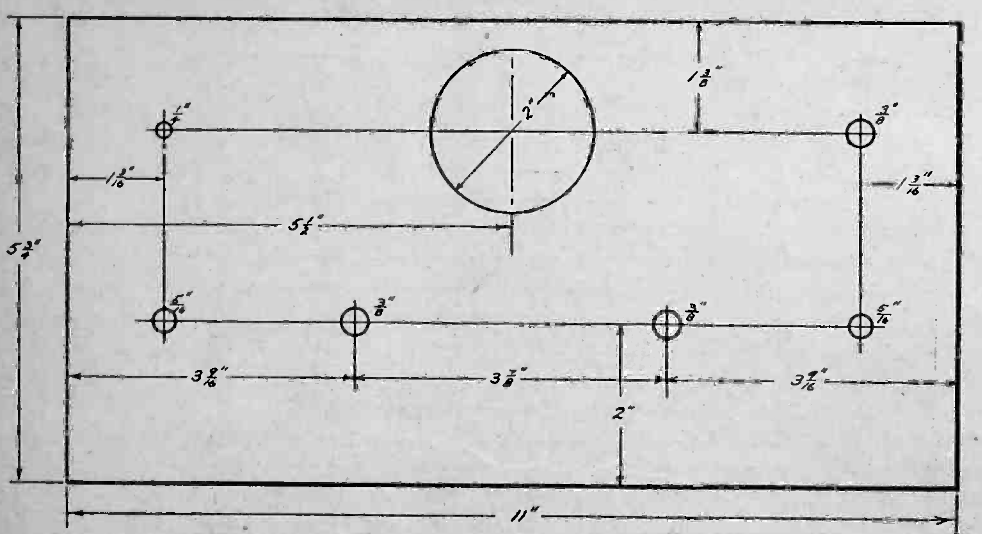


Fig. 3. Panel Layout of Midget Super.

If your "trap" in the antenna circuit will not work as it should, be sure that it actually covers the wavelength range that you wish to eliminate!!

"Oiled silk" such as can be obtained from druggists makes a fairly good insulator in an emergency where a thin flexible insulating substance is needed.

Faulty and corroded connections on the terminals of lead acid batteries often set up many sounds that are identical with static, and which may be very hard to locate.

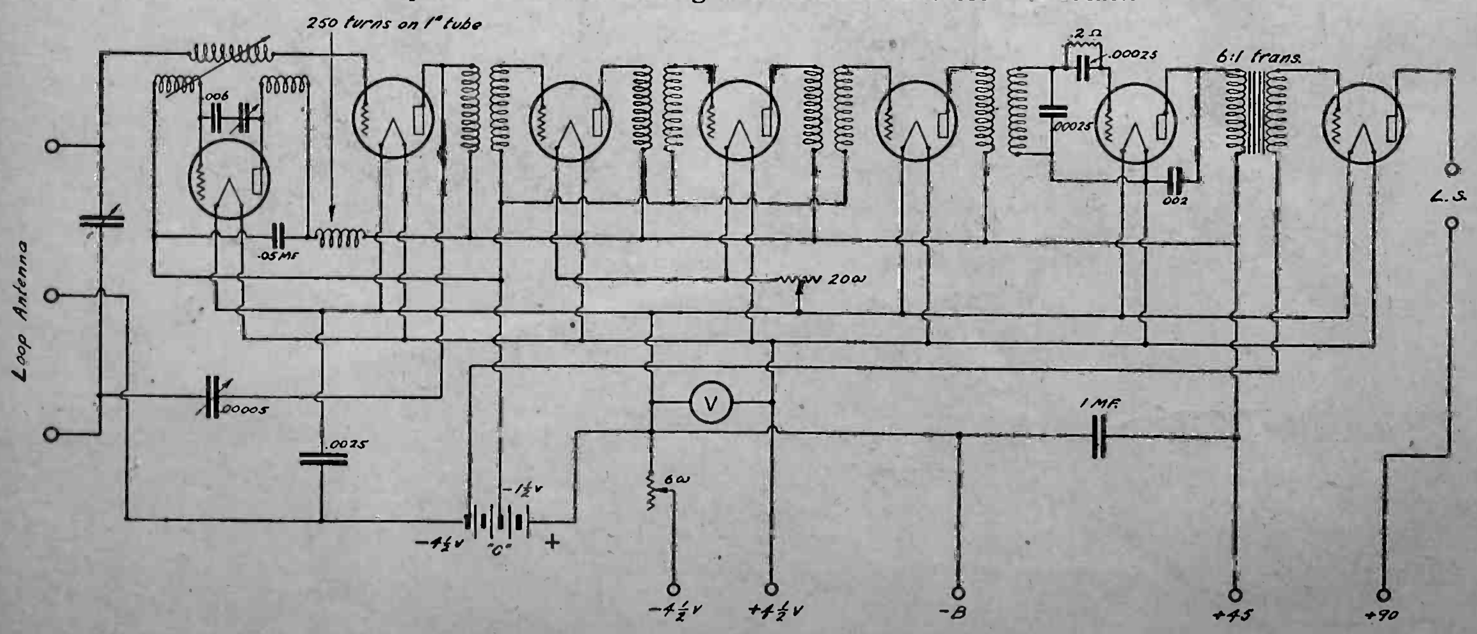


Fig. 2. Schematic Circuit Diagram of Midget Super.

The Batteryless Receiver

A Compact Combination of a Reflexed Two Tube Receiver with An "A" and "B" Current Supply Set

By G. M. Best

THE widespread use of alternating current rectifying devices to eliminate the *B* battery from the radio receiver has attracted the attention of the radio public, especially those to whom the cost of battery maintenance is a major item. Most of these current tap devices supply the plate voltage for the receiver, but no provision is made for lighting the filaments of the receiving tubes from A. C., for the reason that the circuit of the receiver must be changed to make such operation practicable. One manufacturer developed such a device two years ago, to accompany a particular type of power amplifier, but it did not come into general use since it was adapted for one special application and could not easily be attached to other sets.

The receiver herein described operates entirely from the A. C. mains, is economical to construct and operate, and can be made up in it's entirety from standard radio and house wiring supplies. It is amply protected against short circuits to the house lighting circuit, is not dangerous to operate, and fully answers the needs of those who desire a selective receiver which will operate a loud speaker and yet employ no batteries. It is ideal for congested city districts where the numerous high powered radiocast stations make distant reception difficult as a rule, and since it does not radiate energy into the antenna, it cannot interfere with reception in neighboring receivers.

Before describing the construction of the set, it is well to state that under ordinary conditions, with a 50-ft. antenna 25 to 50 ft. above the ground, this set has a loud speaker range of not over 100 miles at night. Hence it would not be advisable for anyone living at a considerable distance from the radiocast centers to build the set exactly as shown.

With the best apparatus available in the open market, it is not possible to entirely cut out the alternating current hum when lighting the filaments of a multi-tube receiver. This hum is not objectionable when using a loud speaker and is hardly audible when a station is being received, but it is strong enough with the headphones to prevent reception of weak signals. So for those whose radio health depends upon getting the most possible distance with a given

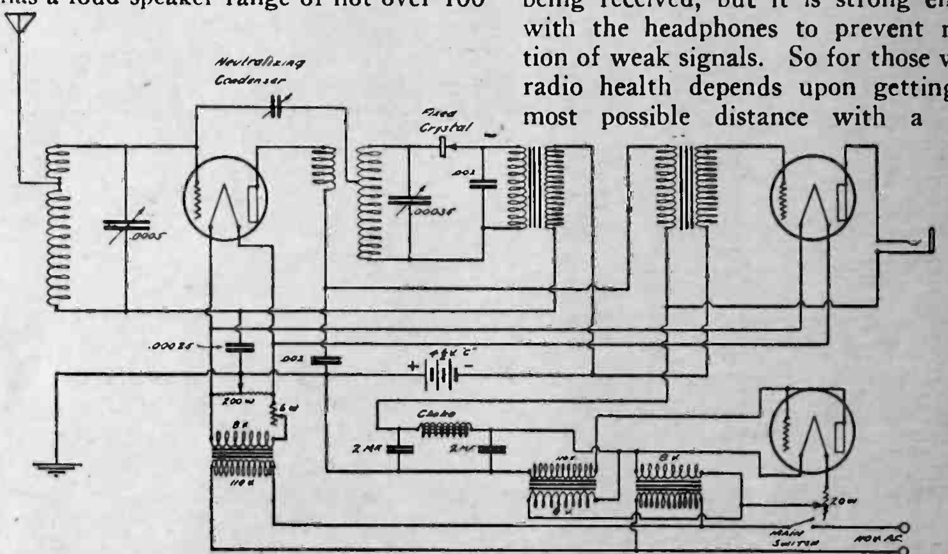
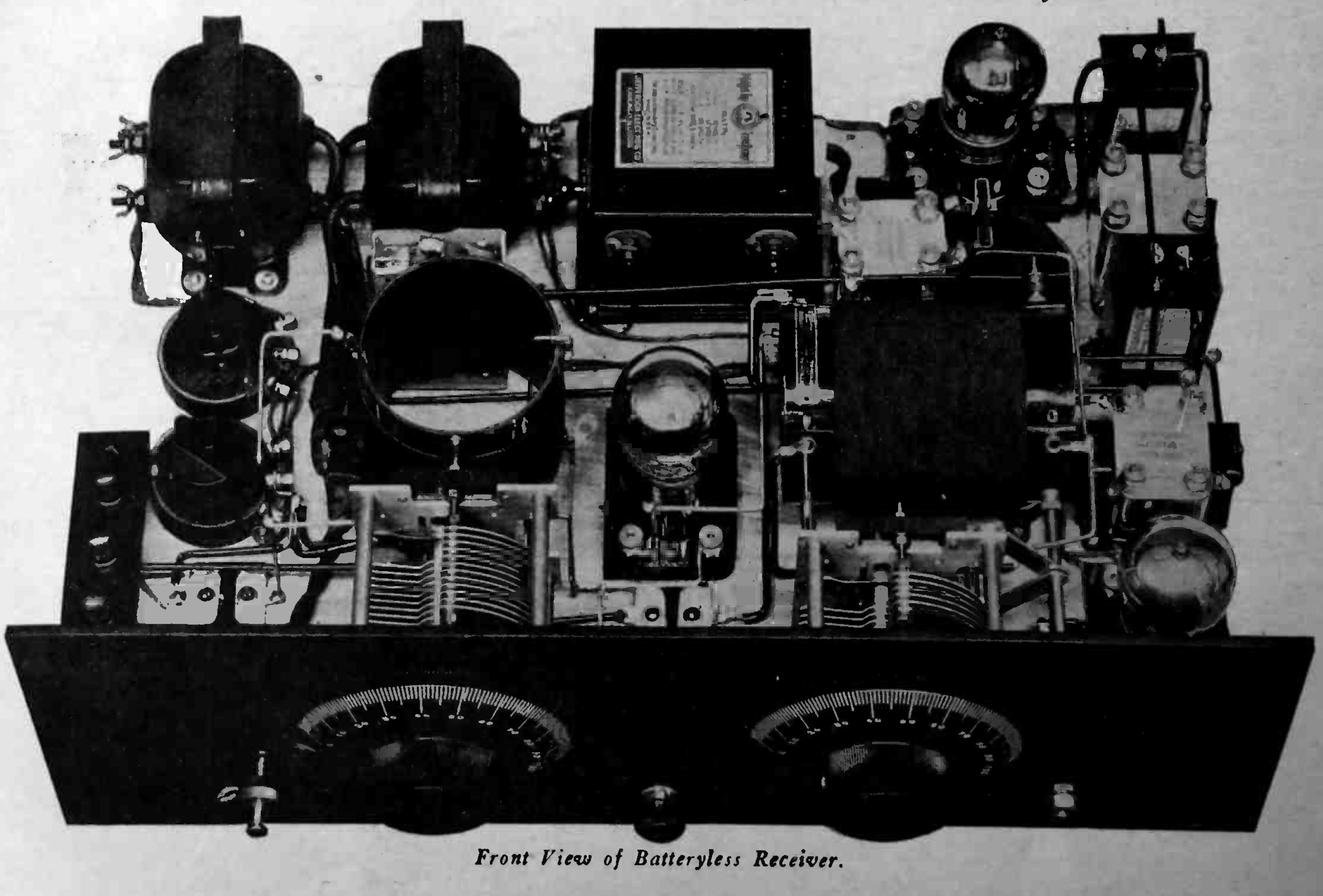


Fig. 1. Schematic Circuit Diagram.



Front View of Batteryless Receiver.

amount of apparatus, we do not recommend this arrangement.

The receiver, as illustrated, consists of two vacuum tubes with associated apparatus to provide one stage of radio frequency amplification, crystal detector, and two stages of audio frequency amplification, the radio stage being reflexed to provide the first audio stage. The current supply system is mounted on the same baseboard, to the rear of the receiving apparatus and consists of three transformers, a rectifier tube and a filter.

The list of parts as shown will enable the selection of good material and it is particularly important that the power apparatus be of good make and designed to carry the load. For the filter choke, the secondary winding of an audio frequency transformer was used, the primary winding having been burned out. This is a good way to make use of an otherwise useless piece of equipment and saves the construction of a special choke coil, or the use of a new audio transformer. The 2mfd. paper condensers should be capable of withstanding a voltage of 250 d. c. even though the voltage delivered to the receiving tubes is only 90 d. c. at the most. The three bell ringing transformers should each have a rated power output of at least 10 watts in order to carry the load without heating. The main power switch mounted on the front of the panel must be capable of handling 110 volts. Ordinary cheap jack switches will not do and may be the cause of severe shocks if defective. The Cutler-Hammer switch for filament circuits is rated at 3 amperes, 110 volts and is a safe one to use in the circuit. The radio frequency transformers are National Browning-Drake coils, which were selected because of their efficiency. The tickler coil mounted inside the second transformer was removed, since it cannot be used in this circuit. For those who wish to construct their own coils, data will be given later in this article.

The schematic circuit diagram, Fig. 1 shows the method of connecting each part in the best manner and is useful in discussing the theory of the circuit. The antenna circuit consists of a single coil, tapped at one point to permit change of the antenna connection. This coil is tuned by a 23 plate condenser having

(*Continued on Page 70*)

LIST OF PARTS

3 10-watt bell trans.
3 Vacuum tube sockets.
1 Set Browning-Drake Coils—National or home-made—see text.
2 Audio freq. trans.—see text.
1 Variable cond.—.00035 mfd.—see text.
1 Variable cond.— .0005 mfd.—see text.
1 Fixed crystal detector.
1 20-ohm rheostat.
1 6 " "
1 200 " potentiometer
1 Single circuit jack.
1 Balancing cond. .00005 mfd.
1 Cutler-Hammer switch.
2 Mica cond. .002 mfd.
1 Mica cond. .00025 mfd.
1 Filter coil—see text.
2 2 mfd. paper condensers.
1 Bakelite panel. 7x18 in.
4 Rubber insulated binding posts.
1 Baseboard. 12x18x½ in.
3 A type vacuum tubes.

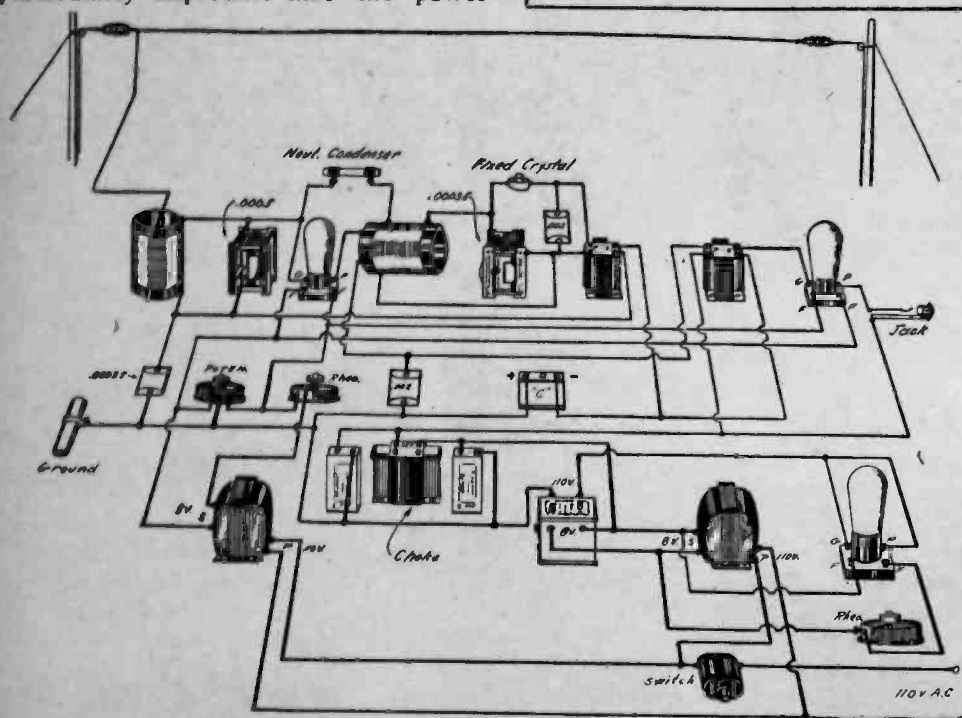
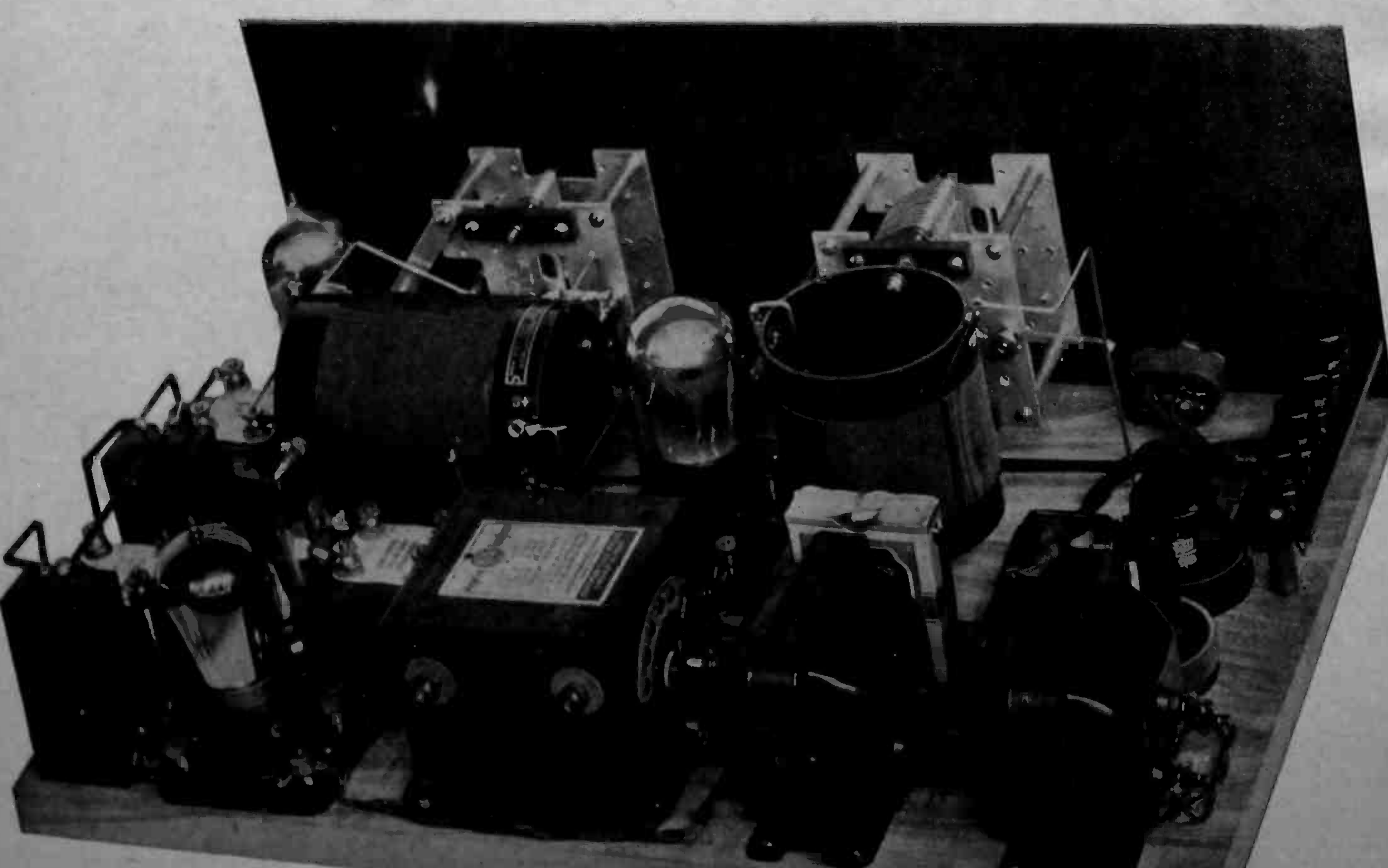


Fig. 3. Pictorial Wiring Diagram.



Rear View of Batteryless Receiver.

Regenaforming

Detailed Directions for Adding One Stage of Tuned Radio Frequency to a One-Tube Blooper

By Harry A. Nickerson

MANY one-tube regenerative tuners, with or without audio amplification, can be greatly improved by "regenaforming" in accordance with the Browning-Drake principle of adding one stage of efficient tuned radio frequency amplification. They can thus be made practically non-radiating, more selective and more sensitive, together with an improvement in tone quality and volume at but small increase in expense for construction and operation.

This can be accomplished by the use of an antenna inductance and shunted condenser that will cover the 200-550 meter range in the antenna-ground and grid circuit of the radio-frequency tube and by a variocoupler (regenaformer) to act as a tuned r. f. transformer ahead of the detector tube. Both the untuned primary and tuned secondary (shunted by a variable condenser) are wound on the stator of the variocoupler which is placed in the grid circuit of the detector tube. The rotor of the coupler, being in the detector plate circuit, produces the regeneration.

In the regenaformer the primary is wound in a groove under the first few turns of the secondary so as to reduce the capacity coupling without reducing the electro-magnetic coupling.

The following data are for a standard regenaformer coupler and antenna inductance such as used in the manufactured variety of Browning-Drake parts. Regenaformer coupler:

3 in. tube.
Pri. 24 turns No. 30 D. C. C. in groove about 1/8 in. wide wound under last few turns of secondary at fil. end.
Tickler. About 20 turns No. 28 D. S. C. on rotor.
Secondary 77 turns No. 20 D. S. C.
Neutro-tap taken off at 17¼ turns from filament end of secondary coil.
Antenna Inductance:
3 in. tube.
50 turns No. 20 D. S. C. tapped at middle.

Mount regenaformer and antenna inductance with axes at right angles to each other, with centers of coils about 8 or 10 in. apart. Preferably solder all leads direct to coil ends and avoid close proximity of grid and plate leads to each other and filament leads. High grade variable condensers, preferably with vernier controls, are needed for best results.

To regenaform an existing set, one does not necessarily have to wind the primary in a slot in the tube. The standard method may be somewhat more successful but, though this may sound like treason, the primary does not have to be wound that way. It may be wound over the outside of the secondary with a narrow piece of paper separating primary from secondary at the point, or it may be wound alongside the secondary, a continuation, as it were, of the secondary winding. The essential point is that it be wound at the filament end of the secondary winding, as close to that filament end as possible. If appearance with efficiency is desired, the winding may be bank wound over the last few turns of the secondary at the filament end, outside the secondary, just as well, apparently, as inside.

The standard set uses a coil in the antenna circuit of such inductance as to cover the radiocast wavelengths when tuned with shunted .0005 mfd. condenser, and in the tuned r. f. circuit, one of such inductance that it covers the radiocast range when tuned with shunted .00035 (17 plate) condenser. Other coils and condensers may be used provided the desired wavelengths scale is covered. Thus a few less turns may be used if the tuned r. f. regenaformer coil and a 23 plate condenser be used, or more turns be used in the antenna inductance and a 17 plate condenser be used in shunt.

The number of turns on the rotor of the coupler as used in the regenaformer will probably be found considerably less than the number required with the same type tube as used in an ordinary regenerative set. About 2/3 is suggested for trial. If one is adapting an existing coupler to be a regenaformer, a start with 30 turns might be made on the rotor and the number removed until the highest wavelength is reached on the tuning dials. The rotor must be turned until its windings are very nearly parallel to the stator windings in order to cause the detector tube to break into oscillation. Of course the leads to the rotor should be tried reversed if regeneration is not had with one connection.

For pleasant operation and good volume it is necessary that the set "go into oscillation" smoothly without a click or abrupt break from signal to distorted mush. Usually with UV-199 tubes as detector, at least 5 megohms grid leak is required and up to 10 megohms should be tried if necessary. A good variable leak with maximum of about 10 megohms is useful.

The antenna inductance in the usual Browning and Drake is tapped at the middle. Other combinations than those suggested in Fig. 1 are to run antenna direct to the tap, or to a tap taken nearer the filament end. One may try the antenna connected to one side of a .0001 mfd. fixed mica condenser and the other terminal of this condenser connected direct to the grid end of the antenna inductance. One type of antenna may require the one connection while another length of antenna may require the other connection.

For even greater selectivity (such as might be wanted where an antenna was several hundred feet long), an "untuned primary" may be added to the antenna inductance and the coupling be made wholly "inductive", or in other words,

(*Continued on Page 64*)

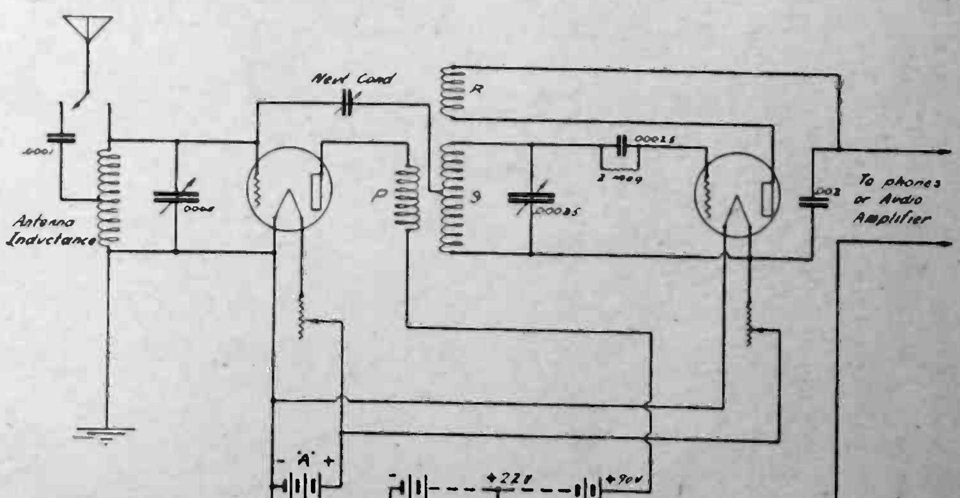


Fig. 1 Circuit Diagram for "Regenaforming" a Regenerative Detector.

Figuring the Wavelength of Your Set

By E. M. Sargent

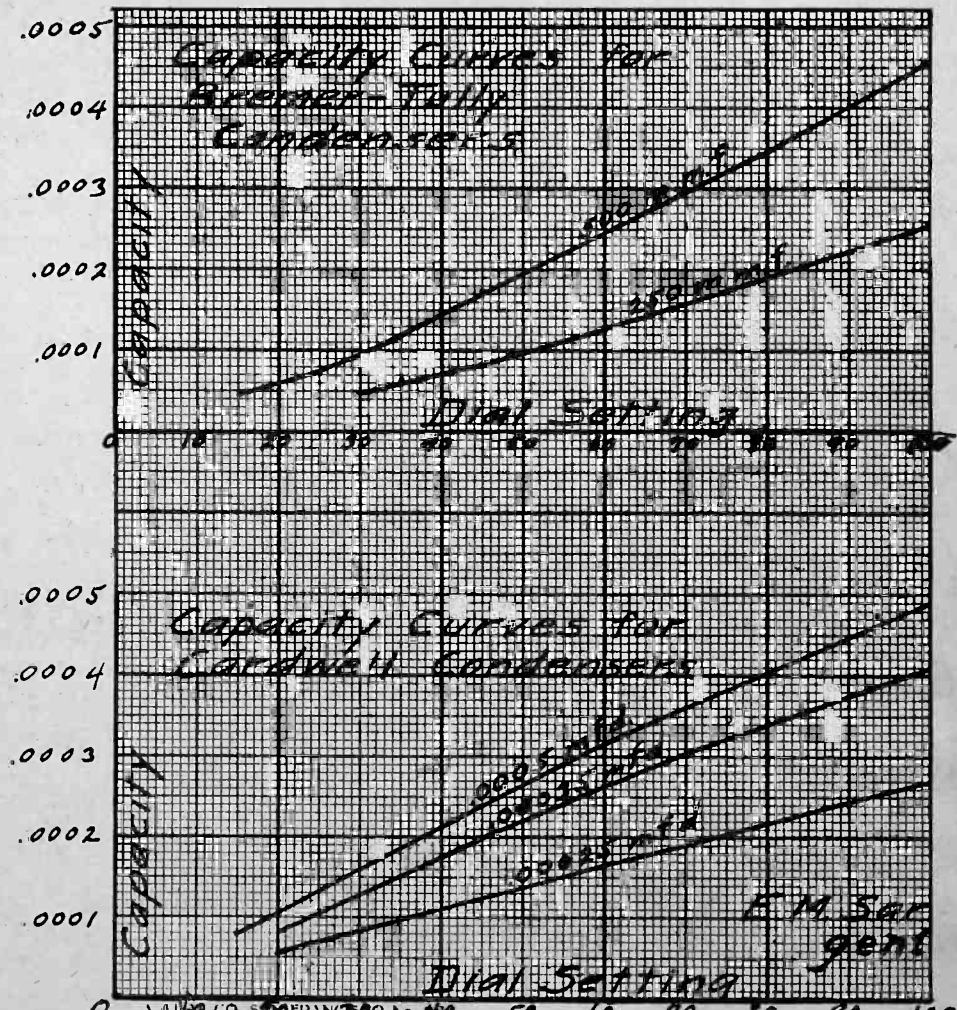
THIS is a practical article on the calculation of wavelength for different types of receiving sets. Many amateurs and experimenters lack the ability to calculate the cônstants of their circuits although they have a good understanding of how they work. This is unfortunate as it can be done easily and accurately. No higher mathematics is necessary—only simple arithmetic. After reading this article any radio set builder should be able to:

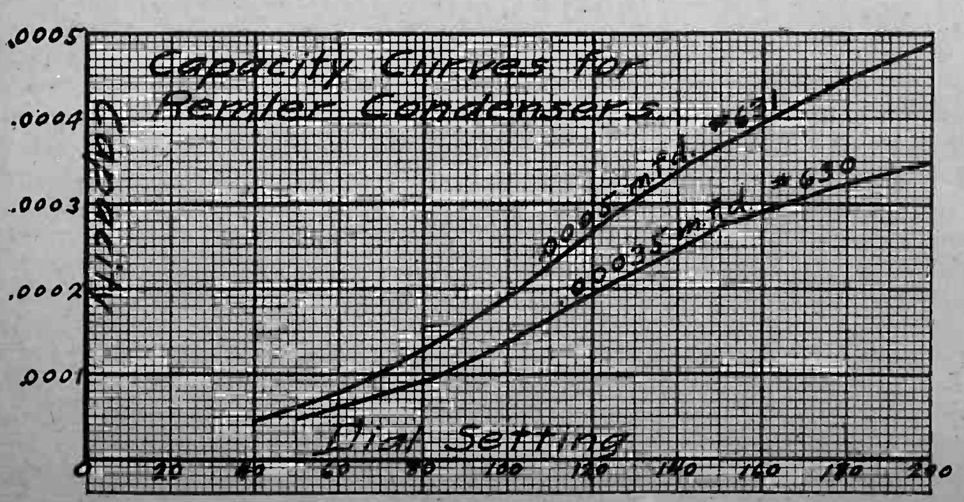
1. Design a single circuit tuner to cover any desired wave band.
2. Design a low loss three circuit tuner for use on the short waves.
3. Calculate the proper size for a set of neutrodyne coils.
4. Find the number of turns needed on the oscillator coupler of a superheterodyne to cover a wave band of 40 to 100 meters or to cover the radiocast range.

Many other applications of this simple method of figuring can be used and it is suggested that after studying the article, the reader try a few calculations on his own set to see whether or not it is properly designed.

Accurate capacity curves are shown for three standard makes of variable condensers. While these makes have been chosen because of their sturdy construction and low circuit losses, there are many other good makes which could just as well be substituted. The corresponding curves can generally be obtained from the manufacturer. The capacity curves will apply with reasonable accuracy to any stock condensers.

The wavelength of the circuit depends in general upon three factors—the inductance, capacity and resistance. In radio frequency circuits, the resistance is so small in comparison with the inductive and capacitive reactances that it may be neglected without introducing error into the calculations.





For a given wavelength the product of the inductance times the capacity is always the same. For example, a circuit having an inductance of 505 microhenries and a capacity of .0002 mfds. would have an *LC* constant of .101 (the inductance multiplied by the capacity). Any circuit having the *LC* constant = .101 would have the same wavelength. By referring to the table of LC constants, it will be seen that the wavelength in this case is 600 meters. If the inductance were increased to 1010 microhenries and the capacity cut to .0001 mfds., the wavelength would still be 600 meters. There are thus any number of combinations of inductance and capacity that may be used to make the wavelength 600 meters.

If either the inductance or the capacity is known for a given wavelength, the other can always be found by dividing the known inductance or capacity into the *LC* constant for the wavelength in question. The accompanying table of *LC* constants, which covers the amateur and radiocast wave bands, gives the corresponding wavelength and frequency for the different *LC* values.

EXAMPLE No. 1: A single circuit receiver has a Cardwell .0005 mfd. variable condenser. The set is to be used for radiocast reception over a wavelength range of 260 to 560 meters. What should be the inductance of the coil to cover this wave band?

In this circuit the variable condenser is in series with the antenna and ground capacity which may be assumed to be about .0005 mfds. The maximum capacity across the coil will therefore be this antenna and ground capacity in series with the Cardwell condenser. It is nominally equal to their product divided by their sum .0005×.0005÷.001, which gives a resultant capacity of .00025 mfd. This is the capacity that will be used across the coil for 560 meters. Referring to the table, the *LC* constant for 560 meters is .0883. Dividing this by the capacity .00025, gives *L*=353 microhenries. A coil having this value of inductance may be calculated from the curves given on page 34 of April RADIO. The *LC* constant for 260 meters is .0190. Dividing this by the inductance, 353 microhenries, gives a capacity of .0000538. This is so low a value of capacity that it would be very difficult to tune to this wavelength with such a large coil. For best efficiency, therefore, it would be advisable to take off two or three taps for use on the lower waves.

EXAMPLE No. 2: Design a low loss tuner having a secondary coil that will tune from 36 to 100 meters, using a Bremer-Tully 250 mmf. (.00025 mfd.) condenser.

LC for 100 meters equals .00282. Dividing by *C*= .00025 gives 11.3 microhenries. *LC* for 36 meters equals .000365. Dividing this by the inductance of 11.3 microhenries gives the capacity for this wavelength as .0000323. Although this is a low capacity, it can be reached easily with the variable condenser that has been selected for this circuit and it is about the right capacity for a wavelength of 36 meters.

Suppose that when this set is in use, it is desired to tune in WGY broadcasting on a short wave of 90 meters. At what point would the condenser dial be set for WGY, assuming that the dial reads 0 to 100?

LC for 90 meters=.00228, which divided by *L*=11.3 gives *C*=.000202 mfd. Referring to the capacity curve for a Bremer-Tully 250 mmf. condenser, we find that when the dial is set at about 83 degrees the capacity is .000202 mfd. WGY would, therefore, tune in at about 83 degrees.

EXAMPLE No. 3: What should be the inductance of the secondaries of a set of neutrodyne coils to cover a wave band of 260 to 560 meters, using Remler .00035 condensers.

LC for 560 meters=.0883 and dividing this by .00035 gives *L*=252 microhenries. The capacity needed across the coil to tune to 260 meters is obtained by dividing .0190, the *LC* constant for 260 meters, by the inductance. This gives .0000753 as the required capacity. Referring to the capacity curve for the Remler .00035 condenser, it will be seen that this capacity will be obtained when the dial is set at about 70 degrees. (NOTE: The dial on the Remler condenser reads 0 to 200.) Suppose that the coil is to be wound with No. 22 DCC wire on a 3-inch tube. To find the required number of turns, refer to the April issue of RADIO, page 34. No. 22 DCC wire winds 28 turns per inch. The square of 28 is 784. The "inductance constant"=252 divided by 784 or .32. Reading up from this value to the curve for a 3-inch coil, then over to the left, gives the length as 2¼ in. Multiplying 2¼ in. by 28 turns per inch, gives 63 as the number of turns needed.

Where would the second and third dials be set to receive PWX broadcasting on 400 meters? (NOTE: It is impossible to accurately compute the first dial because of the antenna capacity.)

LC for 400 meters equals .0450, which divided by *L*=252 gives the capacity for 400 meters as .000179. Referring to the capacity curve for this condenser gives the dial setting as about 114 for this wavelength. This setting may be one or two degrees out on account of the circuit wiring and capacity of the primary coils.

These examples cover fairly well the ordinary problems encountered in circuit design. In order to check the accuracy of these computations, it is suggested that the reader try one or two of these problems on his own set. By doing this a few disgruntled radio fans may discover why they cannot "tune up to KYW or tune down to KFRC."

For those who would like to try some calculations on the intermediate frequency of a superheterodyne, an explanation of the *LC* table will be in order. The table as shown is for amateur and broadcast wave bands only. However, the numerals are the same for all wave bands and it is only necessary to change the decimal point to shift to another wave band. The decimal point in the *LC* column must be moved two places for each place that it is moved in either of the other columns. For example, at 600 meters *LC*=.101. At 6000 meters, it would be equal to 10.1. For 4545 kilocycles (4,545,000 cycles) it is .00123, for 45,450 cycles it will be 12.3, etc.

A formula that will apply for the calculation of inductance in multi-layer coils, such as are used on the higher wavelengths, is as follows:

$$L=\frac{.081\ n^2\ a^2}{.588a+1.118b+.991c}\text{ microhenries}$$

where

n=total turns.
a=*average radius in inches.*
b=width of winding as measured parallel to the axis of the coil.
c=depth of winding (distance in inches from the outside turn to the inside turn measured along the radius of the coil.

SHORT WAVE SETS FOR NAVAL RESERVES

THE Bureau of Engineering of the United States Navy Department will equip all naval districts with short-wave transmitters for the experimental use of naval reserves and radio amateurs who will be commissioned to construct these high-frequency sets. They will have an operating range from about 40 to 80 meters.

Dr. A. Hoyt Taylor, superintendent of radio at the Bellevue Naval Research Laboratory, in the building and operating of the model short-wave transmitters has made interesting observations relating to high-frequency transmission effects. "Night effects," according to Doctor Taylor, "differ greatly according to the season of the year. In the summer time frequencies up to 7,500 kilocycles (about 40 meters) are almost as good at night as they are in the daytime, except for the fact that atmospheric disturbances are usually worse at night, but in the winter time frequencies in excess of 5,000 kilocycles (60 meters in wavelength) frequently fail to get through altogether at moderate distances, but strangely enough, still continue to get through at low ranges.

"For instance, all last summer our 5,530-kilocycle (54-meter wavelength) emission was received with great regularity in the Argentine, in Brazil, and Chile, from the beginning of the dark hours—that is, for ten or eleven hours every night, although it was winter time in South America. Frequencies higher than 6,000 kilocycles (a wavelength of 50 meters) worked over moderate ranges between 250 and 1,000 miles commonly fall to very low intensity or disappear altogether in the winter nights. Nevertheless, if sufficient amount of power is used, namely, between one and two kilowatts in the antenna, they are still capable of good work at long distances. East and west work has proved more difficult to carry out over long distances than north and south."

The phenomenon of fading as it applies to low wavelengths has been studied by the Naval Research Laboratory. "All the high frequencies are afflicted at night with high-speed fading effects," notes Doctor Taylor, "rendering telephony difficult unless something is done in the way of a very elaborate compound receiving system that equalizes these effects; receivers being spaced a considerable fraction of a wavelength apart. This high-speed fading does not affect telegraphy at hand speeds. It probably will affect it at high speeds. Slower fading effects are very common within 1,000 miles radius, but at greater distances this type of fading, which is detrimental to telegraph work, is very much reduced.

"Very much less fading is reported on our 5,530-kilocycle (a wavelength of

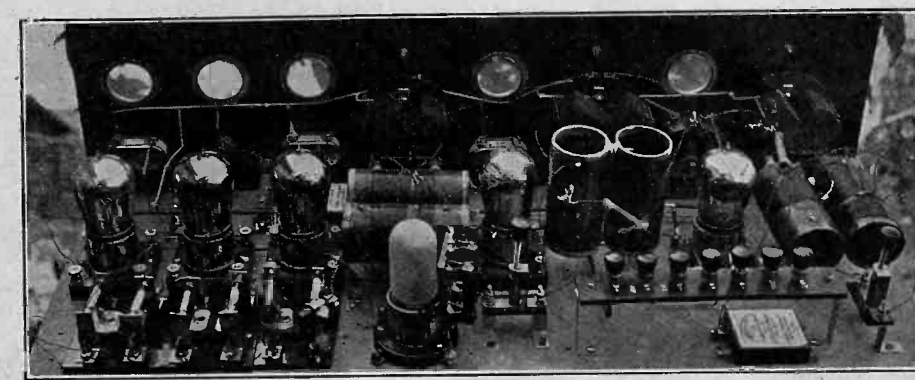
(*Continued on Page 76*)

Bringing a Receiver Up-to-Date

Suggestions for Adding Several Recent Radio Frequency Amplification Developments to a Set

By E. C. Nichols

MANY radio receivers containing one or more stages of radio and audio frequency amplification are no doubt not giving perfect satisfaction to their owners. Perhaps the radio frequency amplifier oscillates and the audio amplifier distorts, or the selectivity is not good. Whatever the trouble, the set described here will offer an interesting field for experiment for these who desire to improve their present circuit without changing the condensers, sockets and panel layout.



General Arrangement of Parts in Modified Set.

The general arrangement of parts is shown in the illustration, the panel being approximately 7x21 inches, and the baseboard 10x21 inches. The schematic circuit diagram is shown in Fig. 1. As it is intended to discuss the suggested changes in a previously constructed set rather than to describe how to build a new one, Fig. 1 will serve as a basis for reference.

Begin by inserting a .0001 mfd. fixed condenser in the antenna circuit with a switch for cutting it out. The antenna inductance is an auto transformer nearly approaching the single circuit tuner. There are two good reasons for this arrangement: to obtain as much initial signal as possible and to stabilize the first r. f. tube, selectivity being obtained in the second and third r. f. tuned transformers.

The inductance is similar but not identical to the binocular coil, and for want of a better name, might be called a figure eight coil. Its construction is fully shown in detail in Fig. 2, each turn being wound alternately on either tube. The antenna inductance consists of 60 turns of No. 28 enameled wire wound on two 1½ in. diameter pasteboard tubes which are well paraffined. It is tuned with a .000375 mfd. variable condenser, which will give ample range for the radiocast field. It is possible that the number of turns in the inductance will have to be varied for different makes of condensers. A condenser of low minimum capacity has a wider range of tuning when combined with a given inductance and should be used where possible.

The r. f. transformers are made by winding 60 turns of No. 28 enameled wire on two 1½ in. diameter pasteboard tubes for the secondary and 25 turns of No. 28 enameled wire for the primary.

The secondary of the second r. f. transformer is tapped in the center for the negative filament connection. This type of coil will be found selective and efficient. None of the standard neutralizing combinations have any effect with it in controlling oscillations and a 5,000 ohm resistance in series with the second r. f. transformer and the negative filament connection is used as a stabilizer. Three tuning controls are necessary.

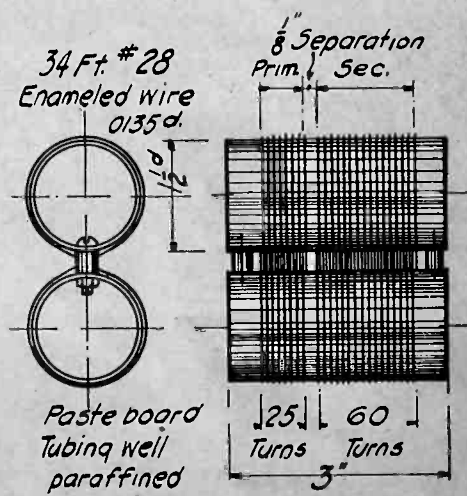


Fig. 2. Constructional Details of Figure Eight Coil.

A D-21 Sodion tube is used as the detector with satisfactory results. It is stable, gives crystal quality and has low filament current consumption. It is particularly adapted to D. X. work. As a detector for reflex circuits it should be

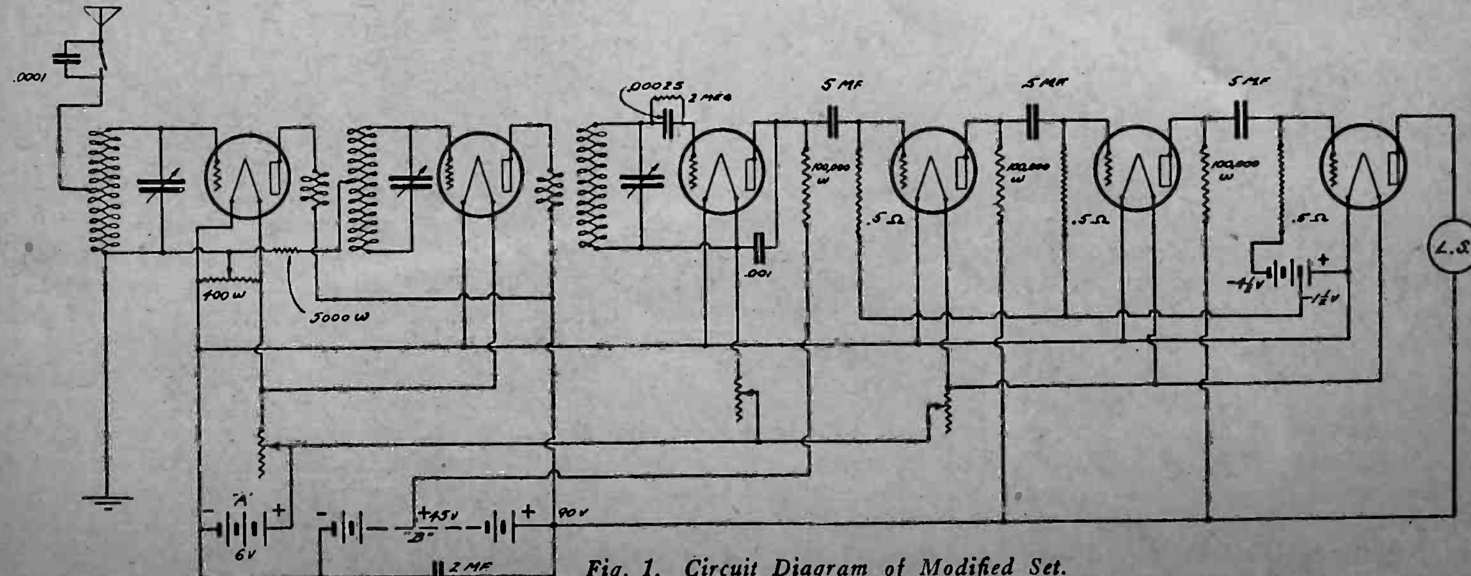


Fig. 1. Circuit Diagram of Modified Set.

very efficient because of its nonregenerative feature. Although the manufacturers of the Sodion tube specify a negative grid return it is well to try a positive grid return. In the case of the tube used in this circuit the positive return gave the best results with 25 volts on the plate.

The audio amplification is of the resistance coupled type. The plate resistances are .1 megohm each or, if more volume is desired, a resistance as low as .05 megohm may be used, although the .1 megohm resistances insure the best possible reproduction. The grid leak resistances are .5 megohms each. The variation of the grid leaks has more effect on the adjustment of the amplifier than the plate resistance does, but neither are critical.

The coupling condensers may be any of the good standard fixed condensers ranging from .1 to 1 mfd. The capacity shunted across the plate resistance of the first stage of the audio frequency amplifier is of a variable nature, depending upon the requirements of the amplifier. Its effect is similar to that of a condenser shunted across the primary of an audio transformer, by-passing the radio frequency currents. Fixed condensers varying from .00025 mfd. to .002 mfd. may apply here. Select the one giving the best results.

The set as now composed is an expression of some of the late developments in the art of radio reception.

An unusual variation of the standard two stage r. f. amplifier is shown in Fig. 3, incorporating the feature used in the Roffy super circuit. The changing of one connection only will accomplish the desired effect. This is an interesting modification of r. f. amplification, the first tube acting as a blocking stage of r. f., preventing radiation. The second r. f. tube, due to its connection to the plate of the first tube, is capable of oscillating but these oscillations are controlled by the filament rheostat and in this way selectivity and maximum amplification are secured in the second tube. Also that percentage of the output of the first r. f. tube which would otherwise be lost in the second r. f. transformer finds a direct path to the plate of the second r. f. tube and thence to the detector. The departure from the usual two stage r. f. circuit is the change in the *B* battery plus connection of the primary on the third r. f. transformer which, instead of being connected directly to the *B* battery plus, is connected to to the plate of the first r. f. tube. This is a clever application of the regenerative principle and, when properly adjusted, gives exceptional selectivity, good quality and ample volume.

There is a decided increase in the popularity of the single control receiver and, by a little mechanical and electrical ingenuity, it is possible to combine the adjustments of a multi-controlled receiver into one control. The tuning condensers may be mounted on one shaft or connected by gearing and the inductances carefully adjusted to them by correcting the number of turns so that the inductance of each coil is identical. This will necessitate broader tuning and closer coupling between the primary and the secondary windings of the tuned r. f. transformers because of the variations in any make of variable condensers on the market.

It is important that the three tuning condensers for a single control receiver should be carefully selected by test and inspection. Each should be tested with the same coil and the readings for high, intermediate and low wavelength stations should be recorded. Those condensers should be chosen which give as nearly as possible the same readings. It is essential that the intermeshing plates be truly aligned and exactly centrally spaced, for unsymmetrical spacing of the plates will increase the capacity for a given reading on the dial. A more efficient method is to use vernier condensers for the first and third inductances, the single control dial being used for the regular run of tuning and the verniers for sharpening the tuning, as in D. X. reception. In the case of a single control receiver it is necessary to insert a .0001 mfd. fixed condenser in series in the antenna circuit to insure that the antenna has no effect on the tuning of the first inductance.

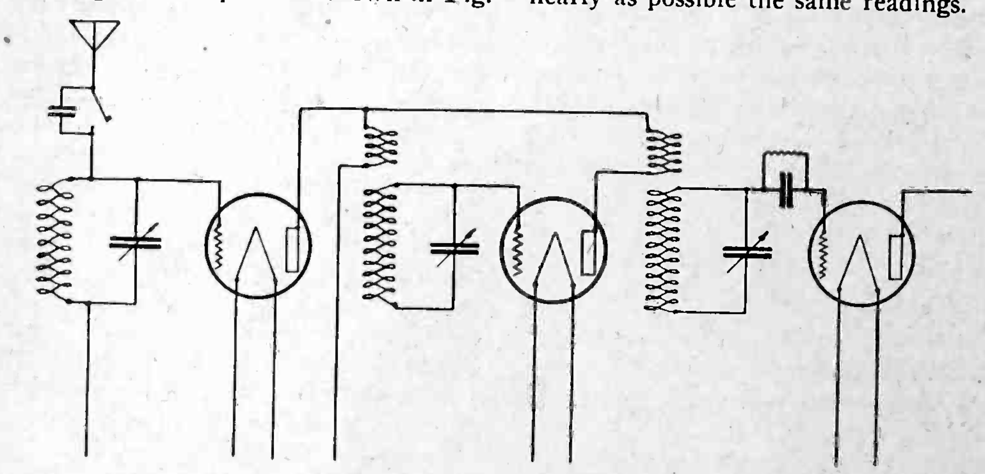


Fig. 3. Roffy R. F. Amplifier.

BRINGING UP SULPHATED BATTERIES

By D. B. McGowN

Although it is always to be avoided, sometimes it can't be helped when storage batteries get sulphated, due to neglect, lack of use, etc. A storage battery of the lead variety will sulphate and become worthless in time, and if the sulphation has gone too far, the junk-man will get it, without question. If lead cells are put away, even in a fully charged state, there will be enough action in them, so that they will finally run down and sulphate.

This sulphate is in the form of a hard white mass, which covers the plates, and quite effectually insulates them from the action of the solution. This white sulphate may be removed in several ways, among them being repeated charging, or by removing plates from the cell, and mechanically scraping off the sulphate. This latter process is a rather messy job, and its efficiency is questionable; the former method wastes "juice", especially if the battery is badly sulphated. Repeated charging requires that the battery be started at a very low charging rate, and the charge kept up for sometimes as long as several weeks, at from one-quarter to one-tenth of the normal charging rate. This is, however, a very good way to restore such batteries when possible to do so.

Another way is to break down the sulphate at the start, and then charge the cells up to normal. This requires a source of direct current many times more powerful than is usually available for charging a few cells, but it has the great advantage of saving a great deal of time. Connect the sulphated battery to the charging source, and gradually boost the terminal voltage, until there is an appreciable current flowing. On a common three-cell battery, this may require anywhere from 15 to 75 or 100 volts, at first, depending on how badly the cells are sulphated, and but one or two amperes will flow; suddenly the current will start, and break through and as soon as it does this, the impressed potential should be reduced, or the battery taken off the line. The battery will drop immediately in internal resistance, to such a point that an enormous current will flow, if this is not done.

The best method in this case is to reduce the charging voltage, such as can be done with a motor-generator, and field rheostat for control thereof. With the battery still connected to the line, allow a high current to flow through it, up to anywhere from half to equal its ampere-hour rating in *amperes*. Continue this high rate charge for a few minutes, or until the temperature starts to rise to about 110 to 115 degrees F. and then take the battery off charge, en-

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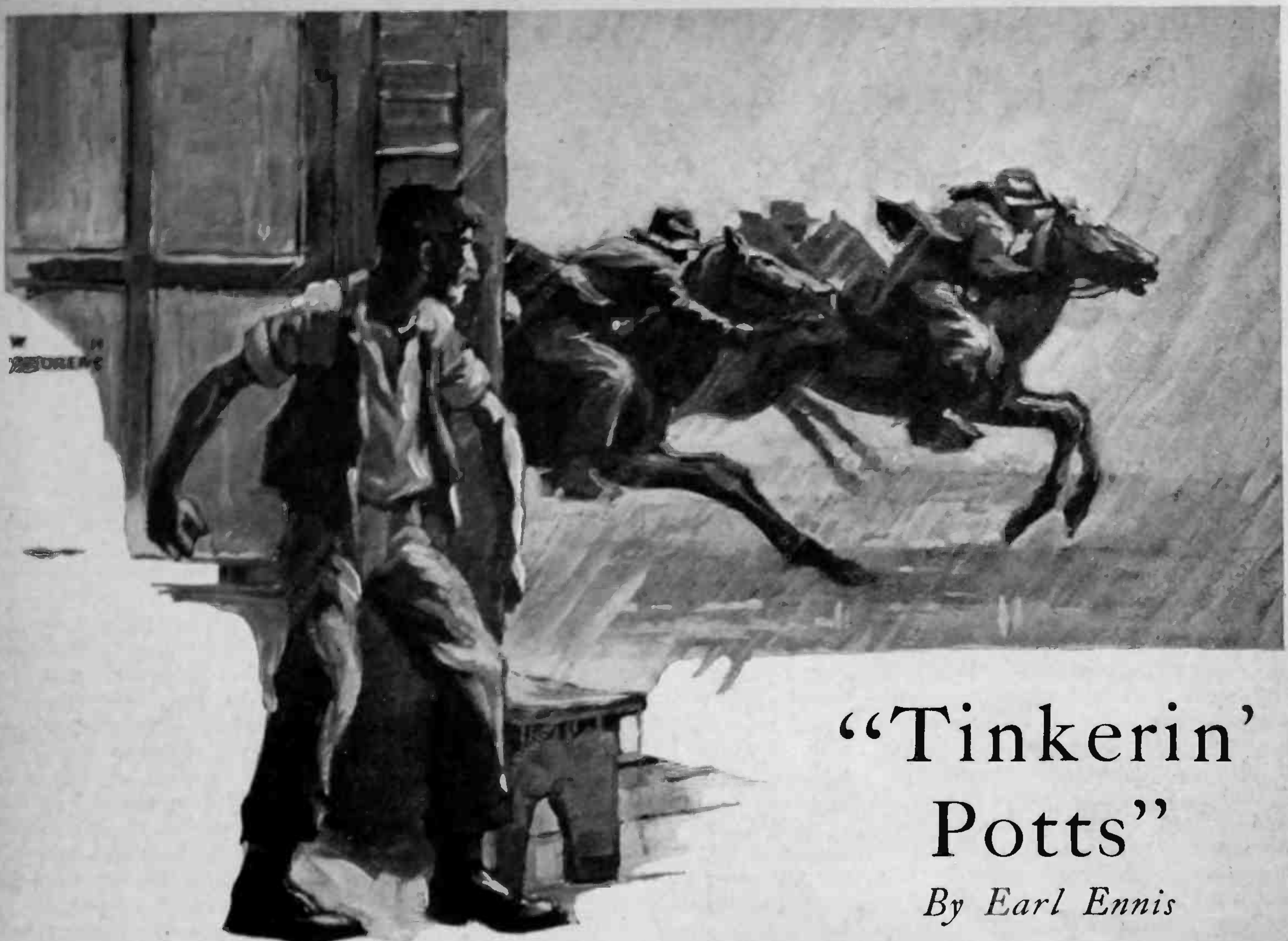


"Tinkerin' Potts"

By Earl Ennis

WHEN one visits Gila Grande for the first time, the bus driver always points out two details in which the leading metropolis of Oaju Valley has won signal recognition—the "mansion" of Tinkerin' Potts and the weatherbeaten shack of Two-Gun Ike. After which, he drives up in front of the Union Hotel, kills his engine and goes to sleep in the sun.

The visitor carries his own baggage indoors, signs the register with a rusty pen and then, if he has a grain of curiosity in his makeup, inquires of Walloby Jones, "prop", as to the whys and wherefores of Tinkerin' Potts and Two-Gun Ike. And because it is for such moments that Walloby Jones exists, he waves his guest to a convenient chair, places his foot in the seat of another, and with a preliminary shot at a dingy cuspidor, tells him the story of Gila Grande's famous darned fool.

The story of Tinkerin' Potts recalls the famous Ladybird well, for Oaju Valley is oil country from end to end, whose gaunt wilderness of mouldering derricks stand as monuments to fortunes that were made and lost in the heyday of its pre-eminence. Millions were made on the rim of Gila Grande, whose dance-hall windows blinked sleepily down upon the purple shadows of the flatlands. When the last grim drop had been wrung from the reluctant shale, the money-mad population had flitted away, leaving the town like an old man who has seen much of life—bent, drawn and toothless, but with eyes still bright from an inner vitality.

Tinkerin' Potts came with the oil rush just before the Ladybird was sold for a million to the Lorimer interests. They still recall, when talking of the bonanza days, how he drifted into the town on a late October afternoon on a sorrel mule, slid one long, lean leg over the pommel of the worn saddle and fell to whittling while he sized up the town from under the brim of a flappy hat with pale, colorless eyes.

"An' there he sits on the front porch of his mansion right now whittlin' still," says Walloby Jones, as though the doing of it was a crime. "He's just as much a darned fool now as the day he come here. And yet . . ."

That's just it. Gila Grande always adds those two words "and yet", when speaking of Tinkerin' Potts. Towns have done that from time immemorial, and when a town calls a man a darned fool and adds "and yet", keep your eye on him. He's usually dynamite.

Tinkerin' Potts looked anything but explosive. He was in appearance what Spurlock Mead called "a peaked critter", of the gangling type, as mild and inoffensive as "a pan o' sour milk on a high shelf." The simile is again Spurlock's. When the marshal, who made it his business to greet all newcomers, in the interests of peace and quiet, inquired as to his business, the newcomer returned an answer in keeping with his appearance.

"M'name's Potts," he said mildly. "Some folks call me Tinkerin' Potts because I'm right handy fixin' things."

The marshal grinned.

"Well's long's yuh don't come tinkerin' 'round the jail I reckon yore welcome," he said.

"Thanks," said the newcomer. "I ain't hankerin' to enjoy your hospitality none. My line's sewin' machines, Fawds and headers. I'm right good too, on screen doahs and general solderin'."

"You'd ought to die rich in this town," said the marshal. "There ain't anything here that don't need fixin' someways."

In a manner of speaking, Tinkerin' Potts' advent into Gila Grande marked the coming of the first walking repair shop and service station the place had ever known. The marshal's statement was no exaggeration. Nearly everything in the place needed fixing. There was a deficiency of mechanical skill. The great lust was oil and men played for

(*Continued on Page* 54)

Inductance, Capacity, Wavelength, and Frequency Relations for the Home Constructor

By E. E. Griffin

AN understanding of the relations of radio circuit constants is simplified by the accompanying chart, giving capacity, inductance, wavelength and frequency. Comparative values of the honeycomb coil are shown on the inductance scale for a better sense of inductance values. Average capacities of variable condensers are given on the capacity scale. Frequency in kilocycles is given on the wavelength scale.

By passing a straight edge through any two known values, we may determine a third unknown. As an example, assume we have a variable condenser with a maximum capacity of 500 micromicrofarads, which when connected across a coil of unknown value, tunes to a wavelength of 540 meters. With a straightedge or ruler, we connect 500 on the capacity scale with 540 on the wavelength scale, and reading along the edge of the ruler where it crosses the inductance line we find approximately 160 microhenries, which we may assume to be the inductance of the coil; shown by the dotted line of the chart.

If the minumum capacity of the variable condenser is known to be .00002 microfarads, or 20 micromicro-farads, when used with the above coil we would expect to be able to tune down to approximately 105 meters. However, in actual use we would probably find that we could reach only 150 meters, as our inductance coil always has a distributed capacity whose amount depends upon the construction of the coil, spacing of turns, dielectric constants of tubing, etc. In this example it is estimated at about 20.

If this coil and condenser be further connected to a vacuum tube, and coupled to an antenna and ground circuit, as in a radiocast receiver, we further add to the inherent circuit capacity, and correspondingly decrease our range of tuning on the shorter wavelengths. This inherent circuit capacity also effects the tuning range on the longer waves, making the circuit respond to slightly longer waves, but in a much smaller degree, as the maximum capacity of the condenser is many times the circuit's inherent fixed capacity.

On the short wavelengths the circuit's fixed distributed capacity generally is equal to, or greater than, the variable condenser's minimum, and therefore must be taken into consideration. This can be better explained by the fact that in doubling the capacity or the inductance of a circuit, we increase its wavelength by the square root of 2, or by 1.414; doubling both capacity and inductance doubles the wavelength. But since it is common practice in receivers to use a fixed inductance and a variable capacity, our circuit must have a high maximum to minimum capacity ratio in order to cover the band of 200 to 550 meters.

The same chart may also be used for the longer wavelengths above 1,000 meters by multiplying the wavelength values by 10 and the inductance values by 100. For an example, suppose we desire a circuit capable of reaching 6000 meters, using a 43 plate variable condenser. Connecting 1000 on the capacity scale with 600 on the wavelength scale gives us 100 on the inductance scale; which multiplied by 100 is 10,000 microhenries (10 millihenries) the approximate inductance required. The minimum wavelength to which this circuit would be capable of tuning would, of course, depend on the total minimum capacity, the combined effects of the condenser's minimum capacity, the distributed capacity of the coil, tubes, wiring, etc., and in this case if equivalent of 100 mmf. we would have a wavelength range of from about 1900 to 6000 meters.

The chart may also be used for larger capacities than those given on the scale by multiplying the capacity values and dividing the inductance values by the same number. Using 10 for instance, assume we have a condenser of 3000 mmf. (.003 microfarad) capacity and desire a wavelength of 500 meters. Connecting 300 on the capacity scale with 500 meters we get 240 on the inductance scale and dividing by 10 equals 24 microhenries, the required inductance.

Various other applications of such a chart will become evident. Using multiples of 10, for instance, we can make our scales read in microfarads and henries, and upon converting wavelengths to frequencies, we could have cycles within the range of ordinary commercial alternating current.

For simplicity, the values on the kilocycle scale are from the factor 300,000. To find the kilocycle equivalent of any wavelength in meters, simply divide 300,000 by the known value, and vice-versa. For more accurate conversion, however, and the method used by the Department of Commerce in assignments of wavelengths or frequencies to radiocast stations, the factor 299,820 is used instead of 300,000. However, the difference in results obtained by the two methods is much smaller than the inaccuracies of drafting and reproduction of such a chart and may, for all practical purposes be disregarded.

HANDY HINTS

By D. B. McGown

A dead dry battery can be temporarily revived for a few hours' use by punching a hole in the zinc case of each cell, soaking in a strong salt water solution for half an hour, carefully drying out, and replacing in the paper containers.

Common glass beads make good insulators for short lengths of bare wire which are likely to short circuit things.

By soaking a photographic film in hot water and scraping off the gelatin emulsion a good dielectric can be made for fixed condenser in a receiving set.

By renewing the cords on head phones about once a year many unaccountable "funny noises" may be eliminated.

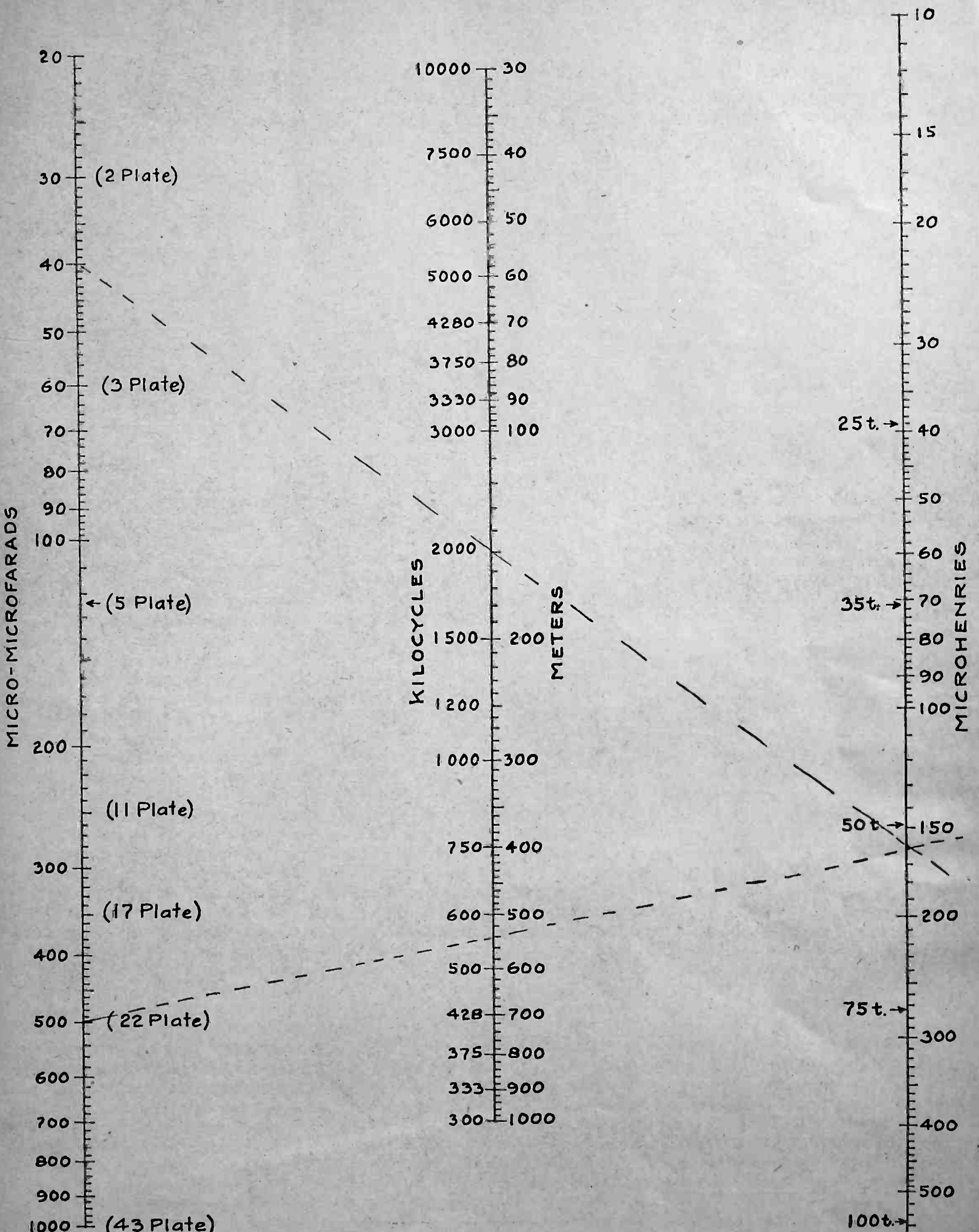
One test for genuine vacuum tubes is understood to be brought forth by the fact that the genuine have the trademark etched inside the glass bulb, while with the imitation it is outside.

The life of the thoriated filament type of vacuum tube does not depend on how long the filament will last, but on how long the thorium will remain, without evaporation. A tube may, as is well known, light up, and still be worthless for any ordinary use, when the thorium is exhausted.

In using a set with an antenna and ground system, it quite often happens that electrolysis due to street cars, and other power sources in the water pipes will cause noises that can't be traced in the set or outside. A counterpoise will sometimes entirely eliminate such interference.

When you hear of certain stations being on different wavelengths, and yet heterodyning, or having "harmonics", be *sure* that before you go up in the air about it, that it is not due to some bug in your own apparatus. It often is!

Probably half the complaints directed against radiocasting stations are due to differences in personal opinion, rather than to any technical difficulties. This is especially true of tuning, and the elimination of undesired interference. A skilled operator can quite often get results out of a set that a novice could not believe were even possible, let alone try to duplicate.



Nomogram of Inductance, Capacity and Frequency Relations.

(For explanation see preceding page.)

An Excellent Code Practice Outfit

By Howard S. Pyle

WITH the increasing interest in mastering the characters of the telegraphic code used in radio communication, there has arisen a demand for some arrangement whereby the character could be practiced at home in a way that would lead to some proficiency in deciphering the myraid voices of the night.

For years the high frequency buzzer, familiar to users of crystal sets provided with a test buzzer, has held the front rank among simple, inexpensive devices for this purpose. With the advent of the oscillating vacuum tube, however, a simpler method of producing a note resembling a radio telegraph transmitter is available. At the same time it permits of a wide variety of frequency changes to suit the pleasure of the user. Thus can the shrill, high-pitched whistle of a 500 cycle spark, the flute-like note of a vacuum tube transmitter, and a myriad of intermediate tones be obtained instantly and at will.

One of the chief drawbacks to the buzzer practice set has been the buzzer itself. There are a number of good buzzers available for a variety of purposes but unfortunately none that readily lend themselves to practice sets with any surety of their holding a constant tone. Elaborate adjustments are provided and other methods have been introduced to keep the tone constant, but the slightest variation of battery current produces a like variation in the note of the buzzer which tends to annoy and interrupt the student.

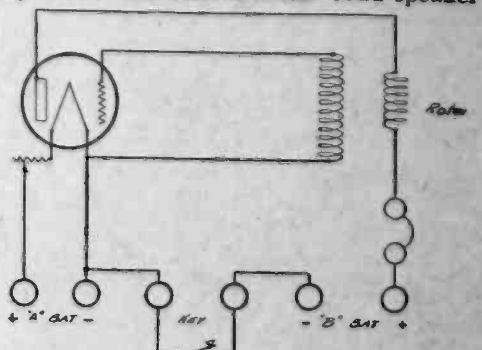
For those who desire the ideal in practice equipment for learning the radio telegraph code, and who already own a radio receiver that can be made to "howl" at some particular adjustment, it is necessary only that they invest in a hand key and the result will be a perfect apparatus for practice purposes. The key should be securely fastened on a table of standard height, and far enough back to allow the forearm to rest comfortably on the table when the fingers grasp the key-knob. This is important in order to properly formulate the code characters. The head-set or loud-speaker is then connected in series with the key, which should be of the legless type with circuit closing lever switch integral with the base. This completes the installation.

To use the equipment for code practice, it is only necessary to so adjust the set as to produce a howl in the receivers or loud-speaker, with the switch on the key base in the closed position. It will then be found on opening the key, that the set may be made to howl in exact conformity with the characters as formulated by the student. As a precautionary measure against undesirable radiation into the air, the antenna and ground should always be disconnected from the set.

For those who have no oscillating receiver—and there are extremely few receivers today that cannot be made to "howl" at some particular adjustment—a separate oscillator may be made for code practice and connected to the same batteries used on the receiver. One of the receiving tubes may also be borrowed when it is desired to use the code practice set, thus making the actual cost of a separate oscillator but slight.

The sketches indicate clearly all necessary connections for the oscillator. While it is not essential that the plate coil of the oscillator be made to rotate, it is advisable to do so in order that a wide range of frequencies may be had by merely turning the rotor coil. These windings may be of any convenient size as we are not interested in the wavelength at which the circuit oscillates.

A single tube oscillator will be found to produce plenty of volume when the head-fones are used, but it will be necessary to employ an amplifier of the conventional audio-frequency type, if loud speaker volume is desired for class instruction or similar work. Using the key with the conventional loud-speaker receiving set will, of course, require no additional amplifier.



Separate Oscillator for Code Practice.

Such an arrangement as one of the above will be found to produce exceedingly pure and steady tones and to be a distinct asset to the aspirant to a knowledge of the radio telegraphic code.

Ever happen to think that a very good concealed loop antenna can be made by winding it on a closet door? Swing the door, to get your directional effect, and close the door, and thus keep the loop out of sight, when not in use. That is. the loop will be out of sight, if it is wound on the *inside* of the door.

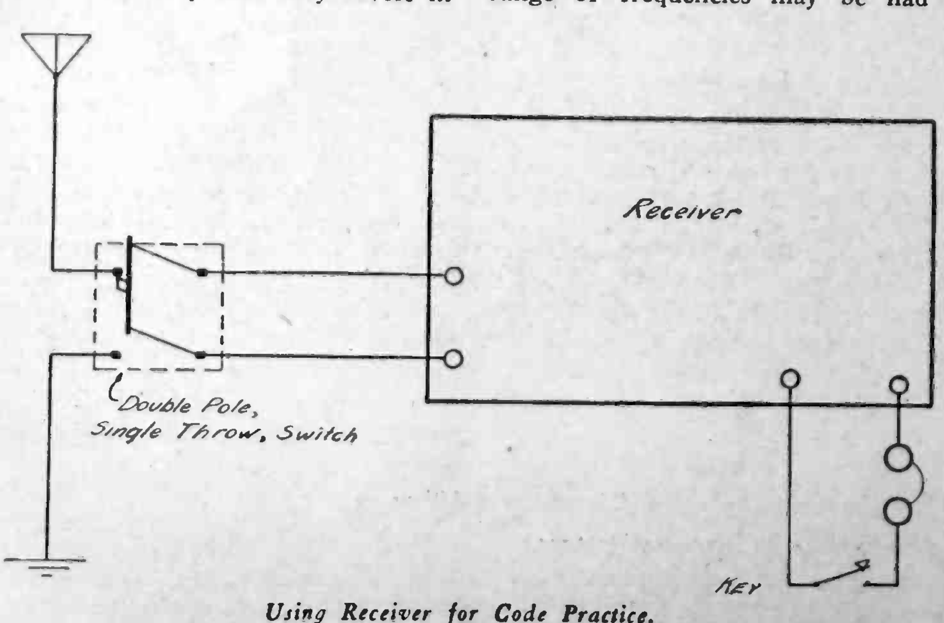
Ever try to use a piece of common insulated wire laid on the ground for a portable antenna? It often will work just as well as a poorly arranged antenna in the air.

If your storage battery and charger is in the basement, be sure that the leads to the filaments are large enough. The voltage drop on small wire is often enough to give the effect of a constantly discharged battery, when the latter is really well up.

A ground wire should be at least as large as that used for the antenna, as otherwise objectionable resistance may be introduced into the circuit.

Neat knobs can sometimes be made from the knurled tops of ink-bottles (stoppers), which are made of moulder material, which generally is a fair insulator.

Clothes-line pulleys with porcelain wheels often will serve as efficient insulators for a receiving antenna.



Using Receiver for Code Practice.

Resonance or Free Play

An Account of Its Effects in Radio and Audio Frequency Amplification and in Loud Speaker Design

By L. R. Felder

THE phenomenon of resonance is one which occurs at almost every point in the radio receiving and sending system. It therefore plays a most important part in determining the action of the system. In some instances it is present by design, and its action is advantageous. In other instances its presence is unavoidable, or is due to poor design, and in such cases its action may be decidedly disadvantageous.

A system is in the resonance condition when its response to a given force is a maximum. This simple definition is applicable to both electrical circuits and mechanical ones. The application of this definition to electrically tuned circuits is well known. When the applied voltage has the same frequency as the tuned circuit, the current in the circuit is a maximum, and the system is in resonance. The same application may be made to the mechanical system.

Every body has its own natural period of vibration which it would execute if it were given an impulse and were free to move. The example of the tuning fork is well known. If the tuning fork is given an impulse, as by a hammer blow, it will vibrate at its own natural period, and the musical note heard corresponds to the natural vibrations of the tuning fork. If the frequency of this impulse or hammer blow corresponded to the natural frequency of the fork's vibrations, in other words, if the resonance condition were obtained, the fork would vibrate most vigorously for that particular strength of hammer blow, and the sound would be the loudest. Not only is this true of the tuning fork but of any other mechanical system, for example diaphragms, horns, etc. The maximum effect is always secured when systems are in resonance.

In radio the tuned circuit is used to secure the maximum effects which are always associated with the resonant condition. Thus the circuits of receiving sets are always tuned, and are adjustable so that the tuning may be altered. When the circuit is tuned to the same frequency as the arriving signal the current set up in the receiving set is a maximum, and therefore the signal will be a maximum. All receiving sets are essentially tuned circuits of various designs.

In transmitting sets all the circuits are likewise tuned to one another so that the output current will be a maximum. The wavemeter, which is nothing more or less than a variable tuned circuit, operates on this principle of resonance, that is when the current in the wavemeter circuit is a maximum then the circuit to which it is coupled has the same frequency or wavelength as the wavemeter.

The tuned radio frequency amplifier is likewise based on this resonance effect. Each stage of the amplifier is likewise based on this renonance effect. Each stage of the amplifier has a tuned circuit which builds up the voltage to a maximum, after which it is passed on to the detector.

The wave trap is likewise based on this principle. The tuned parallel circuit develops across it a maximum voltage, due to resonance, at that frequency to which it is tuned, and which also corresponds to the frequency of the wave which is to be eliminated. Maximum voltage being developed across the wave trap there is no voltage at this undesired frequency available for the receiver, which is in series, hence the signal is eliminated. Other illustrations might be adduced of the advantageous applicability of the resonance principle in the radio system.

Before going on to a discussion of the effects of resonance in the audio frequency part of the system it will be instructive to point out an instance where resonance in the radio frequency part of the system may prove disadvantageous. In radio telephone transmission a single frequency is not transmitted, but a large band of frequencies about 10,000 cycles wide. This band is produced by the audio frequencies up to 10,000 cycles modulating the radio frequency. If anything in the radio frequency system tends to discriminate against any part of this band distortion results. In a tuned radio frequency amplifier, the sharper the tuning the greater the amplification. If the tuning is too sharp, however, the resonance curve will be extremely sharp and frequencies not very far removed from the carrier or main frequency will not be amplified to the same extent as those close to the carrier frequency. This means that the upper side bands, or the higher audio frequencies, will be discriminated against and will be dropped out, giving speech a muffled or thick tone. This effect is often noticeable in superheterodyne sets not well constructed. The intermediate frequency amplifiers are so sharply tuned that the upper side bands are completely eliminated with resultant distortion. This is one important instance where resonance may produce disadvantageous effects if not properly taken into account. In all of the above radio frequency illustrations resonance is purposely introduced into the circuit for the effects which it produces. When we consider the audio part of the entire system we find resonance also noticeably present, but not by design. Rather is it present because it is more or less unavoidable and must be tolerated as a necessary evil, where it cannot be eliminated. Where it can be altered the resonance is removed to a point where it is not so obnoxious in its effects.

At the transmitting end of the radiocast system the starting point is the microphone. The type usually employed is a modification of the ordinary telephone microphone which has a diaphragm with a chamber of granulated carbon on one side. The radiocast microphone has a diaphragm with a chamber of carbon on both sides. This diaphragm has a natural period of vibration, which, in the case of the ordinary telephone transmitter, is somewhere about 1000 to 2000 cycles per second. Thus when a 1000 or 2000 cycle speech wave strikes it the diaphragm vibrates most vigorously due to resonance. Hence these particular frequencies stick out most conspicuously above the others. Such a state of affairs is permissible in ordinary telephone conversation where intelligibility is the sole object.

But in radiocasting where faithfulness of reproduction is of prime importance such a condition cannot be tolerated. The distortion is too great. In other words we have here a resonance phenomenon, unavoidable since any diaphragm must have some natural period of vibration, but which produces undesirable results. Resonance at 1000 or 2000 cycles is extremely objectionable, but resonance of the diaphragm at 7000 or more cycles would hardly be noticeable. The diaphragm is therefore constructed of such material and in such way, that its constants produce resonance at around 7000 cycles. Furthermore the motion of the diaphragm is damped so that even at its resonant frequency its motion is not excessive. We then have a case here where the harmful effects of unavoidable resonance are reduced and practically eliminated by removing the point of resonance to a point where its effects are a minimum.

The same thing might be done in the case of the ordinary telephone transmitter, but the gain resulting would not be worth the loss. It might be pointed out for the reader's information that the ordinary telephone microphone with its 1000 or 2000 cycle resonance has maximum sensitivity. It gives greatest output and requires no amplification for talking over as much as 20 miles or more of cable. If it were changed so as to give better quality by moving the resonance point of the diaphragm to 7000 cycles its sensitivity would decrease and it would require considerable amplification to secure its original sensitivity. Thus the equipment for local talking over the telephone would be more complicated and costly and would certainly not be worth the improvement in quality thus secured. Speech is sufficiently intelligible with present equipment. In the case of radiocasting, however, quality is the prime essential, and plenty of amplification is available for increasing the output of the microphone.

The next point in the audio frequency system where resonance manifests itself is in the audio frequency transformers, either in the speech amplifying system or in the audio amplifier of receiving sets. One of the principal causes of distortion in receiving sets is due to the phenomenon of resonance in transformers. The transformer constitutes by itself a tuned electrical circuit. It must be remembered that an audio frequency transformer is wound with many thousands of turns of wire and that the distributed capacity gets to be quite appreciable. The inductance is also a large quantity and it happens that the inductance and capacity of the transformer tune to some frequency within the audible range, the exact frequency depending upon the design of the transformer. But many transformers have resonance peaks around 1000, 2000, 3000 cycles, and the result is that these frequencies are enormously exaggerated.

By proper design of the transformers the point at which this resonant frequency occurs may be removed well without the audio frequency range where it is not the cause of any distortion. Inasmuch as a transformer is bound to have inductance and distributed capacity this resonance effect is unavoidable, but may be made harmless by proper design. Some transformers have been built to have a pronounced resonance effect at some predetermined frequency, as for example 1000 cycles. Resonance in such cases is advantageous. Audio frequency or tone transformers designed to operate at a single frequency are such. For example where 1000 cycle telegraph signals are to be received a transformer with a pronounced resonance peak at 1000 cycles would be extremely efficient. In such cases the effect of resonance is decidedly advantageous.

Finally there is the matter of the loud-speaker and horn in the audio system. The loud-speaker generally contains a diaphragm of steel or mica, which has a natural period of vibration. When a signal of the same period is applied it responds most vigorously to such a signal due to resonance effects. Attaching the horn to the loud-speaker results in new resonant periods being introduced, and the result is that most loud-speakers have a large number of resonance periods, and the distortion resulting therefrom is very pronounced.

It is out of the question to make the diaphragm of the loud speaker similar to that of the high quality microphone. For if this were done the sensitivity would be reduced enormously and it would require not two, but five stages of audio frequency amplification to operate a loud-speaker, which obviously is out of the question. As it is, loud-speakers are extremely inefficient and to make them more inefficient would seem to be the wrong way of tackling this problem. One tentative solution, which seems to be on the right track, is to get away from the usual steel diaphragm loud-speakers, and the paper cone type of loud speaker is the first of its kind.

battery charging can often be obtained at automobile wreckers. When driven by a small motor from the lighting circuit this will permit batteries being kept charged up to their maximum efficiency.

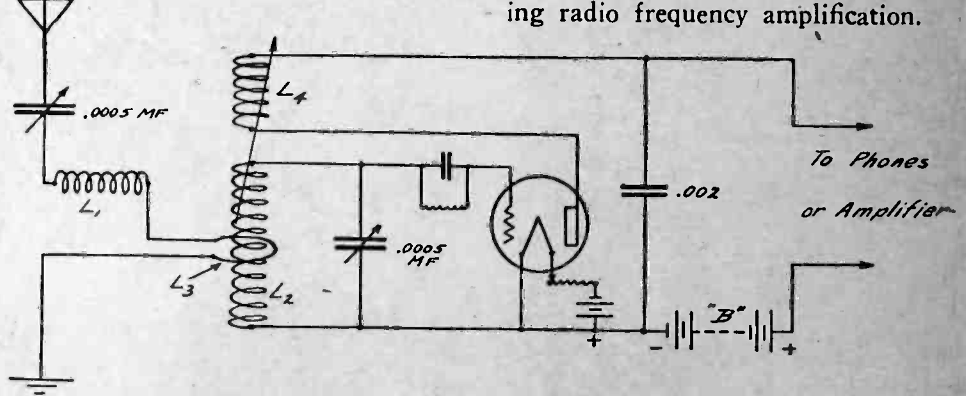
It is a good plan to arrange dry cell *B* batteries so they have the wax top up. This keeps the cells in a vertical position, and sometimes increases their life.

Never test a storage battery with an ammeter, as it may be burned out. Use a voltmeter while the battery is on normal load.

RECEIVER SIMPLICITY AND SELECTIVITY

By Ralph E. Henry

For the benefit of our fellow radio fans, we offer the accompanying circuit of an inexpensive, yet efficient and selective radio receiver. In the inception of this circuit, we had in mind the building of a receiver which would separate the local radiocast stations absolutely, and at the same time retain sufficient signal strength to obviate the necessity of adding radio frequency amplification.



Circuit Diagram for Simple and Selective Receiver

L_1—primary, 60 turns No. 22 D.S.C., 3 in. diameter.
L_2—secondary, 45 turns No. 22 D.S.C., 3 in. diameter.
L_3—coupling, 1 turn No. 22 D.S.C., wound around L_2 (not variable).
L_4—tickler, 20 turns No. 22 D.S.C., 3 in. diameter.

Paraffine-impregnated wood is about as good as any insulation for use in receiving apparatus, either for coil forms, or for panels, insulators, etc.

Blown out or short-circuited condensers, such as are used on wire telephones, make a fine source of supply of tinfoil, and usually can be had for the asking around a telephone office.

If your audio frequency amplifier insists on howling, you may reduce, or possibly eliminate the trouble, in some cases, by placing an ordinary tin can over the whole transformer, taking care not to short-circuit anything, as you do it.

When a receiving set is not completely shielded and boxed you may have considerable trouble in audio frequency "feedback" between the detector tube and the loud-speaker, if the latter is in the same room. This is due to the mechanical vibration of the sound making the tube walls vibrate mechanically, which is repeated through the amplifier system, and through the loud-speaker, out into the room, and back again.

Cheap and efficient generators for

The loose coupled tuned antenna coil seemed to present the easiest solution of our problem; but our old friend, mutual conductance, between the antenna, or primary coil, and the grid, or secondary coil, offered more or less of an obstacle, especially as we desired simplicity of tuning, so that friend wife could adjust the receiver without referring to a book of rules at each attempt.

So, keeping the aforementioned requirements in mind, we tuned our primary circuit, but kept the mutual conductance at a minimum by placing the primary and secondary coils at right angles, and separated as far as possible. Then we coupled these two circuits with one turn of wire around the secondary, as shown in the diagram.

We used low loss coils to keep the distributed capacity as low as possible, which helps its selectivity.

We find that this circuit is very satisfactory for local reception, selecting very nicely any one of the five local broadcasting stations and giving ample volume. It also promises reasonably good DX reception.

The Facts About Resistance Coupling

A Graphic Discussion of Resistance Amplification Based On Accurate Laboratory Measurements.

By G. M. Best

CONVINCING, and final answer to the controversy regarding resistance coupling can be given only by the correct interpretation of definite measurements with dependable instruments such as are used in the tests discussed in this series of articles on audio frequency amplification. Let us consider some of these questions: "Is resistance coupling perfect in quality?" "Is its frequency characteristic entirely flat with a consequent equal reproduction of all tone values?" "What difference is made by the size of the coupling condenser?" "Is the grid leak resistance critical?" "Is a *C* battery necessary?"

The answer to the quality question is shown in Fig. 1. The horizontal lines represent the number of times the voltage of the initial signal is amplified and the vertical lines represent the sound frequencies from 95 to 3500 cycles per second. The tubes used, UV-201-A and C-301-A have a normal amplification of 7, the difference between this and the results shown representing the loss due to resistance coupling.

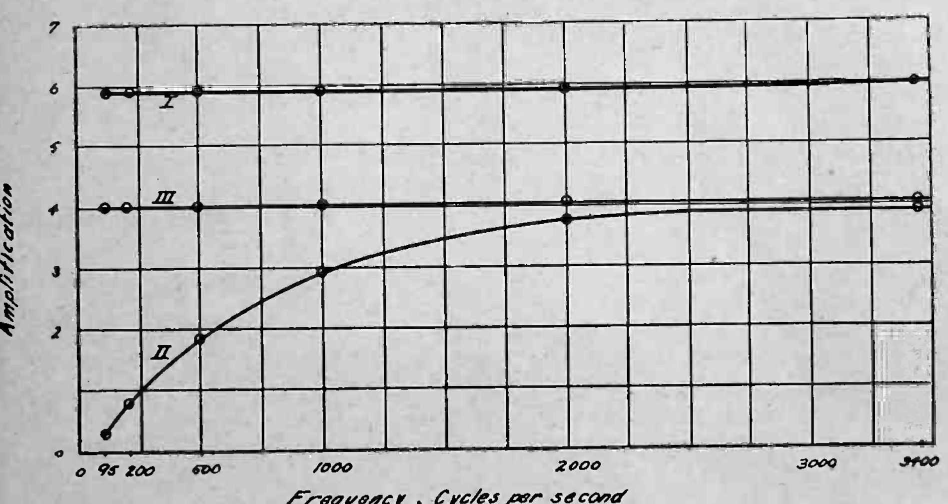


Fig. 1. I. Well designed 2 stage resistance coupled amplifier.
II. Effect of too small blocking condenser and grid leak.
III. Amplifier shown in Curve 1 with too small grid leak.

The test circuit used is shown in Fig. 2, which represents the usual form of resistance coupling. Three tests were made: one with the constants R_1=100,000 ohms, R_2=500,000 ohms and C=1 mfd.; the second with R_1=100,000 ohms, R_2=50,000 ohms, and C=.0025 mfd., and the third with the same R_1 and R_2 as the second but with C=1 mfd. The results are shown respectively in Curves I, II and III of Fig. 1.

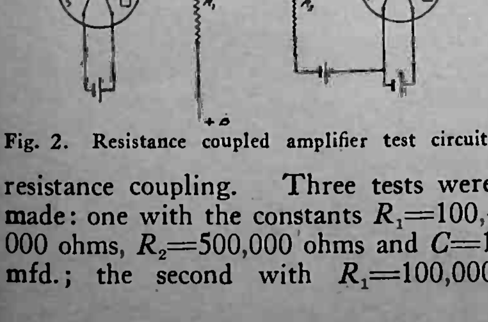


Fig. 2. Resistance coupled amplifier test circuit.

Curve I represents a well-designed two-stage resistance coupled amplifier and closely approximates a straight line, rising slightly as the frequency increases. II shows the effect of using a blocking condenser and grid resistance both of which are too small, and III indicates the improvement made by using a condenser of the right size. And yet some of the ardent proponents of resistance coupling tell us that the constants are not critical!

A moment's consideration will show why a fairly large condenser is necessary, especially if R_2 is small. Referring to Fig. 2 it will be observed that there are two paths for the alternating current component of the output of tube 1; one through the plate resistance R_1 and the *B* battery to the negative filament, the other through the condenser *C* and resistance R_2. In this second path the *i r* drop across R_2, which is applied to the grid of tube 2, represents only a part of the total output voltage since the condenser *C* is in series. If the impedance of this condenser at the frequency being amplified is small compared to R_2 then nearly all of the voltage across R_1 will also appear across R_2. If, however, *C* is small, its low frequency reactance may be very high, so that these frequencies will not be proportionally amplified. If C=.0025 its reactance at 100 cycles is over 650,000 ohms. Consequently very little current will flow in this branch and the drop across R_2 will be very small. As a matter of fact this circuit gives a loss instead of a gain in volume for all frequencies below 240 cycles and at 95 cycles the voltage ratio is about 1/3!

It would, of course, help matters considerably to increase R_2. For example, increasing R_2 from 50,000 ohms to 500,000 would increase the fraction of the available voltage applied to the grid from about .077 to .62 at 100 cycles (the vector relation of the voltage being taken into consideration) even with the .0025 mfd. condenser. Why, then does a certain manufacturer of resistances for resistance coupled amplifiers recommend a grid leak of 50,000 ohms for the last stage?

THE answer is that this manufacturer stoutly maintains that no *C* battery is necessary in a resistance coupled amplifier, but finding with a ½ meg. or more resistance and no *C* battery that not only is poor quality unavoidable but blocking of the last tube occurs on every loud note, he reduces this resistance to a value low enough to largely eliminate this difficulty. In so doing, however, he loses over 30% of the amplification even at high frequencies and over 100% of it below 200 cycles!

It is perfectly true that almost any amplifier employing any kind of coupling may be made to function, in some uncertain manner, without a *C* battery. It is also true that, if the reduction of *B* battery current were the only consideration, the *C* battery could well be omitted from the resistance coupled amplifiers because the space currents are already considerably reduced by the insertion of the high resistance R_2, provided that the *B* battery voltage was not greatly increased If, however, quality is a consideration the *C* battery becomes a necessity.

Suppose, for example, that we wish to deliver to the loud speaker a power of .01 watts. This is approximately the greatest power obtainable from a C-301A tube using 90 volts plate battery and a 4.5-volt *C* battery without appreciable distortion, assuming the impedance of the loud speaker to equal that of the tube. On this assumption the input voltage must have a peak value of about 4.5 volts. If there is no *C* battery in the grid circuit of the last tube the grid must alternately swing 4.5 volts positive and 4.5 volts negative. If there were no grid current flowing there would be no distortion, since the plate current-grid voltage characteristic of the tube is quite straight in this region. Actually, however, a grid current begins to flow as soon as the grid becomes slightly positive, increasing rapidly as the grid becomes more positive. If the grid leak resistance R_2 is 500,000 ohms and a grid current of only 2 millionths of an ampere were to flow at the peak grid voltage the *i r* drop in R_2 would be 1 volt so that the effective grid potential would be 3.5 instead of 4.5 volts at the peak. On the negative swing, however, no grid current flows and the full value of -4.5 volts is reached. Hence the output voltage wave will be unsymmetrical; that is, distorted.

The fact that the grid does not reach its full positive value on each positive swing means not only that the A. C. output current will be less than its normal value but that the plate current will also be reduced.

It is this latter phenomenon which is referred to by a prominent resistance coupling exponent as "modulating down" when he says, "In resistance coupled amplifiers the plate current always modulates down, hence no *C* battery is required." As a matter of fact this plate current variation or "modulation" as observed on a milliammeter in the plate circuit is *an infallible sign of distortion except where a large component of carrier wave is present.* In this case the resistance "expert" apparently assumed that since the detector tube in the receiving set is a distorter and the modulator tube in the transmitting set is also a distorter, the distortion in the resistance coupled amplifiers is permissible and of no consequence. He overlooked the fact that since there is no carrier wave present in an audio amplifier this supposed advantage of the *C* batteryless resistance coupled amplifier is really a serious fault.

If, on the other hand, a 4.5 volt *C* battery is used in the amplifier just described the most positive swing of the grid will just bring it to zero potential with respect to the filament. At this potential there is still no grid current flowing; hence the wave will be symmetrical, the output amplitude will be undiminished and the plate current of the tube will not fluctuate when the input voltage is applied. Under this condition the resistance R_2 may be as large as desired. Since, however, an occasional extra loud note may still cause the grid to swing positive and "modulate down," R_2 should not be so large that the accumulated grid charge will leak off too slowly as would be the case with, say, 10 megohms. A value of .5 megohms is ample to give good quality of amplification and is probably the most satisfactory one to use. If the last tube in the amplifier blocks when sufficient volume is maintained to properly operate the loud speaker, and the grid leak is .5 megohms, then there is grid current flowing in excessive quantity and a tube capable of handling larger plate battery and *C* battery should be substituted. The ineffective compromise of a lower grid leak should never be employed when the use of a larger tube is possible.

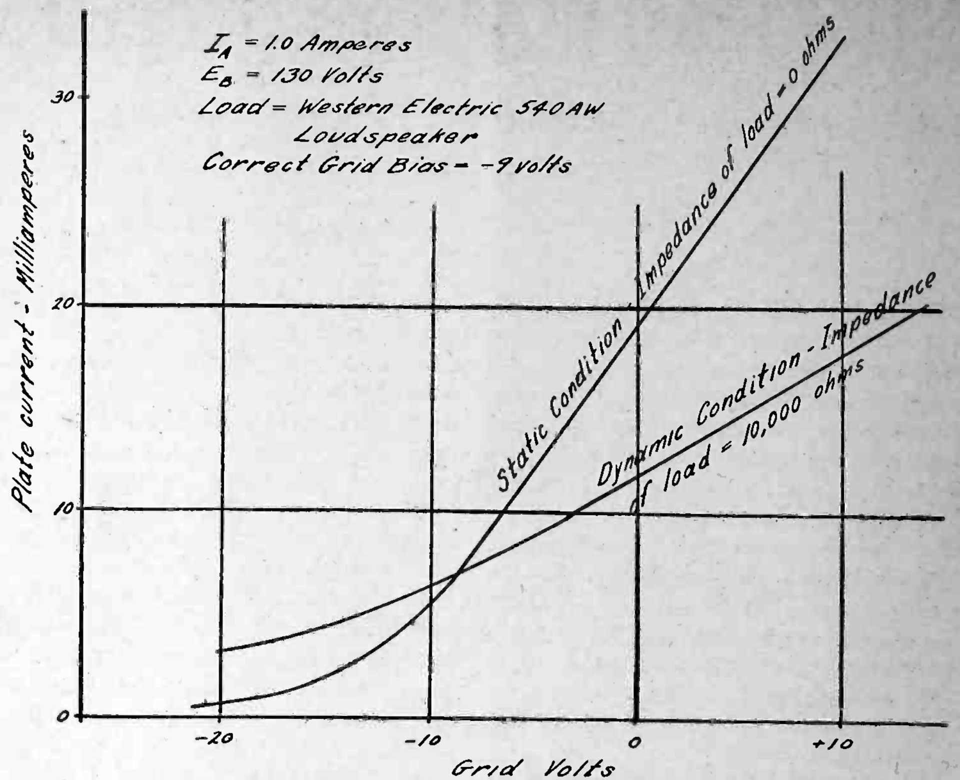


Fig. 3. Characteristic curves of Western Electric 216-A tube.

The best way to compare various methods of obtaining the required amplification is to plot the overall frequency characteristic curves for the necessary number of stages for each method. The grid voltage-plate current curve for the last audio tube should also be known, in order to select the proper *C* battery to handle the load. In Fig. 3 is shown the average static and dynamic characteristics of a number of Western Electric 216-A tubes, the static curve being without load of any kind in the plate circuit, and the dynamic curve being taken with a load of 10,000 ohms, which is the impedance of a Western Electric 540-AW loud speaker at 1000 cycles. From the dynamic curve it will be seen that a *C* battery of 9 volts can be used without the introduction of distortion due to the incoming alternating voltage. With an A. C. voltage of 8 to 9 volts on the grid of last tube, the grid will at no time become positive and will not reach a

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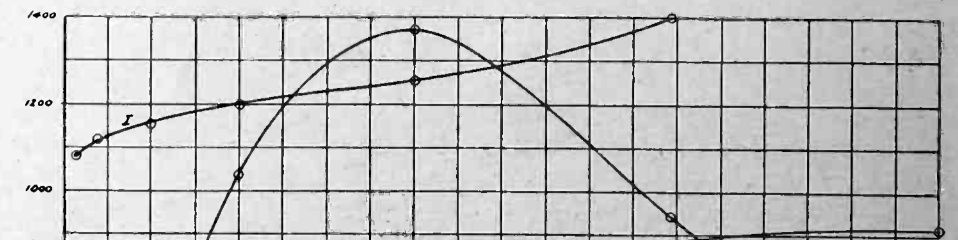


Fig. 4. I. Good 2 stage transformer coupling.
II. Poor 2 stage transformer coupling.
III. Well designed 3 stage resistance coupling.
IV. Well designed 4 stage resistance coupling.
V. Poor 3 stage resistance coupling.
VI. Poor 4 stage resistance coupling.

A Recording Tube Tester

A Simple and Convenient Chart Drawing Device Using But Two Meters to Determine All Characteristics

By Arthur L. Smith

THE need for an instrument which will automatically draw the characteristic curves of a vacuum tube under test has led to the design of a simple device that can be duplicated by the ingenious experimenter by means of the description and drawings here given. The purpose is to give a permanent chart record of the visually observed meter readings, thus obviating the necessity of first writing down the readings and then plotting points for a curve to be drawn on cross-section paper. The instrument will not only give a graphic record of the usual tests, but will also give the several other curves which foretell tube performance.

As may be noted in the circuit diagram of Fig. 1 the visual indication portion of the apparatus consists essentially of the tube under test, a variable *A*, *B*, and *C* battery supply, a potentiometer, a voltmeter, a milliameter, various resistances, and four switches. The voltmeter is intended only as a check on the readings of the grid potential, the recorded voltage readings being obtained by a proper multiplier of the milliampere readings. Closing switch (1) gives the *A* voltage and (3) gives the *A* current. Closing (2) and (4) together gives the *B* voltage and pressing on button of (4) gives the plate current.

The recording mechanism is shown in Fig. 2. The principle of the device depends upon transferring the several positions of the milliameter pointer through a fine silver wire which perforates a piece of paper on a revolving drum by means of the spark produced by a high tension spark coil. The needle extension is a 5-inch silver wire light enough not to throw the needle out of balance.

A roller friction drive gives a slow enough motion of the drum to allow the needle extension to follow the fluctuations of current.

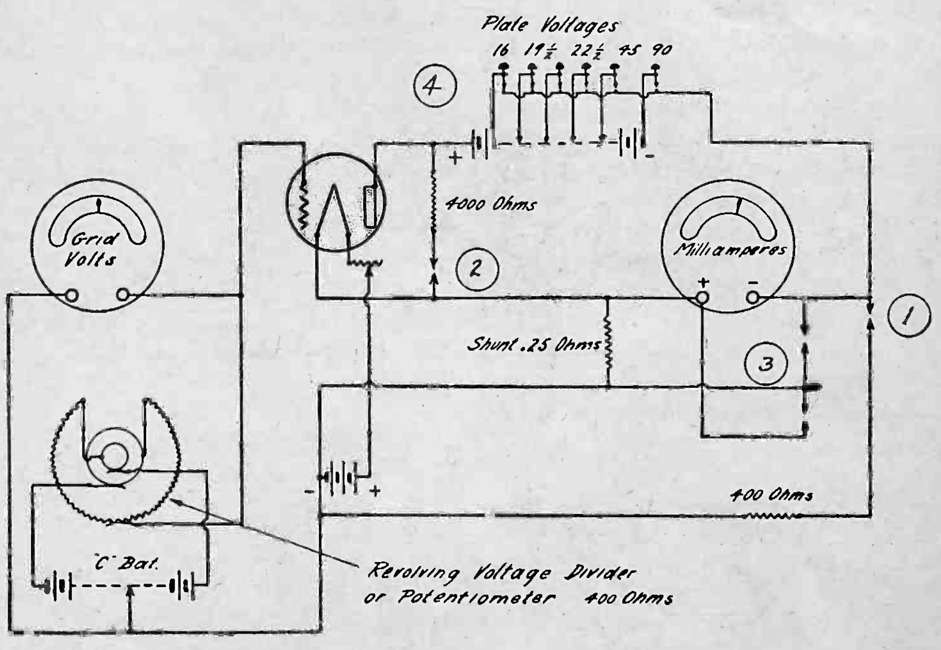
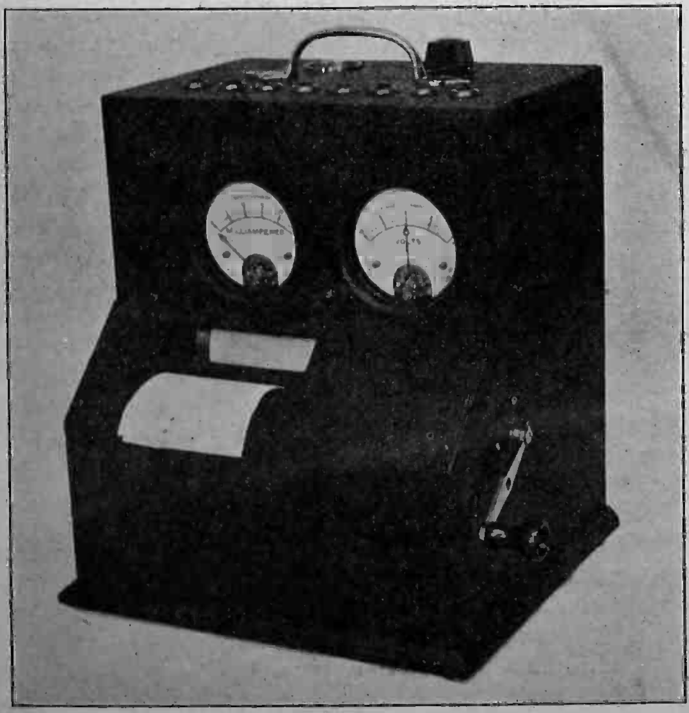
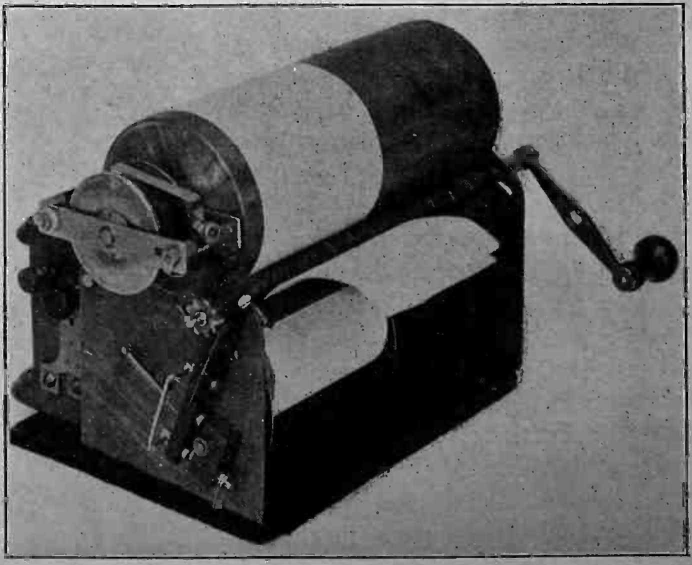


Fig. 1. Circuit Diagram of Connections for Tube Tester



Exterior View of Recording Tube Tester.



Interior Mechanism of Recording Tube Tester.

Any tendency of the very fine wires melting from the heat of the spark is obviated by the use of an automatic cut-in switch on the interrupter, this switch cutting in as soon as the handle is turned to rotate the drum. The details of the spark coil connections are shown in Fig. 3.

If the grid voltage readings on the graph do not coincide with the readings of the grid voltmeter the voltage divider, or potentiometer, shown in Fig. 1, is adjusted to change the grid bias voltage until the readings are identical. The voltage divider is connected directly to the main drums so that for every complete revolution of the drum the grid voltage varies from 10 volts negative to 10 volts positive.

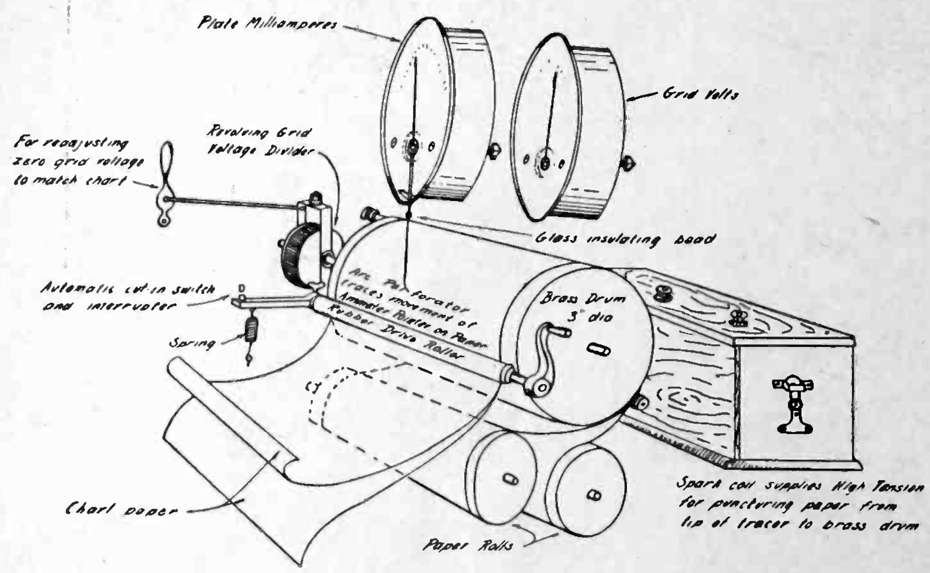


Fig. 2. Recording Mechanism of Tube Tester

The procedure in testing a tube consists in first turning on the filament supply without *B* battery, press (3) of Fig. 1 and turn up rheostat until rated current flows, release (3) and press (1) to get *A* voltage; release (1) and put down readings on chart; press any button on (4) while drum is turned for complete revolution, and press on (2) and (4) to give check on plate voltage.

These instruments as constructed by the author in the Radio Research Laboratories at Portland, Oregon, are being used with utmost satisfaction by many local dealers. The graphs are made in duplicate, one being given to the customer and the other retained for the files.

THE MARCONI-BELLINI-TOSI DIRECTION FINDER

By WALLACE KELK

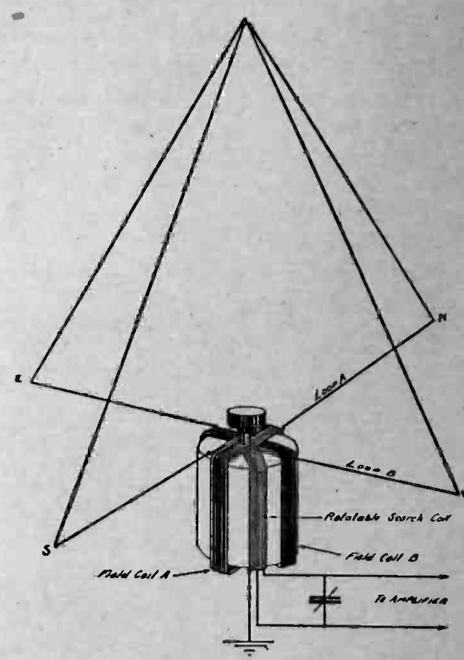
Unlike the U. S. radio compass stations, all Canadian and many European stations are using the Marconi-Bellini-Tosi system. This consists essentially of two non-rotating loop aerials, set at right angles to each other, and a direction finding receiver. The aerials are triangular in shape, one pointing due north and south and the other due east and west. They are connected through separate lead-ins to the respective N, S, E and W terminals of the direction finding receiver, and thence to the *A* and *B* field coils of the radiogoniometer.

The complete equipment, except the aerial, is contained in an eight-compartment cabinet. Each compartment has a separate panel and is completely shielded. The five front panels are inclined at a convenient angle and the three rear panels are vertical.

The initial control element is a three-position key-way switch mounted in the central front panel. In the compartment under it are three air-core transformers which, with the tuning condenser on the panel to the left, give a wavelength average from 300 to 4500 meters in three ranges. The right central panel contains a jigger or tickler condenser, whose associated inductance controls are on the front panel to the extreme right. The front panel at the extreme left contains the direction finder or radiogoniometer dial.

The rear panels consist of a central detector and six-stage radio frequency amplifier unit, flanked on the left by a control panel and on the right by a double note magnifier consisting of one, two, or three stages of audio frequency. The detector tube is a Marconi "Q" and all the amplifier tubes are Marconi "V24."

The three-position key-way switch is marked *Stand-by, D. F. and Sense.* The first brings in all-round reception. The second connects to the radiogoniometer when bearings are required. The third, the *Sense,* enables the operator to determine the true direction of the station, eradicating the possibility of reverse bearings.



The *Sense* functions in the following manner: Connected in series between the aerial loops and the air core transformer is a resistance known as the Sense winding. In taking a bearing, the operator must first ascertain the position of the two minimums on the radiogoniometer; one minimum being of course the true direction and the other the reverse. He then wants to know the true direction, which is impossible to tell on hearing alone. So by placing the switch on the *Sense* position, and the *Sense* pointer, which is set at right angles to the direction finding pointer, on one of the minimums, and rotating, he will find only one minimum instead of two, due to the influence of the *Sense* winding. This one minimum is indicative of the true direction of the vessel. So by reverting to the D.F. position and working with the direction finding pointer on the minimum indicated by the *Sense,* the operator is assured he is taking the bearing in the correct direction.

The radiogoniometer consists of two field coils—*A* and *B*—and a rotary search coil mounted on a rotary core. The field coils are connected to their respective *A* and *B* aerial loops; the coupling between the field and search coils is made as tight as possible, and

(*Continued on Page* 68)

This Wavelength Frequency Question

A Simple Explanation of the Meaning of the Kilocycle Designation and a Statement of Its Advantages

By Frank J. McManus

MOST of us who are accustomed to tuning our receiving sets to the wavelength of a radiocasting station have some sort of general idea of the meaning of "wavelength in meters." However if we examine ourselves closely in this respect and ask ourselves the question, "Just what *is* wavelength?", we would find it pretty difficult to give a specific answer.

Our lack of technical knowledge may have little to do with our inability to gain a conception of radio wavelength for the reason that the precise nature of radio waves is not known. Wavelength is a phenomenon of space and we can neither see it, nor indeed, measure it,—that is we can not make a *direct* measurement of wavelength. (A partial exception to this statement is found in a method of measuring waves at rest—so-called "standing waves",—where the distance between waves is determined by linear measure.)

We say that the propagation of radio waves through space is accomplished by a motion of the ether, frequently compared to water motion (water waves) caused by throwing a pebble into a pond. A wavelength is defined as the difference between similar parts of adjacent waves. The analogy between water waves and ether waves is a fairly good one,—but what is ether?

Ether may be defined as a sort of highly elastic fluid which pervades all space, yet it has never been seen, smelled nor in any way detected.

In contrast to wavelength as existing only in space, frequency is a phenomenon occuring in radio transmitting and receiving circuits. To obtain an understanding of this effect, reference can be made to the alternating current found in the lighting circuit of most homes. This current rises from a zero value to a maximum value, dies down to zero, rises again to a maximum value, while flowing in the opposite direction, and then dies down to zero again. This completes one "cycle" and the process is repeated 60 times each second. We say that this current has a frequency of 60 cycles per second.

The alternating currents in radio transmitting and receiving circuits have just as definite a frequency. However instead of the low frequency of 60 cycles per second, these radio currents have frequencies of many thousands of cycles per second. In speaking of these radio frequencies, the term "kilocycles" ("kilo" meaning one thousand) is used, because an expression in cycles would require an inconvenient number of ciphers. The number of kilocycles of a radiocast station means the number of thousands of cycles per second in the transmitting circuit.

As a general rule it may be stated that all alternating current circuits radiate waves into space. One wave is sent out for each cycle of current. Low frequency alternating currents, as for example 60 cycle currents, radiate an almost infinitesimally small amount of power in the form of waves which are 5,000,000 meters or about 3,100 miles in length! Such waves have apparently no practical value. The 60 cycle hum sometimes heard in a receiving set has nothing to do with these waves; it is electromagnetic induction.

Unlike the 60 cycle alternating currents, the alternating currents of enormously higher frequency in the antenna of a radiocast station radiate much power into space. These currents differ also from the 60-cycle currents in that they are set up in a tuned circuit and are modulated or controlled by the voice or music.

There is a definite relationship between wavelength in meters and frequency in kilocycles. This is determined by the velocity of radio waves in space—300,000,000 meters (186,000 miles) per second. Suppose it were possible for an observer to place himself at this distance from the earth and suppose also that it were possible for him to receive the signals from a radiocast station located on the earth. If the frequency of this station is 600 kilocycles (600,000 cycles) per second, then in one second 600,000 waves would be shot out into space—one for each cycle of current. In that time the first wave will have reached the observer and over the intervening space there will be 600,000 waves evenly distributed. The distance separting adjacent waves is

$$\frac{300,000,000}{600,000} = 500 \text{ meters.}$$

This is the wavelength of the transmitting station. To obtain it we have divided the velocity of waves by the frequency in cycles per second. If the numerator and denominator of the fraction is divided by 1,000, the denominator is expressed in kilocycles. Hence to obtain any wavelength in meters, corresponding to a known frequency in kilocycles, divide the number of kilocycles into 300,000; conversely, to obtain kilocycles, divide meters into 300,000. For more accurate conversions, the number 299,820 replaces 300,000.

The term, "wave frequency" is sometimes used in place of frequency. It means the number of waves passing a given point in space in one second. Wave frequency and frequency have the same numerical equivalent.

From the preceding discussion it is seen that as the frequency of a circuit increases, the radiated wavelength decreases, and vice versa. Hence there must be a particular value of frequency for which there is an identical corresponding value of wavelength. This value is 547.5. In other words, 547.5 kilocycles is equivalent to a wavelength of 547.5 meters.

Owing to the fact that frequency designations of stations are becoming more common, the listener will find it to his advantage to become familiar with the method of converting meters into kilocycles and vice versa. When the given number of meters or kilocycles is a multiple of 50 it is easy to make a mental conversion. Meters and kilocycles of most broadcasting stations are figures of three digits and this makes it unnecessary to worry about the decimal point. Thus to convert 750 kilocycles, divide it into 300,000, getting 400 meters; or what is much simpler, divide 7.5 into 30, getting 4, which a little experience tells us is 400 meters.

There are several reasons for the tendency to designate broadcasting stations by kilocycles instead of meters. There is one particular reason which all listeners should understand because it concerns the interfering beat note between carrier waves. Most everyone has looked through two parallel picket fences from such a distance that the pickets appear to be bunched together in groups having a regular spacing. This serves to explain the production of a beat note by the interaction of two carrier waves of slightly different frequency. If the frequency difference between these waves is about five kilocycles, a high pitched beat note will be heard in the phones of the receiving set. If one of these waves is now changed so that there is a resulting frequency difference of ten kilocycles between them the resulting beat will be a pretty high squeak, which is hardly noticeable under the

(Continued on page 75.)

Notes on Short Wave Work

By C. William Rados, 1BFA

MANY amateurs are trying work on the waves between 5 and 20 meters but only a few are really successful. The main difficulties seem to be irregular, inconstant note, improper wavelength and no frequency standard.

There are several ways of making a 5 meter oscillator. Taking the base off the tube, as in the picture, is one way. By using small glass plate fixed condensers and 1 to 4 turn coils, the system will oscillate easily. If it is not desired to take the base off the tube, then the metal shell of the socket can be removed. (See February RADIO). The circuit in Fig. 1 with two tubes in series will get down to 3 meters without difficulty if proper precautions are taken. Use 5-watt tubes or less. They should be matched for best results.

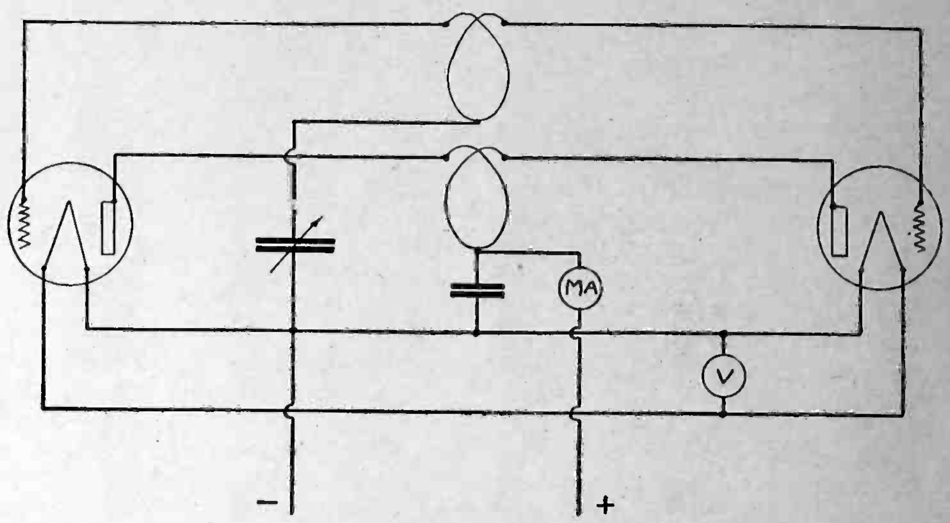
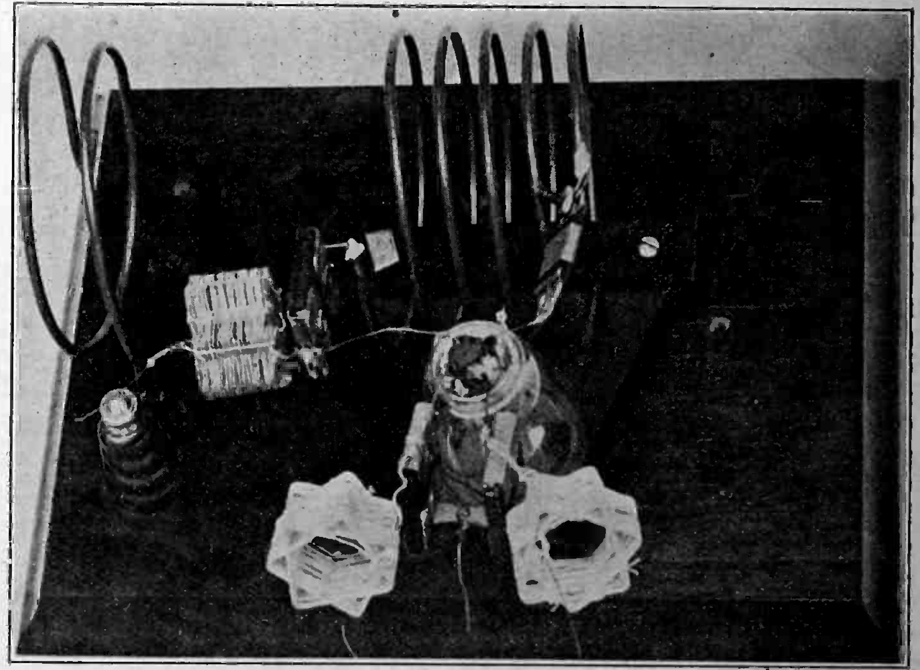


Fig. 1. Circuit Diagram for Short Wave Oscillator.

It is easier to build the oscillator than to keep it at a constant frequency. Use rectified AC but not pure DC as the note is much better with the former, strange to say.

After the system is oscillating, try to couple it to an antenna. As the regulations prohibit conductive coupling, an inductive scheme must be used. Get about 30 feet of 1/8 in. copper tubing and mount it rigidly as in Fig. 2. (This much tubing cost me 95c in a hardware store.) The one turn coil comes to the outside of the window pane and the oscillator is just inside the window.



Short Wave Oscillator.

Now we have the outfit transmitting with a supposedly constant wave. Do not overload the tubes because the emitted frequency will vary. Now get some colleague to listen for you, at prearranged times. You will now discover the need of an effective frequency standard.

The frequency band between 4 and 5 meters alone is 15,000 kilocycles. This is ten times the band from 200 to 20,000 meters. So you must have a wave meter with which to find out what range your transmitter and receiver will cover.

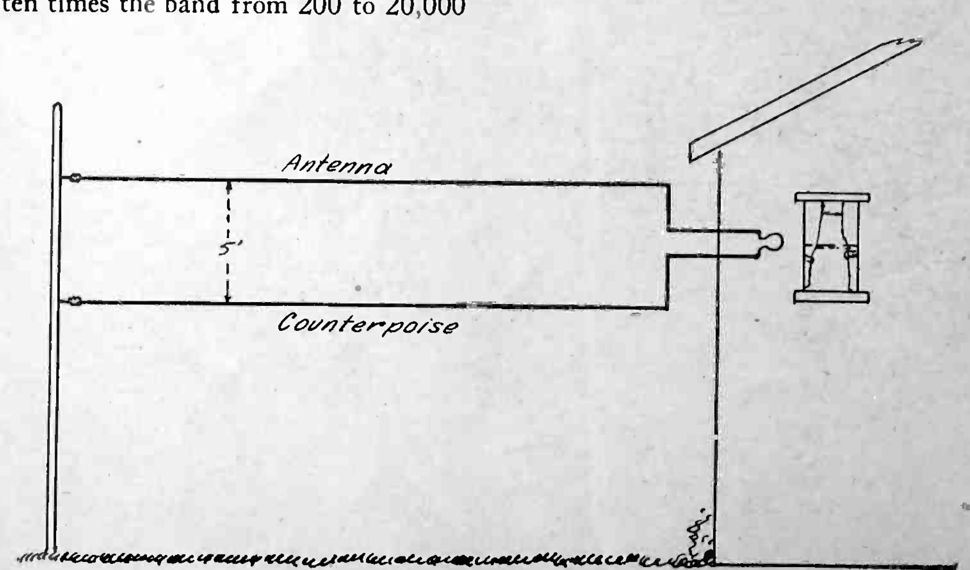


Fig. 2. Antenna Coupler for Short Wave Oscillator.

If, by chance, a transmitter is assembled which works somewhere in the band from 5 to 20 meters, the experimenter usually cannot tell with any certainty where he is. The problem of a good wave meter is not easy to solve as reliable standards are few. If the experimenter is interested in waves a little higher, he can get a General Radio wave meter for a few dollars which reads from 37.5 to 125 meters. February RADIO also describes a meter with the range 18 to 37 meters. The actual construction is not hard but the calibration is.

One can calculate the constants for resonance at say 5 meters of a condenser

(*Continued on page 76.*)

A Multi-Use Oscillator

Details of Construction of a Short Wave Transmitter, Local or Master Oscillator

By G. F. Lampkin, 8ALK

MANY amateur transmitting layouts are not much more than piles of junk, overrun with flopping wires and due mainly to continual experimenting. This junk can be easily collected into a neat arrangement, and still be flexible enough for experimental needs. The drawings shown give an idea of one way in which this may be done.

An excellent method is to first draw the circuit, making it as open and uncomplicated as possible. For transmission, the standard Hartley circuit is as efficient and as flexible as any, so it is used here, and is drawn in Fig. 1. The parts should be placed, in plan, as nearly as possible as they appear in the circuit as in this way much complicated wiring will be avoided, and a neater layout will result.

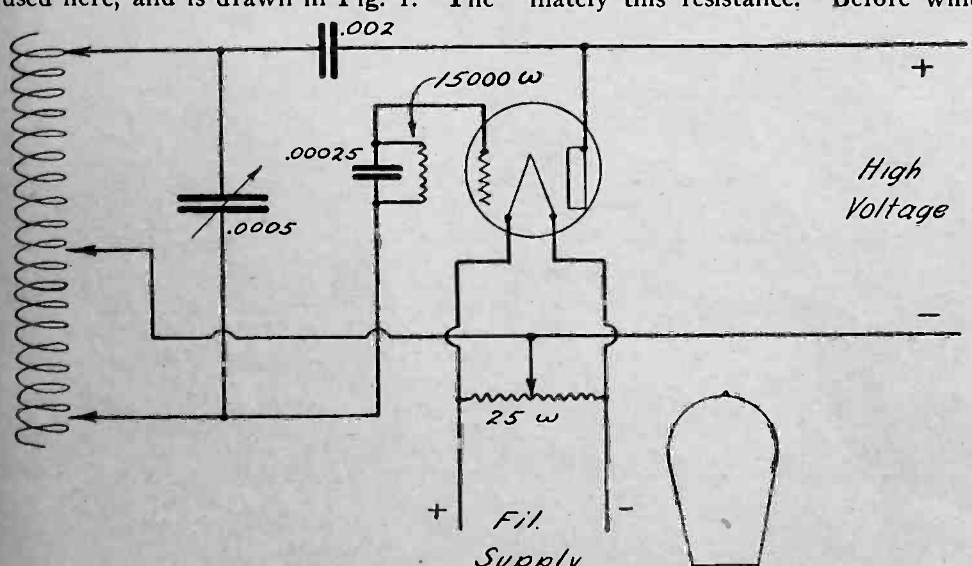


Fig. 1. Hartley Oscillator.

The oscillator is assembled on a 12 in. by 18 in. wood base; two cleats are screwed under the ends of the base, to strengthen and support it. The filament wiring is run under the base, dropping from the socket lugs through holes in the wood, the negative plate lead being run under the base also. These wires are all at practically ground potential, and there is a maximum of about 5 volts between the negative plate lead and the filament leads, so there is no harm in running them underneath. Any meters used on the set, including those for measuring grid and plate and filament voltage, may be conveniently mounted on the vacant space to the side of the layout.

The center tap for the filament is obtained by means of a tapped resistance across the leads, the form for this element being shown in Fig. 2. The wire should have a fairly high resistance, so as not to draw too great a current from the filament supply; a value of about 25 ohms is near enough and a sufficient length of nichrome or German silver wire should be used to give approximately this resistance. Before winding on the form the wire should be measured to find the exact center. This point is tightened under the middle machine screw, and the winding taken outward to both ends, which are secured to the screws and connected to the sides of the filament supply. The filament leads should be crossed under the base, to bring the two sides conveniently to the resistor ends.

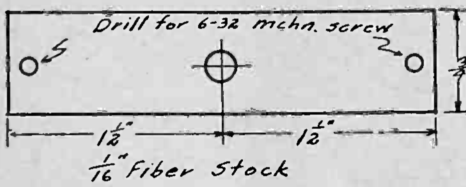
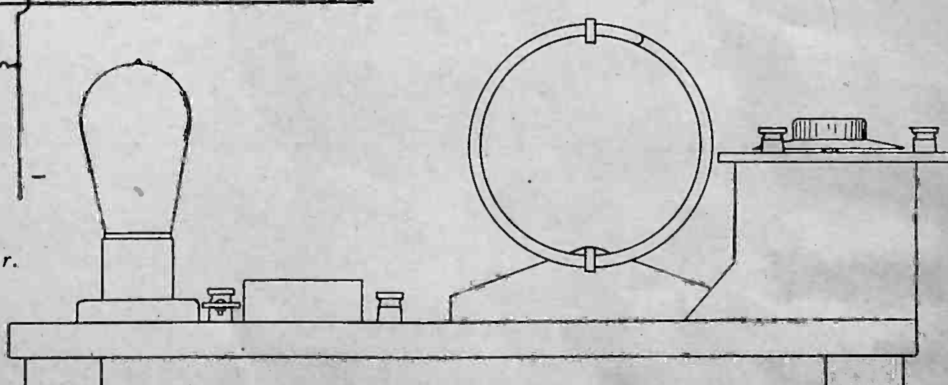


Fig. 2. Form for Center Tap Resistance.

There are several advantages in this method of obtaining the center tap. The tap can be taken very accurately in the center, by measuring the lengths accurately before winding; a transformer can be used which has no center tap; and regulating resistances may be used in the filament leads without throwing the tap off-center. The addition of the resistance in the plate and grid returns does no harm. In the first place, the two halves of the resistance are in parallel for the returns, giving a resultant resistance of ¼ the total value; and this resultant resistance merely carries the d. c. plate and grid currents, which is



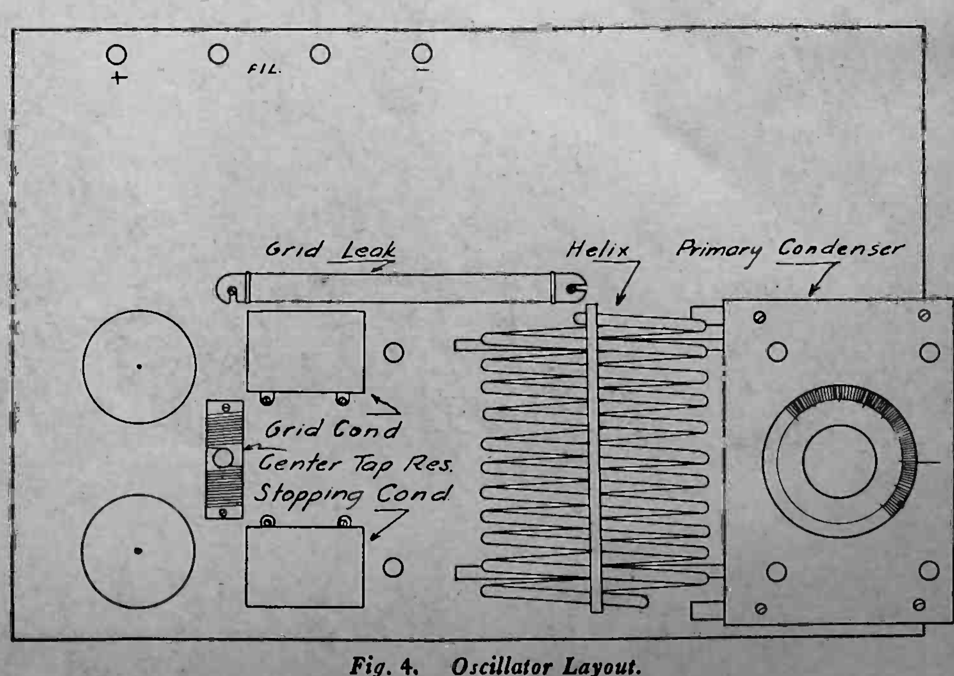


Fig. 4. Oscillator Layout.

not objectionable. The resistance is not in the oscillating circuit.

Details of the helix, shown in Fig. 3, contemplate a wave range of 15 to 100 meters. This range can be increased by winding with smaller copper wire, such as No. 8 or No. 10, thus making room for more turns, or by enlarging the diameter. Two hard rubber strips are drilled and used as spacers for the helix turns. The winding is made of 1/4 in. soft copper tubing, 12 turns being first wound on a 3 1/2 in. or 4 in. form. When taken off the form, they will spring out to a diameter about 1/4 in. greater than that of the form.

The two supporting strips are threaded on the helix turns simultaneously. When completely on, they are spaced diametrically and one of them forced into the rabbets in the bottom supports. If the holes in the spacers, and the rabbets in the supports are a tight fit, a sound mechanical job will result. A vertical hole is drilled at one end of each bottom support, to fit over brass brads driven in the oscillator base. This keeps the helix from sliding, yet it permits easy removal to make place for another. The helix clips are soldered to flexible cords, which connect to the three binding posts—grid, filament, and plate—shown on the oscillator drawings. (Fig. 4.)

The primary condenser may be a low-loss receiving condenser, of .0005 mfd. capacity. When the antenna is in tune with the primary, no sparking over will occur. It may spark over otherwise, with a high plate voltage, but no harm is done. The condenser is mounted on a hard rubber panel, which in turn is supported by the wooden ends. The panel is drilled for four binding posts; the condenser connects to two of these, and the helix clips, through flexible cords, to the other two. When the oscillator is used as a transmitter, the condenser posts are connected to the clip posts by short jumpers.

The principal use of the oscillator is as a "ten watt" transmitter. By mounting the helix and condenser as shown, they are easily removed to allow other helices or condensers to be connected to the tubes and thus make it possible to use any desired wave range.

When desired for amateur communication an additional coupling coil of 12 turns wound on a 7 in. diameter will be required together with a series condenser for tuning the antenna system. This coupling coil must be loosely coupled to the oscillator in order to comply with government regulations.

This setup can also be used as a local oscillator, the condenser jumpers being removed and a radio frequency ammeter placed in one side of the oscillating circuit. A line of twisted pair may be placed in the other side, and run to a pick-up coil. In the latter case, the clip on the pick-up coil side of the condenser should be placed at the filament tap on the helix, so the coil will be at or near ground potential. If this is not done, the oscillator will be unstable.

For antenna, or for superheterodyne transformer measurements, a helix can be wound on a large tube with small wire, and the necessary long-wave range be obtained. The oscillator losses are not important in such work. If a low radio-frequency potential is needed for receiving measurements, the pick-up coil may be shunted by a suitable resistance. The oscillator is small enough to be easily portable, and it is only necessary to run two pairs of wire for the power supply.

In addition to its use as a transmitter and a local oscillator, the layout may be used as a master oscillator. With care it may be made to excite two 50-watt tubes. The filament and plate leads may be made common to the master and the power amplifier, and the first coupled to the second, to give the necessary excitation.

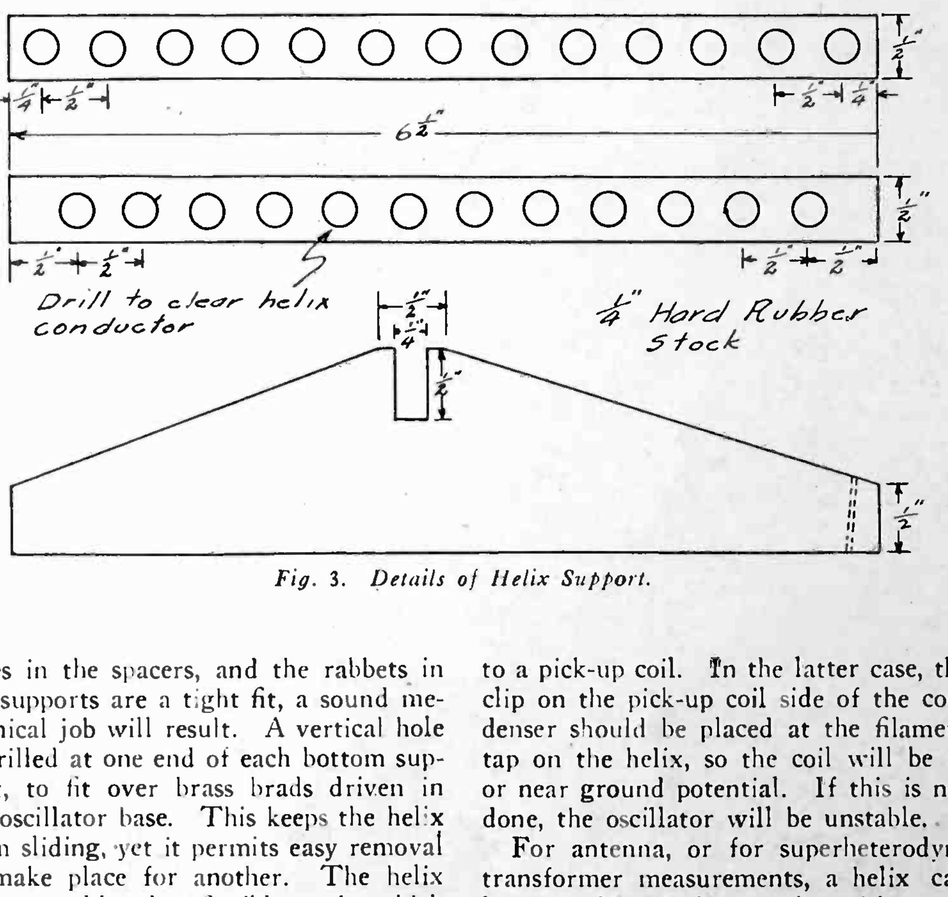


Fig. 3. Details of Helix Support.

NEW ZEALAND RADIO REGULATIONS

The New Zealand government regulations to control radiocasting and amateur radio activities in the Dominion provide for the erection of a 500-watt station in each of the four chief cities of New Zealand, the service to be maintained by the revenue derived from an annual tax on listeners and transmitting amateurs. The tax on listeners has been fixed at 30s (7 dollars), and the tax on both classes of transmitters at £2 2s (10 dollars).

The two classes of transmitters are ordinary transmitters and experimental transmitters; the chief difference between the two classes being that special concessions in the matters of power and wavelengths may be granted experimental transmitters, who are presumed to have a higher degree of technical skill. The normal power of an amateur experimenter is 100 watts of radiated energy, and the maximum power of an ordinary transmitter 100 watts, also measured in the aerial circuit. The normal band of wavelengths for transmitters is from 120 to 160 metres; but experimenters may be granted extra wavelengths under special license. Amateurs may transmit at any time during the twenty-four hours.

The only method of transmission allowed is C. W.; both Morse and telephony. I. C. W. and spark transmission are prohibited, except for strictly experimental purposes. All transmitters must be inductively coupled, and all plate supply must pass through a smoothing circuit, whether from an A. C. or D. C. source. Amateur transmitters are enjoined to listen on 600 metres for the official jamming signal "AAAAQRM" from a commercial station after every transmission or series of transmissions.

Amateurs and listeners generally are satisfied with the regulations. At the time of gazetting the regulations the broadcasting position was not quite certain, as none of the four stations promised was in course of erection. However, it was expected that a temporary arrangement would be arrived at with the private owners of the present stations, whereby radiocasting could be continued until new stations were operating.

"Broadcasting: Its New Day" by Samuel L. Rothafel (Roxy) and Raymond Francis Yates; 316 pages; 5x7 1/2 in. Published by the Century Co., New York City. Price $2.00.

This is a thoughtful and interesting discussion of the past, present and future of radiocasting. Written in an entertaining style for the non-technical reader it admirably sets forth some of the present pressing problems which confront radio. The authors, one a popular radio entertainer, the other a well-informed writer on radio topics, speak authoritatively and supplement their own comment with that of other competent observers. The book begins with constructive criticism of the similitude of programs. It discusses the influence of radio on politics, religion, education and social relationships. The elimination of interference, means for financial support and its several applications to tele-vision and tele-mechanics round out the list of subjects in this most readable book.

"Henley's Workable Radio Receivers, Their Design and Construction," by John E. Anderson and Elmer H. Lewis, 196 pp., 5x7 1/2. Norman W. Henley Publishing Co., New York City. Price $1.00.

Directions for the construction of nine types of receivers ranging from a crystal to a superheterodyne set. In each case the directions include a brief explanation of the principle of operation, the circuit diagram, small scale layouts, list of parts and hints on construction.

The Choice of A Radiocast Receiver

The most frequent question in radio is as to the best type of receiver to buy. In view of the great number of types and makes available, the selection of the right one is confusing. Yet there are a few general rules which will greatly aid decision as to type, whether a crystal, a regenerative, one or two stages of tuned or of untuned radio frequency, or a superheterodyne.

The first determinant, aside from price, should be the kind of antenna to be used. An outside antenna invariably gives the greatest volume and distance, at the least cost, with any type. For a crystal set it is essential if it is desired to regularly hear stations more than five miles away.

The indoor antenna, whether a wire suspended near the ceiling or a condenser socket attachment to the house wiring, while more convenient to use, requires a receiver that is more sensitive than a crystal. Still more sensitivity, more tubes, is needed for a loop in order to get either distance or volume. The loop, however, gives greater selectivity and less interference from static. No kind of indoor aerial can be expected to do justice to a set if it is placed inside a steel frame building or a stucco house with wire netting support. The metal absorbs so much of the radiation that little or none is left to actuate the set.

A crystal set with an outside aerial is the cheapest in first cost and operation. Under normal conditions it should give good head-phone reception from 500-watt stations 25 miles or less distant. It will not give loud-speaker volume nor is it normally able to separate stations that are radiocasting simultaneously.

Loud-speaker volume with a crystal or any other type of receiver can be secured by adding an audio frequency amplifier, using one tube for local and two tubes for distant stations.

The reflex is an especially economical and efficient set, combining a crystal detector with a tube which is reflexed for both radio and audio frequency amplification. It has a range of a thousand miles with an outdoor antenna and perhaps half as much with an indoor antenna under favorable conditions. It gives loud speaker volume with local stations.

Slightly greater distance but less volume will be secured with a one-tube regenerative receiver. Out of consideration for your own quality of reception and for your neighbor's happiness this should not be of the single circuit type. Such a receiver, unless operated by a considerate expert, gives mushy sounds and its radiations may interfere with other listeners five miles away. Even a two or three circuit regenerative, which does not radiate so much, should be equipped with some anti-radiation device.

One of the best of these is an additional stage of radio frequency amplification which will give greater distance and prevent radiation. Two stages of untuned radio frequency will give a range of 1,000-1,500 miles with an outside aerial, 500 miles with an inside antenna and 200 miles with a loop. Two stages of tuned radio frequency will give 1,500 to 2,000 miles with an outside antenna, 1,000 miles inside and 500 miles with a loop. Still greater distances can be had with the recent development of regenerative tuned radio frequency amplifiers.

A good superheterodyne receiver should give 1,500-2,000 miles with a loop and greater distance with an outside antenna, but correspondingly less selectivity and freedom from noise. The limit of reception is the noise level as compared to the signal audibility. With more noise due to static the summer range is less than the winter. With more powerful stations the range is greater.

But distance-getting ability is not the only criterion in a radiocast receiver. The quality of the sound as reproduced is fully as dependent upon the proper design of the amplifiers in the set as upon the loud speaker. Although even the best set cannot overcome the handicap of a poor loud speaker better results will be secured from a set which gives nearly equal amplification to all tone values.

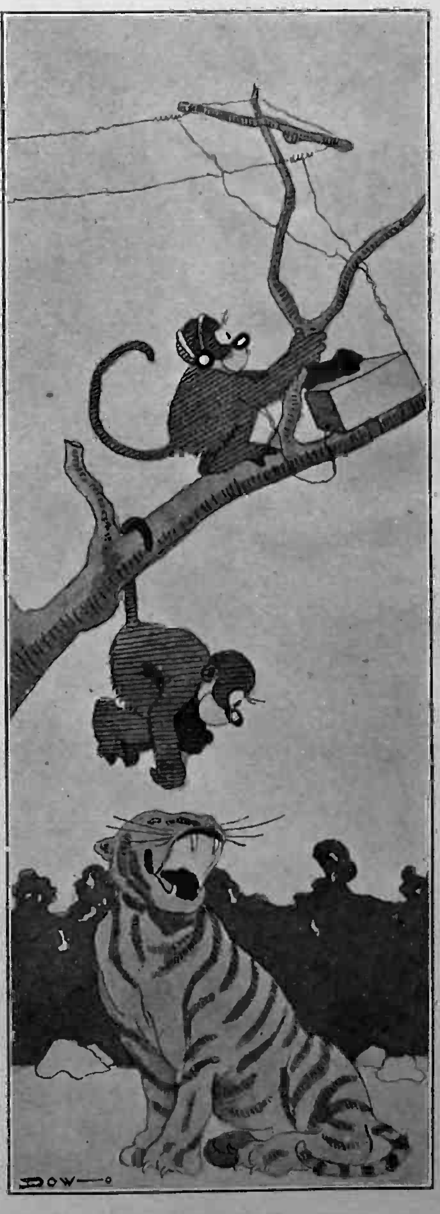
In this respect the reflex and regenerative sets are often faulty. Furthermore by the use of three resistance coupled audio frequency amplifiers better tone values can be secured than with two stages of transformer coupled.

Decision as to the use of dry battery or storage battery supply for filament and plate current depends largely upon how much the set is likely to be used. The dry batteries are the most convenient but the storage batteries are the most economical wherever a set is used several hours daily. The latter also usually involves the expense of a battery charger.

Little can be said as to the particular make of any one of these types which it is desirable to purchase. Care in construction, quality of parts, and elaborateness of cabinets are all factors in the price set by a manufacturer. Another point to be considered is the reliability of the dealer selling the equipment, whether he stands behind his sale and is anxious to build upon satisfied purchasers as a basis for future business.

There was a heavy overproduction of several types of sets by various manufacturers last winter. As a consequence many real bargains are being offered this summer, particularly in cases where the manufacturer will bring out new models this fall. Where the manufacturer is satisfied that his present set already incorporates most of the changes possible at the present stage of the art, or where his production barely meets the demand, any general cutting of prices is not likely.

Furthermore, any radical change in present types is improbable for some time to come. There will be many refinements but a good set of today will bring pleasure to its owner for years to come.



"C'mon Sabre-tooth, give us another whisker for the detector."

"SOBRE LAS OLAS"

By J. Bront

To those upstanding lads who aspire to sail the seven seas, over the sun-splashed horizon of deep water, under azure skies, away to golden isles of romance and fortune, to thrill to the mystery and awe of blue water, to revel in the wine laden intoxication of the murmuring sea, the following is dedicated. (See Sunday papers). Get a license and start asailing:

ROLLICKING LIFE ON THE DEEP

Radio Log — S. S. Lake Discomforts Feb. 5—

6 a. m.—Rose from downy couch—segregated various cornhusks in mattress and resumed prone practice.

6:30 Music in—no antenna or ground (breakfast bell).

6:35 Analyzed series hookup of various patriarchal eggs.

7:00 Hydrometer showed kind engineer friend cut off current during night—Bat. at 11.40.

7:15 Copies press to Captain and saloon (little press copied as cabin boy threw out all old newspapers).

8 a. m. Weather Schedule—Navy operator plays excruciating melodies on new bug—apparently weather is foggy, clear, rainy, fair and overcast.

8:30 Called by WWBZ—"Is my spark coil sharp?" "Yes, your spark coil is sharp—like Hades."

8:55 KPE in-tfc with Hogi Pogi Maru.

9:15 Mate in to borrow "Radio."

9:20 Second mate in to borrow "Radio."

9:25 Third mate in to borrow "Radio."

9:30 Chief in to borrow pencil.

9:35 Second engineer in to borrow typewriter.

9:40 Captain in to borrow fountain pen.

9:45 First engineer in to borrow pliers.

9:50 Third engineer in to borrow "wire tables."

9:55 Steward in to borrow books.

10:00 Freight clerk in a borrow clock.

10:15 KILP de NAVY—Call—"qt-n-?? qm-p-??-vvvv-qpt-qtot-???-qt-qtc? (Hurray he made it. Bugs of navy boys getting buggier every day).

10:17 No. 1CK15 Calwood San Francisco OK KEK.

10:20 Ship rolling in swells—deck head leaking on receiver.

10:30 Bulkhead leaking on transmitter.

10:35 to 10:40 Fifteen calls from WXXX—"You hear me OK?"—"Yes hear you too much OK".

10:45 Mate in — "Can you get GBZW?"—"No, GBZW is 1500 miles east of New York. We are 3100 west of New York—4,600 miles on one tube?—better write a letter"—(Mate) "Funny you can't hear them on the wireless", "Yes, s'funny, mate—(Mate) "Maybe you can hear them on the RADIO!"

(So pulled out few remaining hairs above each ear).

11.01 a. m. Navy station bug, practicing Egyptian code: "qs-ee-?-qsie-??!-qsme--? ? ! - qst (hurray) — Weather warning: "QST-Storm of marked intenssity?? intensaty? -centeap-?-centralon-central over Orepo-Osegof-Oregon coats-coast. String-strung-strong gatesgales tonigh-tonighp-tonight and Sundy-Sunddy-Sunday"—(grand flourish) qst de Navy-qru-va.

11:05 to 11:35 Called Radio Compass WXXZ—he practiced with bug—finally answered—"You want a hearing?" "No we are just playing leap frog"—"Sorri, we are out of commission again"—"!?!!* (censored)".

11:36 Mate in—"did you hear the 'Sally Wickers?" "No."

11:47 Second Mate in—"You hear 'West Wight'?"—"No."

11:48 Third Mate in "Did you hear the 'Cape Reno'?"—"No."

11:49 Captain in—"Did you hear the 'Don Warren'?"—"No."

11:50 nr1ck45 Los Angeles Capt. Warren OK from KFS—nil.

11:51 a. m. Water in motorgenerator—two inches of water on deck—port window shattered by flying end of rigging—pillow stuffed in hole.

11: 56 Time signals NPL arc—O. K.

12:00 noon Tuned in for music for saloon loudspeaker—"so little bear said"—"We point with pride to our noble city"—"Signing off at 12:02"—"two spoonsful of arsenic"—"wind eight turns on the tube"—So started saloon phonograph on the sideboard.

12:15 Repaired to saloon to plug in on various units of ribs au jus and disguised tapioca.

12:35 Noon position to KEK—nil.

12:40 Mate in—"fix my flashlight?" "Yes." (Battery left out).

12:45 Third engineer in—"Can I have extra copy of press?"—"Yes, you can—not." (Want some one to read it to you in bed?)

12:50 Second mate in—"My fans busted."—"So am I—see you later."

1:15 Chief in—"My fans broke—can you fix it?"—"Yes, I cannot, just now."

1:35 Radio compass bearing from NAVY new bug expert proclaims: "Your bearing is: qte 2718?? 21788?? 2711?? 2718 bw?" "Must be versatile circle with 'those degrees.' "

2:55 Off watch—hook up with sheets.

2:56 Swells hit ship—yours truly hits deck.

2:57 Mate in—"Got another copy of press?"—"Yes, bring your lunch, sit here, and will read it aloud to you."

2:58 Doze.

2:59 Cabin boy in to tidy room (!!?XX?!!)—go below to negotiate tea—Resume prone practice at 3:30 p. m.

3:32 Fuse kicks on panel—"hw cum?"

3:32 Arise and cherchez le fuse blower.

3:34 Find third mate in battery room testing live socket with screw driver. Unload lecture and good advice to third mate, concerning sockets, screw drivers and third mates.

3:41 Resume sheets.

3:42 Rain floods berth through deck head leak.

3:43-3:59 Repair leak temporarily.

4:00 Resume phone practice on settee.

4:01 Doze.

4:02 Steward in—"Did you want called at four o'clock?"—"H——l no, lemme sleep!"

4:03 Doze.

4:04 Captain in—"Sparks, see if that's the 'Harvester' over there, will you?"—"Aw Ri', Cap."

4:04½ No juice. Go below to engineroom, exuding brimstone and sulphur. Radio switch out. Switch thrown in. Climb 3 decks to radio room.

4:10 Call "Harvester"—nd gess op off watch.

4:30 Resume settee.

4:31 Doze.

4:32 Third mate in—"We're docking six o'clock. Let's go to a show."——"Aw Ri'."

4:33 Doze.

4:34 Second mate in "Let's go to show tonight. We dock at six o'clock."—"Aw Ri'."

4:35 Third engineer in "Docking six o'clock. Let's go to a show."—"Aw Ri'."

4:36 Doze.

4:37 Sailor in—"Want to send a message to my aunt. You write it?" "Yes, go ahead. What address?" "Er—to my aunt. Just send it to my aunt at Coos Bay—you know—my aunt"—"Yes, I know your aunt—like h——l! What's her name?"—"I think it's Emma—or maybe Anna—my aunt."—"All right, here 'To Aunt Emma Maybe Anna Kinderviken, Coos Bay via KEK, Hello aunt good bye, Charlie Ericksson, —how's that?"—"That's fine—*fine!*"—"All right, Charlie, $3.20!"—"What, do they charge for messages?"—"No, they just keep them flying around for their rheumatism—I'm busy Charlie."

(Exit—"Well, what do you know about that. They charge for messages!")

4:56 Doze.

4:57 Music in (supper bell)—"Oh h——l, why try to sleep on this packet?"

4:59 Supper.

4:59½ Start getting outside of various chunks of Angora goat, sad pie, and tea.

5:00 General remarks (local comedian) from mate: "Pretty soft. Sparks sleeps all day—nothing to do, etc."

5:01½ "!!?XX?!! you're another! etc."

So after the general free for all, we drifted up town, and listened to the radio concert in the park—with one exception.

I sleeps—I do.

Repairing Radio Instruments

By Roy C. Hunter

THIS article deals with the troubles of radio in a different way. It takes up separately the mechanical troubles of the different instruments rather than the troubles of a radio set taken as a whole. There are some instruments which in certain cases can not be repaired and these will be mentioned later.

A great deal of trouble is caused in radio sets by poorly constructed coils, shorted turns being one of the worst offenders. Wire with a single covering of insulation and enameled wire should never be used. Soldering flux dropped on a coil will occasionally cause a high resistance short and a short in the coil will reduce its inductance decidedly and it will absorb energy from the coil, causing it to have low efficiency and high losses. Other fruitful sources of trouble in coils are broken wires and loose or broken connections. The best way to test for these troubles is with headphones and a dry cell, one of the phone tips being connected to one of the binding posts on the dry cell and the other binding post being connected to the coil. If no click is heard when the other phone tip is touched to the other end of the coil there is a break in the coil or one of its connections. If a scraping sound is heard in the phones when the coil is moved, there is a break in the coil or at its terminals which is making contact just part of the time. If the coil appears the least bit damp it should be dried out by placing it in a warm oven. Another idea instead of this is to place a lighted incandescent bulb in the radio cabinet a few hours.

The troubles found in coils are also found in variocouplers and variometers, along with specific troubles found only in the latter types. The rotor scraping on the stator is one of these and this is due either to poor construction, faulty alignment, worn out bearings, or in some cases may be caused by excessive pressure on the dial while turning. In certain types of variometers and variocouplers a spring is placed at the end of the instrument to make contact with the rotor shaft. Sometimes the spring is bent so far back that it will not make contact and the remedy of course, is to bend it back in place. Sometimes the pigtails from the rotor break apart, so that all instruments of this type should be tested with a dry cell and headphones as described above. Sometimes in wiring the set bus wire is run too close to the coupler or variometer, and when the rotor is turned it scrapes on the bus wire. This is generally accompanied with noises in the phones. The remedy, of course, is obvious.

The most common troubles in variable condensers are the plates scraping. This is frequently caused, in the cheaper grades of condensers, by the holes in the bakelite ends which serve as bearings being worn large enough for the rotor to get out of line and scrape the stator plates. This can be remedied by carefully drilling out the holes and placing small brass bearings in them. The bearings should fit tightly in the bakelite, and should of course, fit the shaft. Plates sometimes scrape due to the condenser becoming strained on account of poorly aligned holes drilled in the panel, for mounting the condenser. Sometimes in the types having a spring which makes contact with the rotor shaft, the spring is tightened so much it jams the rotor forward and causes scraping. The test for scraping, if it cannot be heard, is to connect the dry cell and phones to the stator and rotor of the condenser and rotate the rotor. If a click is heard at certain places the condenser, of course, is shorted and scrapes.

Pigtails sometimes become broken, due to wear and the break should be soldered or a new one put in place of the old one. The plates may also be shorted by dropping hot solder between the plates accidentally when soldering. In the types that have spacers between the rotor plates and a nut at the end of the shaft to hold them tight, sometimes the rotor plates become loose due to the bumping on the stopping pins. The remedy is to align the plates, tighten up the end nut, and throw away the stopping pins. If only a few of the rotor plates are scraping it may be due to a blow such as dropping, etc. In this case the plates can generally be bent back in place with a screw driver.

Practically the only trouble experienced with fixed condensers of good design is short circuits. Soldering flux allowed to run between the plates of some types causes a high resistance short. Use only just enough flux and hold the condenser so that all excess flux will run off the condenser instead of into it. If any is left of it, it should be washed off with benzine. If the condensers are shorted internally they should be thrown away. They can be tested by connecting them in series with a flashlight bulb and a couple of dry cells. If the bulb lights up the condenser is shorted. The phone test cannot be used here as a click will be heard in the head phones when the circuit is closed even though the condenser is a good one.

A trouble sometimes experienced with bakelite sockets is that the slot, which holds the pin on the side of the tube base, breaks out and the tube of course will not stay in place. They may be repaired by cutting a slot exactly around half way on the socket, and the same distance from the top of the rim and drilling a 3/32-inch hole. Cut the slot with a hack saw straight down from the rim of the socket to one side of the 3/32-inch hole. The cut must just meet the side of the hole so the tube will stay in place. Of course the connections to the socket will have to be changed around to the binding posts directly opposite to the ones they were connected to. Another common cause of trouble in sockets is that the contacts bend so low they do not touch the tube prongs, or they may be loose and out of place. When tubes are placed in sockets they should be held so the pin on the side of the tube will slip directly down into the slot provided for it. Sometimes the spring contacts in the socket are bent so high that they will touch the prongs in the base of the tube without the tube being fastened in the socket. In case the tube is turned one-fourth way round to the right, from the normal position, the filament would be connected to the *B* battery and consequently it would be burned out.

In rheostats and potentiometers having a wire winding, the winding occasionally becomes broken or worn by the control arm. In case the winding is wound on a fiber strip, which may be removed, the break may be soldered and the winding turned over and used again. In the types of resistance using carbon or graphite discs the spring inside may be worn out or has lost its springiness. The discs may be broken or cracked. In case only a few are ruined, they may be removed and a longer spring inserted to make up for the loss, provided the loss in resistance does not amount to much. Trouble is also sometimes experienced in the threads on the knob shaft wearing out. Grid leaks which employ graphite discs or windings may be treated as outlined for rheostats. In case they use a pencil marking and a rubbing contact, the markings may be worn out and it can easily be renewed with a soft pencil.

If a neutrodyne suddenly develops a howl the neutrodon may be at fault. If the glass tube is broken, it of course should be replaced with a good one. If spaghetti tubing is used as the dielectric it may be too short and the metal cylinder touches the bus wire at both ends, shorting condenser. If the spaghetti is damp it will short the condenser which, besides causing the condenser to work poorly, also allows the *B* battery current to leak to the grid and giving the grid a positive charge.

In jacks it frequently happens that the springs have lost their springiness, which results in failure of the jack to operate when the plug is inserted, this being especially true of filament control jacks. The tubes should be removed from the sockets, the battery disconnected and a screw driver used to bend the springs so they will make contact when the plug is in the jacks.

If a fixed type of crystal detector is used it is sometimes a good idea to try a new adjustment. Crystals often get dirty and are unfit for use and they can be used again by washing with alchohol. Cat whiskers frequently become broken and they should, of course, be replaced with new ones.

The troubles generally experienced in transformers are the same kind as given under coils and they should be tested with a dry cell and phones. If no click is heard, the winding may be burned out, or the end of the wire may be loose from the binding posts on the inside. A test should also be made to find if a wire is touching the core or the case. A radio frequency transformer can generally be rewound, if the trouble is in the winding, but in an audio frequency transformer this is generally impossible.

Difficulties ordinarily experienced with headphones are loose connections and loss of sensitivity. The former trouble is usually found in the receiver cord, or in the terminals where they are fastened to the headphone units. If the phones have gradually lost their sensitivity, it may be due to passing direct current through the windings in the wrong direction, or the receivers may have been dropped on the floor without apparent damage. If excessive rattling is heard in mica diaphragm phones, it may be due to the steel wire connecting the armature to the diaphragm becoming loose, in which case a good repair job can be accomplished by an application of LePage's Glue.

COURT DECISION EFFECTS RADIO ON SHIPS.

Rented radio apparatus on a vessel is not part of the ship and, therefore, may not be subject to a lien on the ship, according to a decision recently handed down by Judge Bledsoe in the District Court for the Southern District of California. Radio interests engaged in the Marine Communication business, have long sought a definite ruling concerning the right to subject radio apparatus aboard ships to claims against ships so equipped, it was learned.

The action in which the decision was made was filed against the British Yacht *Frontersman*, on which the Marconi Company had installed and rented apparatus for radio communication purposes. In this suit the Marconi Company were intervenors. The Court held that the apparatus did not become part of the ship, and, therefore, not subject to libel against the vessel. This case is said to be the first of its kind in American Jurisprudence.

THE RANGE OF RECEIVING SETS

By Jerome Snyder

THE editor whose task it is to answer questions is not to be envied for the questions range from the sublime to the ridiculous in content and often the questions indicate a total absence of acquaintance with principles underlying reception and transmission of radio waves. For example, it is not infrequent that one receives a question which reads, "I have a one tube set, how far can I receive?" Others give more complete details and ask the same question as to how far the set can receive. This question of receiving range ought to be settled in the minds of novices and beginners, and a little enlightenment on the point of receiving set range ought to be appropriate at this time.

It should be clear to anyone that there are so many factors influencing the reception of radio signals that no definite range can be ascribed to any set. For example, so much depends upon the individual skill of the operator in tuning his set, that one man may be able to tune in transcontinental stations on a superheterodyne set whereas another may not be able to tune in more than the locals with the same receiver. In considering the question of the range of a receiving set one may make a comparison with the hearing ability of one's ear. In a large quiet room a person stationed at one end may be able to hear another person if he is stationed not too far from the listener. If the speaker moves farther away the listener will no longer hear him, but if the speaker raises his voice somewhat, then the listener may be able to hear him at a greater distance. In other words the hearing range of a person depends upon the loudness of speech transmitted and the louder the speech the greater the hearing range. Translating this in terms of radio we see that the receiving range of receiving sets is first dependent upon the power of the transmitting set or station and the more powerful the transmitter the greater the receiving range of any particular receiver.

However this is not absolute, so let us go back to our analogy of the speaker and listener. In a large quiet room the listener can hear a low voice over a certain distance. Suppose that there is some noise in the room. The intensity of the voice will have to be raised in order that the listener be able to hear it over the same distance as the lower tone was heard in the quiet room, for some of the speech energy is used to ride over the interfering noises. Translating this into radio terms the range of a receiving set depends again upon the interference present in the atmosphere. With no static, no birdies, no interference from electric power circuits, a skillful operator may tune in with a simple rengenerative receiver, stations two thousand miles away. If the static is bad, if power lines and violet ray machines produce their quota of inductive noises, and if birdies due to oscillating receivers whistle up and down the scale, then the powerfully sensitive superheterodyne may not be able to receive more than the local stations.

Thus we have at least two factors influencing the range of receivers, one the power of the transmitter station, and the other the presence of interference. There are other factors which determine the range of a set, and these may be determined from the following equation:

$$I_B = K \frac{I_s h_s h_B f}{\lambda d}$$

In this equation

K is a constant number

I_B is the current in the receiving antenna

I_s is the current of the transmitting antenna

h_s is the height of the transmitting antenna

h_B is the height of the receiving antenna

λ is the wavelength at which signals are transmitted

d is the distance between transmitter and receiver

f is the "attenuation factor"

Now the range of a receiving set may be considered to depend upon the current in the receiving antenna; the greater the current the greater the range. The above equation shows how many factors determine this range. First there is the current in the transmitting antenna, which depends upon the power; the greater the power or sending current the greater the range. Second there are to be considered the heights of the sending and receiving antennas; the higher these are the greater will be the received current and hence the greater the receiving range. Then there is the matter of the wavelength to be considered. In the equation the wavelength enters in the denominator and this means that the received current will also depend upon the wavelength at which signals are transmitted. Finally there is the "attenuation" factor, f, which depends upon the nature of the medium through which the radio wave passes, the medium absorbing part of the energy of the wave as it passes through it. Thus if the wave passes through territory which is full of steel structures, much of the energy of the passing waves will be absorbed and thus the receiving range of sets in that vicinity will be considerably reduced. Then there is the type of ground which is also of great importance in this connection for if the radio waves pass over dry sandy ground there will be a greater loss of energy than if they pass over wet, or moist ground. We see then that there are certain definite factors which

(*Continued on Page* 74)

for The RADIO NOTE BOOK

Useful Facts and Theory

Classified According to Dewey Decimal System.

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1

INDEX SHEET

Abbreviated Classification of Subjects

R 000 RADIO COMMUNICATION.
R 007 Laws, Regulations.
R 010 Research.
R 020 Textbooks.
R 030 Terminology, Symbols.
R 050 Publications.
R 070 Education; Training.
R 080 Collections; Tables; Miscellaneous.
R 090 History.

R 100 RADIO PRINCIPLES.
R 110 Radio Waves.
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R 200 RADIO MEASUREMENTS
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R 343 Electron Tube Receiving Sets.
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R 381 Condensers.
R 382 Inductors.

3

621. 314. 3

Design of Power Transformers

The advent of *B* battery eliminators, *A* battery chargers, and similar apparatus has aroused a new interest in the design and construction of small power transformers. The problem is so simple that it can be tackled by the veriest tyro. The known factors are the voltage of the current supply and the cross-sectional area of the core upon which an unknown number of turns of an unknown size of wire are to be wound to form the primary and secondary windings.

For 60 cycles service, the number of turns T in the primary winding can be obtained by multiplying the supply voltage by 7.5 and dividing the product by the number of square inches in the cross section of the core. ($T=7.5\ E\div A$). For 25 cycle supply the constant is 12 instead of 7.5 and for 50 cycles it is 9.

Having determined the number of turns in the primary winding, then figure the number of volts per turn by dividing the primary voltage by the primary turns ($N=E\div T$)

The number of turns in the secondary is obtained by dividing the desired secondary voltage by N.

Assume a core, of the square window type, the cross sectional dimensions being 1¾x1¾ in., giving an area of 3 sq. in. The house circuit voltage varies between 115 and 120 volts, so that the latter can be assumed as being the safest as a basis for calculation. It is desired to operate a full wave vacuum tube rectifier using C-301-A tubes, for supplying 90 volts plate potential to a receiving set, using the transformer in question as power supply.

Then $T=7.5\times120\div3=300$ turns, the number of volts per turn, N, is equal to $120\div300=0.4$ volts.

The secondary for supplying the plate voltage for the rectifier tubes must have two windings of 110 volts each, as a drop of 10 to 20 volts must be expected in the filter apparatus. The number of secondary turns will then be $(110+110)\div0.4=550$ with a tap taken out at the 275th turn (½ of 550).

The filament secondary is 5 volts and will therefore require $5\div0.4=12.5$ turns.

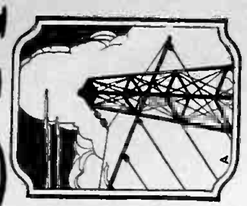
The size of wire depends upon the current to be carried. It may be found from the following table of safe current carrying capacities for different sizes:

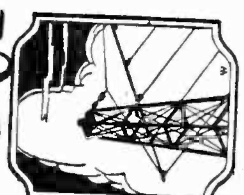
Size No.	14	16	18	19	20	22	24
Amperes	12	6	3	2.25	2	1.2	.08
Size No.	26	27	28	30	32	34	38
Amperes	0.5	0.4	0.3	0.2	0.12	0.08	.025

No. 30 or 32 cotton-covered will be ample for the primary winding since the current will be only a few milliamperes. No. 20 will do for the secondary if a 1 ampere tube is used as a rectifier.

In selecting a core which must be built up from pieces cut to order, it should be remembered that the turns increase in the same ratio as the core area decreases, and it is always desirable to have as large a core as is possible, consistent with the room available for the transformer in

for The RADIO NOTE BOOK





Useful Facts and Theory

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

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Design of Power Transformers
(Continued)

the rectifier assembly, as iron is much cheaper than copper wire. If a small core is used, the number of turns will be large and in case of an accidental short circuiting of turns within the windings, it will be difficult to unwind the coils and locate the trouble. Whereas if a large core is used, the number of turns will be few and the labor of trouble shooting less severe.

It is a good plan to remember that from 1 to 1½ volts per turn is a safe average to use, so that the size of the core can be computed by the following equation: $A=7.5\times\frac{E}{T}$ or the area required will equal the volts per turn times 7.5, which in this case is 7.5 sq. in., the volts per turn being unity.

The actual construction of the transformer is facilitated by the use of a lathe. The mandrel on which the coil is to be wound should be exactly the shape of the core in its finished form. Generally a block of wood cut to the size of the core and tapered slightly toward one end will do. Wooden flanges placed at each end will prevent the layers of wire from slipping off the ends of the form.

This form can be mounted in a lathe or hand turned chuck so that it can be rotated easily. A layer of empire cloth should first be placed on the form and over this should be wound the primary coil, being careful to feed the wire evenly and tightly on the form to conserve space.

Over the primary coil place another layer of insulating cloth, first bringing out the primary terminal wires through small holes drilled through the wooden flanges of the form. The secondary windings can be wound either on top of the primary winding, or on the other leg of the core, in which case two separate winding operations are necessary.

When the coils are completely wound, a final layer of empire cloth should be applied and a small amount of shellac may be used to hold the cloth in place. After removing the form from the winding machine, one of the flanges may be taken off and the coil slipped from the form. The completed coil can now be wrapped with a good grade of linen tape, the tape being threaded through the hole for the core, in and out until the entire coil is thoroughly covered with the tape. Due to the presence of this tape, the wooden form should be made slightly smaller than the core, to allow for the thickness of the tape.

Having wound the coils, the core pieces can now be piled in the form of a square window, being careful not to damage the tape covering of the coils when passing the core iron through the hole. After as much core material as can be forced through the hole is in place, the core can be clamped by means of metal strips, or even wooden pieces large enough to hold the core tightly in place, so that there will be no mechanical vibration of the core pieces when the transformer is in operation.

2

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Abbreviated Classification of Subjects
(Continued)

R 383 Resistors.
R 384 Wave, Frequency and Decre Meters.
R 385 Keys, Buzzers, Interrupters.
R 386 Filters.
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R 400 RADIO COMMUNICATION SYSTEMS.
R 410 Modulated Wave Systems.
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R 500 APPLICATIONS OF RADIO.
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534 Sound.
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538 Magnetism.
R 900 MISCELLANEOUS SUBJECTS.
621.3 ELECTRICAL ENGINEERING.

QUERIES *and* REPLIES

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

Please publish the circuit diagram of the Tuska Superdyne, together with the data on building the antenna tuner and radio frequency transformer.

—P. W. H., Altoona, Pa.

The circuit of the Superdyne is shown in Fig. 1. The secondary of the antenna tuner consists of 44 turns of No. 22 D. C. C. wire wound on a 4 in. tube, with tap at the 22nd turn. Over this coil is wound the antenna inductance, which consists of 4 turns of No. 18 D. C. C. wire, the turns being spaced ¼ in. apart. The tickler coil is mounted adjacent to the antenna coil and should be mounted so that it can be rotated with respect to the secondary coil. The winding consists of 36 turns of No. 22 D. C. C. wire on a 3½ in. tube. The tuned plate coil consists of 46 turns of No. 22 D. C. C. wire wound on a 4 in. tube, with tap at the 23rd turn.

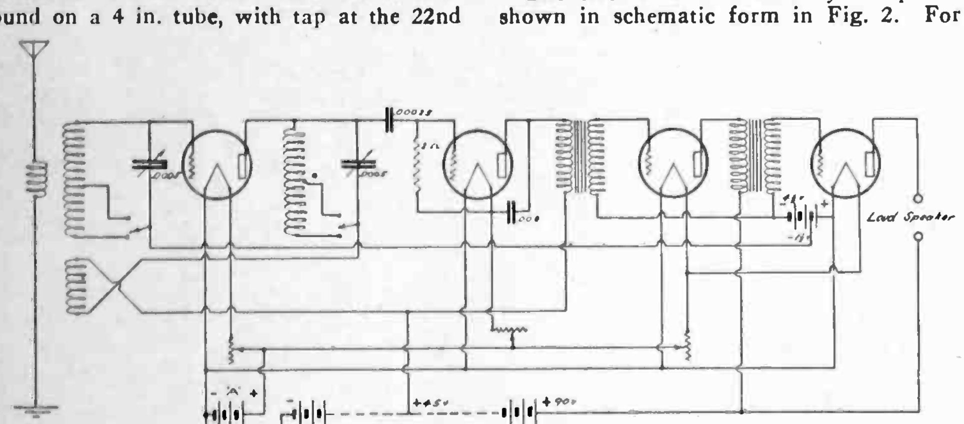


Fig. 1 Circuit Diagram of the Superdyne.

Kindly publish the circuit diagram of the Grebe Synchrophase receiver. On what principle does this receiver operate?

—H. A. A., Waldo, Ore.

The circuit of the Grebe Synchrophase is shown in schematic form in Fig. 2. For a full description of the theory and operation of this circuit, see April QST. The inductance coils are a special type of binocular winding, and provide an efficient radio frequency transformer which is not susceptible to radio frequency currents not associated with the circuit itself, thus providing exceptional selectivity.

Please tell me what modifications of the 5-watt transmitter described in August, 1923, RADIO are necessary to operate on wavelengths around 80 meters.

W. W. C., Atlanta, Ga.

The number of turns in the antenna inductance should be reduced to 15 for the short waves. This particular set is conductively coupled to the antenna and would now be ruled off the air. Hence it will be necessary for you to add another antenna inductance, arranged so that it may be loosely coupled to the present coil. As a suggestion, wind 20 turns of No. 14 bare wire on a 3 in. form and place it in a position near the secondary coil, so that it may be varied through an angle of 60 degrees or more. The secondary circuit can be left as it is, and the new antenna coil placed in series with a .00015 mfd. air condenser, between the antenna and ground.

Can the receiver described by Volney G. Mathison in February, 1925, RADIO be adapted to cover the waves from 150 to 300 meters, as well as the higher waves? Can radio frequency amplifiers be added to the set?

—A. F. H., Philadelphia, Pa.

By the use of honeycomb or other compact inductance coils, the wavelength range of the set can be made to include the lower waves. It would not be practicable to add radio frequency amplifiers to the set, due to the fact that it is designed to use the regenerative detector circuit and the whole panel layout and internal arrangement would have to be changed to accomodate the radio frequency circuit.

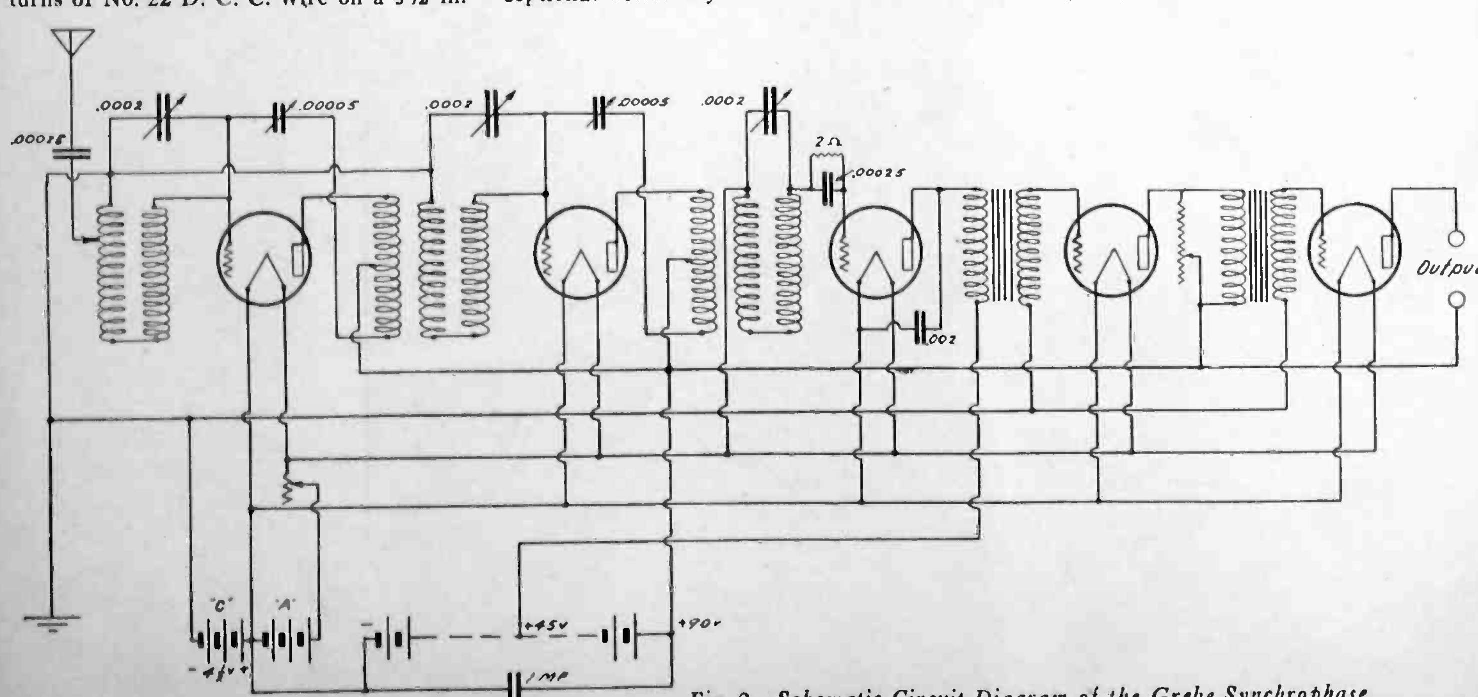


Fig. 2. Schematic Circuit Diagram of the Grebe Synchrophase.

Please give me the data for making a transformer to supply filament current to either a 50-watt or 5-watt transmitting tube. The power supply is 50 cycles, 110 volts.

—S. C. D., San Bernardino, Cal.

The core for this transformer should be in the form of a square window, at least 3 inches square inside, or 1 in. silicon steel core pieces. Pile the core pieces to a height of 2 in., so that the cross sectional area is 2 sq. in. On one leg of the core wind 495 turns of No. 20 D. C. C. wire. On the other leg wind 54 turns of No. 12 DCC wire, with taps at the 9th, 27th and 45th turns. The 27th turn will be the center tap, and in order to obtain 8 volts for the 5 watt tube, the outside terminals will be the 9th and 45th turns. For the 50 watt tube, use the entire secondary winding.

The May, 1924, issue of RADIO contained an article on "Efficient Radio Frequency Amplification". What kind of radio frequency transformers may be used in this circuit? Will the new Browning-Drake coils be of benefit?

—O. O. S., Woodland, Calif.

The new Browning-Drake coils could be used to good advantage. See the article in April 1925 RADIO for data on the circuit. The diagram shown in Fig 1 of the May 1924 article uses a tuned coil similar to the one employed in the Tuska Superdyne shown in Fig. 1 on preceding page.

Kindly publish the diagram of an A battery charger for a 6-volt storage battery.

—F. P., San Francisco, Calif.

A good constructional article on a simple type of storage battery charger was published in the May 1925 issue of RADIO, page 25.

Will you please advise the inductance values in microhenries of the various sizes of honeycomb coils, from 35 to 1500 turns.

—W. S. G., Hollywood, Calif.

The table shown below gives the inductance value for the principal coils:

Turns	Inductance in Millihenries	Turns	Inductance in Millihenries
35	.083	500	17.50
50	.169	750	39.0
75	.377	1000	71.6
100	.666	1250	108.0
200	2.68	1500	159.8
400	11.04		

I would like to have some data on radio frequency as applied to the Simplified Reinartz circuit described by E. F. Kiernan in October, 1924, RADIO.

—R. A. J., Rochester, N. Y.

In order to intelligently answer your question we will require more details as to the information you desire.

If Mr. Leonard Stowe House will furnish us with his street address, we will be pleased to answer his questions by mail.

ELIMINATION OF PRECIPITATOR INTERFERENCE

The result of tests conducted at the Tacoma, Washington, Smelter, for the elimination of interference caused with radio reception by such plants, is submitted for such use as you care to make of it in your publication:

It was determined that the Tacoma Smelter was creating interference with radio reception over a radius of at least twenty miles, and that the mushy part of the interference had a blanketing effect which prevented reception of distant stations within a radius of about ten miles.

The test proved that the size of the radio frequency choke coils depended upon the number of milliamperes used at the rectifier; a 300 turn choke being sufficient, providing not more than 50 milliamperes were used.

Inasmuch as the current at this plant at times reaches 100 milliamperes the test showed that it was necessary to use choke coils of not less than 500 turns, installed as shown in the diagram.

A superheterodyne receiver set up in the yard outside of the rectifier plant formerly would not bring in Tacoma stations, because of the mush and blanketing effect of the rectifiers. After these chokes had been installed the same receiver brought in signals from broadcasting stations 40 miles away with practically no interference.

At a distance of one block from the smelter, the previous interference was reduced by at least fifty per cent. At a distance of three blocks this interference was reduced seventy-five per cent, and at a distance of about one-half mile, no interference could be heard.

Numerous tests indicate that the use of radio frequency chokes are the most practical, and so far as I have been able to ascertain, the only successful method of eliminating interference caused by precipitation plants.

O. R. REDFERN,
Supervisor of Radio, Seventh Radio District.
L. C. Smith Bldg., Seattle, Wash.

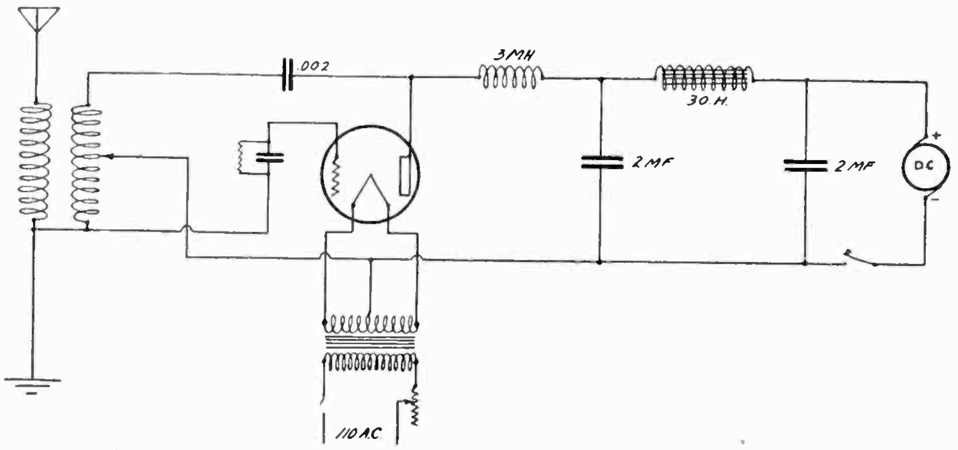


Fig. 3. Circuit Diagram of Transmitter Which Avoids Key Clicks.

I wish to supply my short wave transmitter with plate voltage from a 750 volt generator. Where should the plate supply be keyed for minimum key thump?

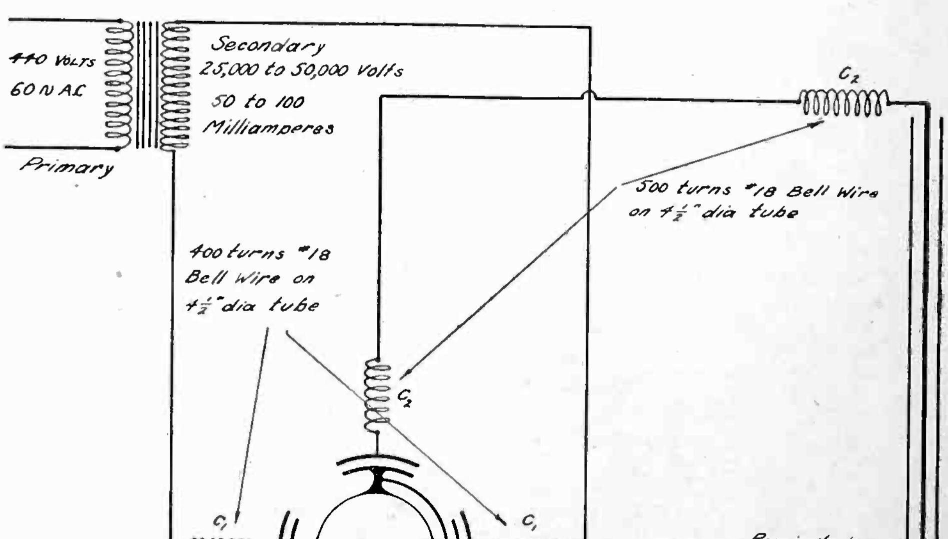
—G. B. H., Augusta, Me.

Fig. 3 shows a good method of keying the generator supply without causing annoying key clicks. The transmitter circuit is shown in schematic form and the method of keying can be used for any transmitter having a generator for plate supply.

I have built a Best Superheterodyne as described in the May, 1924, issue of RADIO. I cannot tune in stations below 350 meters with the loop condenser, although stations above that wavelength come in very well. What can be the trouble?

—W. W. B., Zearing, Iowa.

Either the loop antenna is too large, or you have a fixed condenser across the loop circuit in the wrong place. With a loop designed according to the dimensions given in the article, associated with an air condenser having a capacity of .0005 mfd., you should be able to tune from 180 to 550 meters. Check over the wiring of the set and you will probably find a wrong connection in the loop circuit.

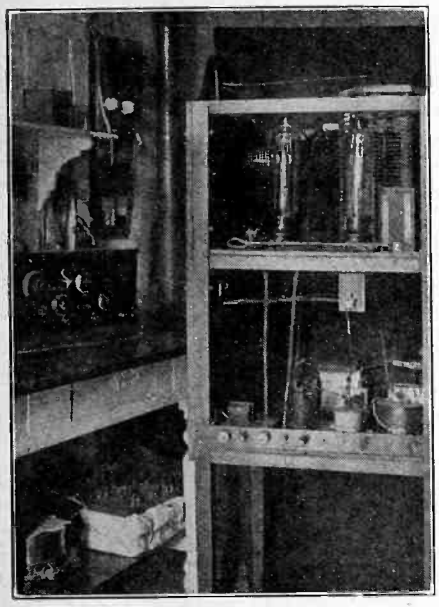


Circuit Diagram for Eliminating Precipitator Interference

With the Amateur Operators

STATION I-1ER, MILAN, ITALY

Station I-1ER, operated by Mr. Santangeli Mario, Via Sa Eufemia 19, Milan, Italy, has been heard by a number of American amateurs and sends a very interesting account of his work with short wave transmitters and receivers, culminating in his present outfit.

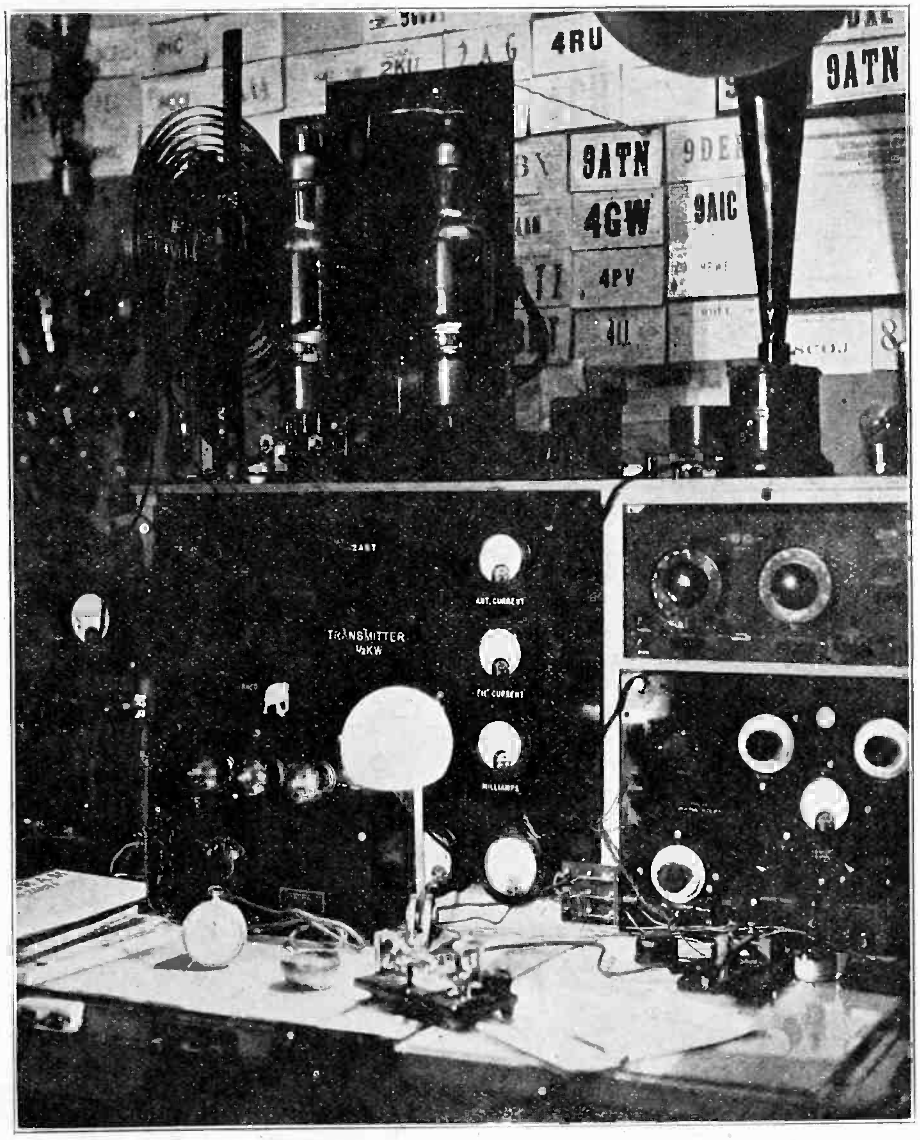


Transmitter at I-1ER.

His present transmitter consists of two 50 watt tubes in a Colpitts circuit, and is neatly mounted, along with the associated apparatus, in panel form as is shown in the illustration. In one corner of the picture can be seen the receiver, which covers the entire amateur band efficiently. Mr. Mario has heard 380 American amateurs during the past winter season and is anxious to continue communication with American stations throughout the summer, if the proper operating schedules can be arranged.

RADIO STATION 2ABT

Envy cannot but fill the heart of the amateurs examining the picture of 2ABT as printed herewith. George C. C. Freisinger, the owner and operator, has installed this 500 watt C. W. equipment at 219 West 81st St., New York City. He has innumerable cards from every U. S. district as well as from England, France, Italy, Spain, Canada and Cuba. He employs a coupled Hartley circuit and is most likely to be found on 75 meters.



Radio Station 2ABT

AMERICAN AMATEUR GETS ENGLAND ON LOW POWER

1PL, C. H. Jackson of Bridgewater, Mass., has worked C. L. Naylor, a British amateur at Shrewsbury, operating with 240 volts, at 9 milliamperes. On the evening of February 2nd, he was listening in on 96 meters, with his Reinartz, two tube receiver, when he heard Station G 5SL at Shrewsbury, England, calling an American second district station. Thinking the other American might not be able to hear it, Mr. Jackson switched on his own transmitter, a 250-watt tube set, calling G 5SL on 80 meters. In about a minute he was answered, and then these two amateurs kept up communication for an hour.

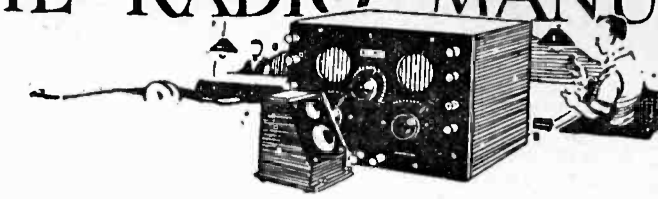
The code from G 5SL was easily readable, Mr. Jackson says; very clear cut, but very sharp. He succeded in holding the Britisher, who was transmitting with only 11 watts, while he reduced his power in stages down to 2.16 watts. Reception was without difficulty, with his two 201-A tube receiver, Jackson says.

It is believed an excellent accomplishment in reception for Jackson, but almost phenomenal on the part of the transmitter, in England. Mr. Naylor, reports that he worked U 1PL through considerable interference at his end from other stations then operating, and for that reason, he did not try to go below, what he roughly calls 2.2 watts in power. The exceptional part of the test, he believes, lies in the aerial employed. As his regular aerial had been blown down, he was using a temporary single-wire antenna seven feet in length. It reached from the lead in, 7 feet above ground, to a mast twenty-eight feet high, thence down to a counterpoise post. The height of the aerial at the far end was ten feet and only five feet from the counterpoise. His counterpoise was composed of four 50-foot wires, spaced four feet apart, and six feet high. Mr. Naylor used an inductively coupled Hartley circuit, employing a single Mullard valve as an oscillator. His emitted wave is pure and perfectly steady. He accords great credit to the owner of U 1PL for his reception with the reduced power.

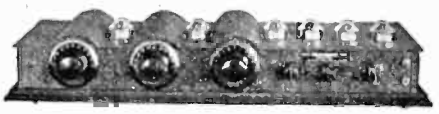
Apparently Jackson is a good DX worker. He has also received the Swiss Station 9 AD, which operated with a plate voltage of only 200, less than G 5SI employed in the test. Among his recent transoceanic correspondents are station owners in Austria, Australia, England, Belgium, France, Italy, Holland, Germany, Luxemburg, Denmark, Brazil, Costa Rica and New Zealand. He has a list of nearly two hundred Pacific Coast stations. He has worked stations in Australia 53 times, and England, 60.

Jackson owns three short-wave receivers, covering 20, 40 and 80 meters, and expects to operate on 5 meters soon. He has also built a new transmitter covering 20 to 40 meters, the circuit for which he calls "The 1PL", after his station call.

FROM THE RADIO MANUFACTURERS



The Neutrowound radio receiving set has two stages of balanced tuned radio frequency amplification, detector, and three stages of audio amplification, giving loudspeaker

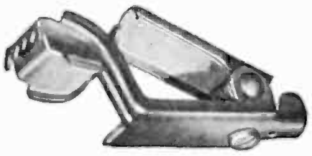


volume on distant stations. It is housed in an all metal case which not only serves as a protection but also acts as an electro-magnetic shield against outside interference. It employs three low-loss tuning condensers giving a straight line curve for variation in frequency thus giving an even spacing down to 200 meters. It also employs a new type of Neutrostat for which unusual selectivity, clarity and volume are claimed.

The Kelbraket is a convenient accessory to neat construction of a receiving set designed with a sub-panel. This not only makes

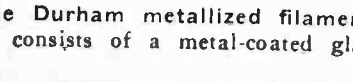
the set stronger and lighter in weight, but also hides most of the wiring. The brackets are made for 7 and 9-in. panels.

The Valley clip for attaching wires to a storage battery is designed so as to be unaffected by acid corrosion, all parts being electroplated with an acid resisting metal which is an excellent conductor. The spring action gives a positive grip that forces the



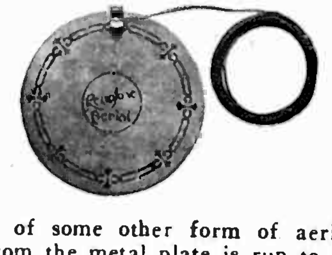
sharp teeth of the jaws through any scale or corrosion on the battery terminals. An oval head screw secures the lead wire to the clip. It is 2⅝ in. long and has an opening up to ¾ in. diameter. Its rated current-carrying capacity is 25 amperes.

The Durham metallized filament grid leak consists of a metal-coated glass rod



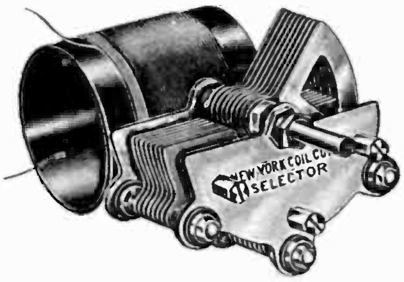
soldered to the brass caps constituting either end of the grid leak. It is made in various units ranging from 40,000 ohms to 10 megohms. It is claimed to remain noiseless, stable and accurate for an indefinite period.

The Remophone aerial is a metal plate upon which a telephone desk set or an electric light portable may be placed so that the telephone or lighting wires may be used



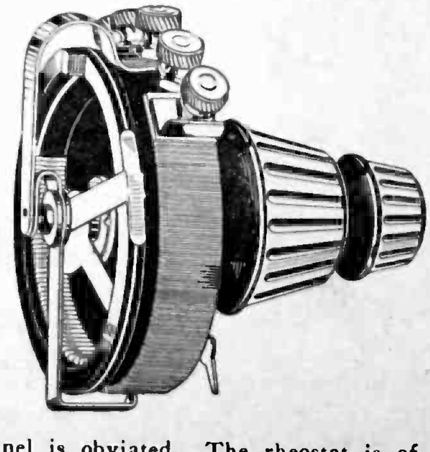
instead of some other form of aerial. A wire from the metal plate is run to the antenna binding post of a radio receiving set. The sound may be increased or diminished in intensity by shifting the telephone's position on the plate.

The New York "Selector" condenser is a low-loss variable with grounded rotor. It is made of heavy aluminum with widely spaced plates and adjustable cone bearings. A portion of the plates is cut out to give



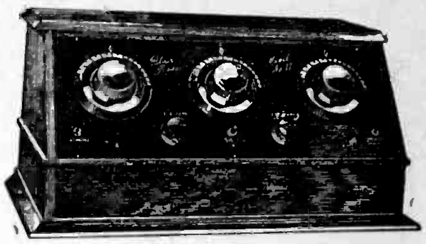
a straight line effect. A minimum amount of dielectric material is employed with a positive spring contact. It is made in 11, 17 or 23 plate sizes. It is sold singly or in combination with a special self-balanced low-loss coil intended to be used as a radio frequency amplifying unit without requiring a potentiometer or neutralizing condenser.

The Frost combination rheostat and potentiometer has one winding on the inside of a bakelite frame and the other on the outside. But one panel hole is required for mounting and crowding of apparatus on the



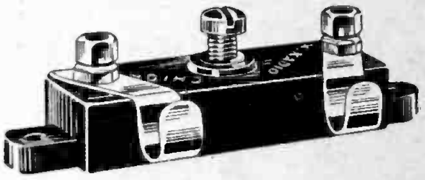
panel is obviated. The rheostat is of the vernier type. A stiff phosphor bronze spring makes the contact between the center and stationary arm of the potentiometer.

The Blair 6-tube receiver employs two stages of tuned radio frequency, detector and three stages of resistance-coupled audio amplification. This receiver received its first



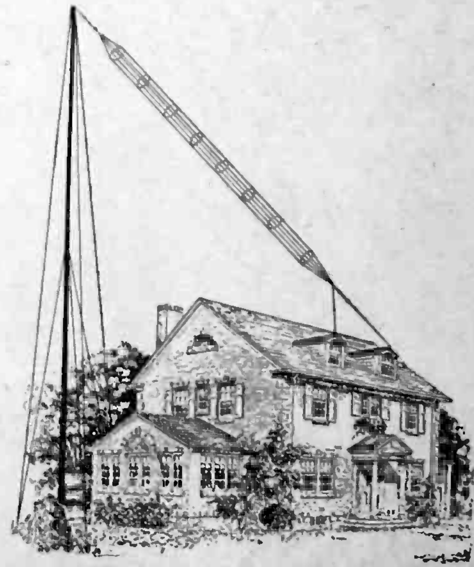
development and sale in Great Britain and is now manufactured in the United States. It combines selectivity, sensitivity and good tone quality.

The X-L Vario-Denser is an adjustable condenser made in two models, one for neutralizing tuned radio-frequency amplifiers, the other as a grid condenser, superheterodyne filter or balancing condenser. The lat-



ter has a range from .00016 to .00055 mfd. The variation is made by turning an adjusting screw. It has low dielectric loss, smooth variation of capacity, low minimum and abundant maximum capacity.

Hercules aerial masts are made in 20, 40 and 60 ft. lengths of a special angle steel construction that gives great strength and



light weight. All sizes may be easily erected in the earth or on the roof without a concrete foundation. They are tested to withstand a 500 lb. pull at the top.

By 6UA, T. R. Runnels, 202 East 53rd St., Maywood, Calif.

1abf, 1ams, (1cab), 1py, 2avg, (2bkl), 2by, (2cpa), (2cwj), (2zv), 3ajr, (3avk), 3bel, 3bpm, 3cc, (3kq), (4tw), 4ux, (5ac), (5aec), (5ath), (5aom), 5ka, (5jb), (5rg), 6ceu, (6cst), 7mb, (7si), 8acm, 8acy, 8aly, (8bcp), 8bdm, (8bga), (8bjy), (8bqa), (8bww), 8dbm, 8czy, 8dsi, (9adg), (9aoo), (9bpf), (9cgn), (9ck), (9cxx), (9dab), (9dxl), (9dwx), (9eic), Canadian-2eu, 3aa, 3ni, (4cb), (4eo), 4gt, (5bf), (5go), Mexican (1aa). New Zealand 2ac, 4ag. Special hva, ket, nqc, way, wgs.

By 1IV, Bridgeport, Conn.

U. S.—6aao, 6adt, 6ae, 6age, 6agk, 6ahp, 6akw, 6alv, 6ame, 6apw, 6arx, 6awt, 6bgv, 6bjj, 6bui, 6bur, 6cdn, 6cgw, 6cms, 6cmu, 6cnl, 6css, 6cto, 6cty, 6ew, 6fy, 6gg, 6lj, 6nc, 6nx, 6of, 6oh, 6oi, 6pl, 6qi, 6rm, 6ti, 6ut, 6vc, 6xad, 6xo, 6zh, 7fr, 7fq, 7gg, 7ku, 7lj, 7ls, 7sf. Bermuda ber; Porto Rico 410, 4je, 4sa; Costa Rica sj; Cuba dz, 2mk, Mexico 1aa, 1k, 1x; South American WJS; Canada 4cr, 5bz, 5go, 5hc; New Zealand 2ac, 4aa; England 2cc, 2jf, 2kf, 2kz (phone and cw), 2nb, 2nm, 2od, 2sh, 2sz, 2wj, 5bv, 5lf, 5nn, 5pu, 5sz, 6nf, 6uv; French 8ab, 8aé 8bf, *8ct*, 8éé, 8go; Holland oba, oll, onl, opc; Belgium p2; Italy 1co, 1mt; Finland 8ssc. Will qsl on request.

By 9APY, 3337 Oak Pa k Ave., Berwyn, Ill. (March)

1aa, (1ajc), 1asy, (1avl), (1axn), (1bkq), 1er, 1jt, 1om, 2agw, (2avg), 2axq, 2bck, 2blp, (2bm), 2bqb, (2br), 2by, 2bzj, 2cel, (2cjj), 2cpa, 2czr, 2rk, 2wr, 3aec, 3blp, 3bnu, 3boj, 3bss, (3bx), 3op, 4cp, (4dv), (4kl), 4og, (4im), 4rw, (4tn), (5abc), 5ahr, 5ail, 5am, 5ame, 5amh, 5ana, 5aom, (5aqn), 5aqp, (5auc), 5aur, 5bw, 5cc, 5ce, 5co, 5in, 5jg, 5ka, 5lr, 5ls, 5mq, 5oq, 5ov 5ph, 5rg, 5va, (5vv), (6ajji), 6bjv, 6xg, 7df, 7sf, (7si), (7sl), 8alf, 8alo, 8aol, 8ayv, 8boy, (8bqy), (8bh), (8ces), (8cjb), 8cx (8ob), 8sf; Canadians (3ck), 3nj, 3ph.

By John H.-p. Andrews, Cor. Lake & Bellalan Aves., Govans Baltimore, Md.

*6afg, 6ahv, 6aib, 6aji, 6ajq, 6akw, 6ame, 6amo, 6bbq, 6bdv, 6bhz, 6bir, 6bmw, 6bra, 6cft, 6cge, 6cgo, 6chx, 6cka, 6ckf, 6clv, 6cmd, 6cmg, 6co, 6cqe, 6cuq, 6ja, 6no, 6nx, 6oi, 6qi, 6vc, -7adm, 7afo, 7df, 7fq, 7ho, 7ku, 7ls, 7nh, 7si, 7sq.

*Canadian 5bz; *English 2af, 2fu, 2jf, 2kz, 2lz, 2nb, 2nm, 2od, -6ar, 6nh; *French 8vaa; *Mexican 1b, 1n; *Spanish ear6, aht, ..., *bsad, *q2ck.

By LeRoy Johnson, 3AFW, Route 5, Allentown, Pa.

(1afy), (2clg), (2sm), (3btl), (3anr), 4fz, 5ql, 5adz, 6rn, 6cuq, 7afo, 7fg, (8dfk), (8cx), (9cvl).

Mex.—9ax1b—(qra?).
British—g-, 2fm, g2lc, g5qg, (qra?)
Italian—1lmt, (qra?), 1ico, (qra?)
French—f8sm.
Cuban—q2mk; German 2cu.

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

1xav, 1py, 1kc, 1rd, 1ow, 1cmx, 1bcr, 1bes, 1cc, 1cmp, 1pl, 2brb, 2ag, 2cqz, 2buy, 2rk, 2br, 2cbg, 2ad, 2by, 2al, 2axf, 2cwj, 2cpz, 2le, 3lr, 3chg, 3hs, 3adq, 3mf, 3bco, 3bfe, 3lw, 4ku, 4oa, 4fz, 4tj, 4sb, 4kf, 4jy, 5bg, 5ew, 5ox, 5ajt, 5zai, 5kc, 5uk, 5aaq, 5dw, 5zak, 5asz, 5vf, 5cv, 5aqw, 5atx, 5xai, 5adz, 5qy, 5lh, 5ls, 6pl, 6ajh, 6zh, 6aoc, 6cso, 6ase, 6nx, 6avb, 6afh, 6ahp, 6vw, 6agk, 6awt, 6cbb, 6csr, 6abx, 6cw, 6blw, 6chl, 6ajh, 6jp, 6avj, 6ea, 6yc, 6wp, 6csw, 6afg, 6cgw, 6cgo, 6bur, 6apw, 6ano, 6cmu, 6no, 6ne, 6ql, 6eb 6anb, 6adt, 6oi, 6lj, 6dao, 6ur, 6ab, 6ew, 6cgc, 6aao, 6caq, 6ut, 6bve, 6cp, 6cty, 6bgcb, 6bbq, 6ceq, 6ajj, 6aam, 6vq, 6cms, 7fd, 7ls, 7df, 7dc, 7uj, 7uq, 7gq, 7afo, 7zn, 7wq, 7wm, 7ald, 8cyi, 8bit, 8kc, 8czy, 8lr, 8doo, 8vq, 8do, 8gz, 9zt, 9bcj, 9cjc, 9cgn, 9sr, 9xbp, 9xax, 9dge, 9bku, 9cuv, 9bcy, 9alm, 9dmj, 9am, 9bm, 9cvo, 9akd, 9bxr, 9elb, 9bkr, 9dtk, 9dwx.

Canadian—5ef, 5ba, 5hc, 5gf.

Glad to answer cards.

(*Continued on page* 50)

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The Speaker *with seven superior features*

1. Permanent Magnet. Sensitivity and volume depend on a magnetic field maintained constant by a permanent magnet. The magnet in the Thompson Speaker is about four times as large as the magnets used in the ordinary "loud-speaker."

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3. Laminated Pole-pieces. More costly than solid pole-pieces, but they add to sensitivity and permit a wider range of sound-vibrations.

4. Driving Armature. Fixed at one end and fastened to the apex of the conical diaphragm at the other end. Movement at diaphragm twice that at pole-pieces, permitting reproduction of very loud sounds with a narrow air-gap, insuring *both* volume and sensitivity.

5. Conical Diaphragm. Effective area 50% greater than flat diaphragm of same diameter. Entire cone moves. Sound created for given movement 100% greater than for equal movement in a flat diaphragm. Result: Better tonal quality and greater volume.

6. Volume Regulator. In one turn around, varies air-gap from zero to maximum. Permits regulation for varying strength of near and far stations.

7. The Thompson Horn. Moulded composite horn delivers sound-waves from diaphragm without adding distorting waves of its own. Double bend gives effective horn-length of 27 inches, in an instrument which (including base) measures only 23 inches high over all.

R. E. THOMPSON MANUFACTURING CO., 30 Church St., New York

THOMPSON SPEAKER

Thompson Tone Stands Alone

Continued from page 48

By Keith Palmer, Nelson College, Nelson, New Zealand.

U. S.—1cmp, 11w, 1ow, 1xq, 3io, 3jo, 4oa, 5ox, 5se, 5ame, 5uk, 5zav, 5ail, 5go, 5ao, 5cn, 6adt, 6ahp, 6avr, 6awt, 6arb, 6ao, 6bcp, 6bug, 6bon, 6cgo, 6cgw, 6cgt, 6chd, 6cms, 6cnl, 6cgls, 6cto, 6chl, 6irb, 6gt, 6irb, 6lj, 6oi, 6ve, 6cso, 6cgz, 6rn, 6bkt, 6xi, 6cfs, 6ea, 7ij, 8zu, 9bji, 9eky, 9hm, 9ny, 9xe, 9zt, 9mm, 9cvt.
Mexican—16, 1k, bx.
Argentine—DA8.
English—2SK, 2NM.
Special—WGH, FL, (testing on about 80 m.) UFT (about 90 m.) NKF, 6xi (?).

By S. B. Trainer, Jr., 4 Shorncliffe Ave., Toronto, Canada.

All hrd between 6:00 A. M. es 6:00 P. M. 2's and 3's too numerous. Daylight only.
4gw, 4jr. 4mi, 4ry, 4tv, 4tw, 4ua, 4ux. 4vs, 5aeq, 5akz, 5ajn, 5atf, 5ath, 5ew, 5he, 5lr, 5uk, 6ahq, 6aib, 6aoc, 6bmo, 6bwd, 6iv, 6qg, 6rv, 7ec; 8's too numerous; 9aaj, 9ado, 9aeb, 9aeu, 9afe, 9agl, 9apz, 9aqu, 9ar, 9auc, 9azn, 9bfx, 9bhx, 9bnk, 9bta, 9bva, 9bwb, 9bwx, 9byi, 9bz, 9cgn, 9cpm, 9cws, 9cxt, 9cyi, 9czn, 9dau, 9dbz, 9dkr, 9dve, 9dwh, 9ek, 9ein, 9eiq, 9eji, 9elq, 9kb, 9mm, 9rw, 9sr, 9th, 9ts.
Canada—2au, 2ax, 2bq.
All enquiries acknowledged gladly.

By 1AKZ, A Hurnanen, 62 A St., Camden, Mass.

4bl, 4bw, 4dy, 4eq, 4fm, 4fz, 4jr, 4mb, 4mi, 4ry, 4sb, (4sh), 4tr, 4uc, 4uk, (4ux), (4vp), (4wj), (5aw), (5abn), 5ado, 5ajn, 5asf, 5asj, 5ath, (5aul), 5aux, (5co), 5di, 5ew, 5hi, 5in, 5jb, 5lh, (5lr), 5nk, 5oq, 5ph, (5ql), (5ty), 5up, 5vc, 5vf, 5vv, 5wt, 6amo, (6bbq), 6bcl, 6bgl, 6bis, 6bmw, 6bnr, 6bsn, 6bur, 6amf, 6caq, 6ccy, 6chs, 6cix, 6chx, 6cka, 6clv, 6cso, 6cto, 6ea, 6ew, 6fy, (6gt), 6rn, 6rw, 6wp, 7ald, 7df, 7gq, (7fq), 7ly, 7qn, (7uj), 7uz, 9acq, 9aen, (9afo), 9afr, 9aha, 9aio, 9aoo, 9aot, 9apm, 9aqu, 9ato, 9axh, 9bbj, 9bc, 9bcy, 9bdf, 9bjo, 9bjz, 9bqe, (9bme), (9bta), 9cea, 9chn, 9cpm, 9cxc, (9cxg), (9clg), 9dau, 9dcx, (9dqu), 9dkl, 9dlh, 9dlj, 9dlp, 9dms, 9dtl, 9dtt, 9dve, (9dwh), 9dzf, 9bwx, (9cvn), 9edf, 9eja, 9eji, 9eih, 9el, 9es, 9fj, (9hb), 9kb, 9mp, 9qd, (9rv).
Canadian—c4er, c5go.
Mexican—1b, 1k, 1n, 1aa, bx.
Cuba—q2lc, 2mk.
England—2bz, 2cc, 2dx, (2fm), 2nb, 2nm, 2kz, 2lz, 2od, 5ba, 5lb.
French—8ct, 8gn, 8sm, 8ssu.
Italy—(1co), 1mt.
Holland—NPC-1.
Spain—S6-EAR.

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

1ajo, 1alw, 1anx, 1awg, 1bv, 1cc, 1pl, 1rd, 1yd, 2aey, 2bq, 2bgi, 2cel, 2cnk, 2ku, 2rk, 2xq, (3ach), (3bau), 3bno, 3bss, 31w, 3oe, 3qt, 3sm, 1wn, 4ah, (4bl), 4dq, 4ig, 4iw, 4sx, 8aal, 8abs, 8afs, (8agp), 8bt, 8bch, 8btf, (8chk), 8cyi, 8dae, (8dal), 8dcb, (8jq), 8lr, (8pl), 8uf, 8ze.
Australia—2bk, (2ds), 2me, 2yg, 2yi.
Canada—3xi, 4eo, 5ct.
Mexico—1x.
New Zealand—(1ao), 4ia.

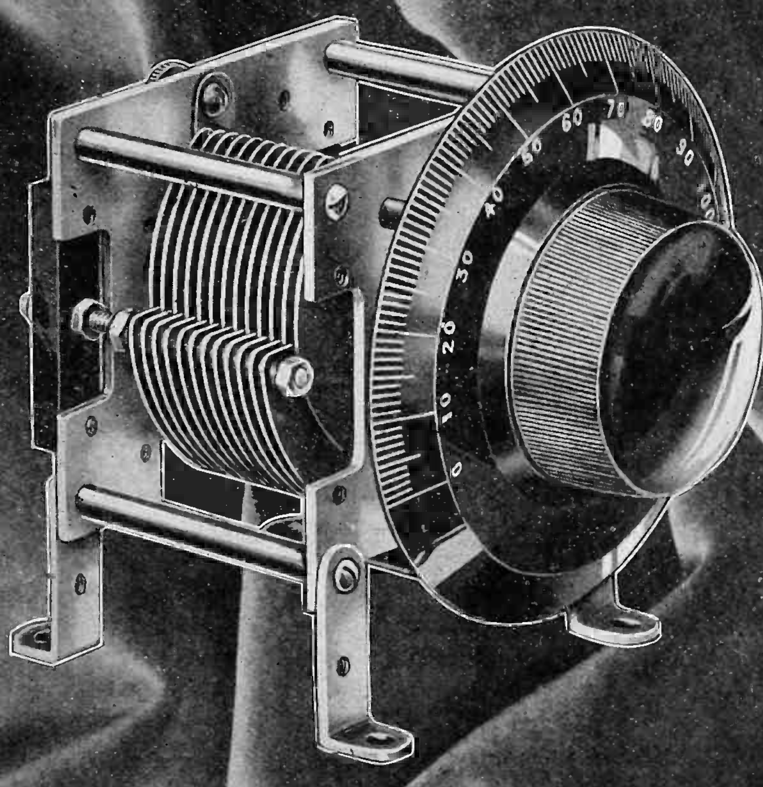
By Radio 1-BFL, D. K. Carroll, 26 Hurlbut St., Cambridge, Mass.

6aao, 6ab, 6abx, 6ac, 6adt, 6afg, 6age, 6ahp, 6aji, 6ajq, 6alv, 6alw, 6aol, 6apw, 6aqd, 6ase, 6awt, 6bbq, 6bhz, 6blw, 6bnr, 6bqb, 6buf, 6bui, 6bur, 6cgo, 6cgw, 6chl, 6chs, 6cmg, 6cor, 6cp, 6crr, 6crs, 6crx, 6cso, 6cto, 6ea, 6er, 6ew, 6ry, 6hp, 6ih, 6jy, 6mi, 6pl, 6rn, 6rv, 6ti, 6uf, 6ur, 6vc, 6xad, 6xi, 6zh, 7abb, 7afo, 7cy, 7df, 7fd, 7fq, 7gr, 7ku, 7lh, 7lq, 7lr, 7nx, 7qd, 7zn.

By 6QD, 437 W. 69th St., Los Angeles, Calif.

U. S. 1aa, 1af, 1cmp, 1pl, 1sf, 1alw, 2rk, 2alu, 2bgi, (2ag), 2tp, 2rm, 2czr, 2adu, 2aey, 3bss, 3bmt, 3oq, 3ni, 4bg, 4rm, 4eq, 4xe, 5qk, 5adz, 5ov, (5se), (5aic), (5aiu), (5atf), 5za, (5zai), 5ox, 5lr, 5ew, 5agn, 5an, 5hy, (7nd), (7mz), (7iu), (7us), (7vu), (7vq), (7kc), (7uj), (7uq), 8ces, 8jj, 8vq, 8ago, 8cvh, 8ded, 8sf, 8pl, 8jq, (8dan) 8gz, (8abs), 8xe, 8agv, 8eha, 9ato, 9ded, 9caa, 9clg, 9cld, (9bfd), 9dxy, (9caw), (9aks), 9bib, 9ny, (9adg), 9ado, (9btz), (9avv), (9cvf), (9bm), (9eak), 9dab, 9ev, 9bku, 9co, (9oa), 9amb, 9apy, (9csg), (9dlj), 9bhx, 9hp, 9cgn, 9cyd, 9bqj, 9bpb, 9dun, 9ob, 9zw, 9ek.
Canadian—3ni, 4hh, (5ba), 5ct, 5gf, 5an.
Mexican—bx, 1b, 1j, 1aa, 1a, 9a.
Foreign—smxa, vr, wiz.
New Zealand—2ac, 4aa, 4ak, 4ag.
Australia—3bq, 3bd.
Misc.—wgh, nkf, (ndx), nq6.

Continued on page 52



Continued from page 50

By 3FI, Chas. Hartman, 2857 N. Bally St., Philadelphia, Pa.

1's, 2's and 3's too numerous.

rfm, 4jr, 4si, 4gw, 4it, 4uk, 4ah, 4van, 4uc, 4nj, 4hw, 4rm, 4tn, 4oi, 4tw, 4fz, 4vg, 5aot, 5co, 5apm, 5ajm, 5aw, 5aeg, 5zas, 5aur, 5ac, 8dg, 8boy, 8ah, 8aal, 8dcb, 8dbm, 8bfl, 8czy, 8vg, 8bxp, 8dgl, 8aow, 8cbx, 8bzt, 8abs, 8cas, 8axn, 8bmt, 8ced, 8dan, 8pk, 8drj, 8ars, 8dnb, 8ajn, 8agp, 8bsb, (c8bj), 9elb, 9dbj, 9bph, 9eas, 9dwx, 9pb, 9bht, 9bff, 9bbj, 9aib, 9zw, 9dge, 9dpj, 9eld, 9bpb, 9eas, 9bby.

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

1cmp, 1bv, 1cc, 1rt, 1cpc, 1ajx, 1rd, 2le, 2bum, 2rk, 2by, 2kx, 2brb, 2cez, 2bm, 2ag, 2ana, 2cgj, 3lw, 3bif, 3aha, 3bco, 3bnu, 3hh, 3kz, 3oe, 3hj, 3ckg, 3bta, 3bms, 3sn, 4jy, 4tj, 4gw, 4io, 4uc, 4bk, 5qy, 5atx, 5lh, 5ls, 5uk, 5ads, 5ka, 5ajt, 5asb, 5acz, 5aic, 5aaz, 5lr, 5ox, 5aeq, 5zai, 5ahd, 5qg, 5ajj, 5ue, 5agn, 5aw, 5cv, 5amv, 5gj, 5rg, 6vc, 6cto, 6no, 6ur, 6asv, 6cty, 6chl, 6aam, 6aao, 6zh, 6cw, 6bve, 6cgo, 6cso, 6alv, 6cgw, 6fy, 6cej, 6lj, 6ckf, 6bni, 6ajh, 6adt, 6bmo, 6awt, 6bbq, 6bnr, 6ahp, 6cfs, 6bmw, 6cbb, 6bra, 6rn, 6aji, 6qi, 6cmu, 6bpf, 6bas, 6cex, 6rw, 6cek, 6bny, 6afg, 6eb, 6akw, 6cjj, 6cae, 6nx, 6crs, 6bdv, 6bad, 6dah, 6amf, 6sb, 6caq, 6bgl, 6add, 6oi, 6cef, 6akm, 6chs, 6alw, 6bjv, 6bur, 6amo, 6cqe, 6xg, 6ctc, 7uq, 7eb, 7acy, 7dj, 7nh, 7uj, 7df, 7ku, 7ls, 7afo, 7fq, 7zz, 7hi, 7se, 7gb, 7eo, 7sy, 7gj, 7acm, 7dd, 7gq, 8wa, 8uk, 8dgp, 8t, 8aly, 8bk, 8vq, 8bf, 8vt, 8xbi, 8axg, 8bfe, 8aul, 8jj, 8xe, 8xaf, 8bcp, 8avd, 8ago, 8bch, 8abs, 8doo, 8dal, 8czy, 9ev, 9zt, 9aim, 9bjl, 9xi, 9bpb, 9dmj, 9biz, 9na, 9on, 9and, 9beu, 9dwx, 9dtk, 9dps, 9bfx, 9axq, 9elb, 9dmi, 9dhq, 9dge, 9amb, 9bkr, 9dqu, 9es, 9bnk, 9co, 9hp, 9ded, 9cxc, 9ee, 9bdf, 9cgn, 9auw, 9abo.

Canadian—4io, 5an, 5ba, 5ct, 5qf, 5rs.
Chile—9tc.
Spanish—EAR2.
English—2sz.
Special—WGH, NKF, NFV, GNQ, KGI, KET, 6XO, XYZ, POX.

By 9APY, 3337 Oak Parke Ave., Berwyn, Illinois.

(1aqi), 1avl, 1bri, 1cak, (2aok), 2bkr, 2buy, 2chg, (2cxw), 2xaf, 3ach, 3gg, 3hj, (3qi), 3rs, (3tp), (3wx), 4cs, 4ez, 4ll, (4mi), 4rm, 4si, (5agq), 5aih, 5ail, 5aph, 5api, 5asd, 5ask, 5ck, 5er, 5gj, 5gk, 5gq, 5hi, 5jf, 5qz, 5uk, 5ux, 5vv, 6bny, 7afo, 7si, 7vu, (8aad), (8apy), 8aul, 8ccn, (8cdu), (8ckm), (8cuk), (8cx), 8dnb, 8wp, 8za.

Miscellaneous—KEL, NERK-1, NKF, WGH.

By 8CTQ, 103 Sturgis St., Jamestown, N. Y.

C. W.: 4bk, 4bq, 4ch, 4db, 4du, 4dv, 4eb, 4eg, 4eq, 4ft, 4fv, 4fz, 4it, 4jk, 4jr, 4ku, 4mb, 4my, 4nj, 4oa, 4pd, 4rm, 4sh, 4si, 4tj, 4tn, 4tw, 4tv, 4uk, 4ux, 4wk, 4wv, 5aai, 5abd, 5abs, 5ac, 5acf, 5acl, 5acz, 5adn, 5ads, 5adz, 5aeq, 5afb, 5agj, 5agq, 5ak, 5akw, 5akz, 5alu, 5ame, 5amk, 5aoa, 5aph, 5aqn, 5apt, 5apu, 5aqp, 5arj, 5ash, 5asz, 5ath, 5atf, 5atp, 5ce, 5ck, 5cn, 5co, 5jh, 5ju, 5lh, 5lr, 5ls, 5nj, 5oq, 5ov, 5po, 5qf, 5qs, 5qx, 5rg, 5sd, 5uk, 5uv, 5vc, 5wo, 5wr, 5xa, 5xau, 5xh, 5zf, 6afh, 6ahq, 6aji, 6akq, 6baw, 6bjx, 6bmo, 6bnf, 6bsn, 6bur, 6cae, 6cc, 6chx, 6cjj, 6cmg, 6cnc, 6csl, 6csr, 6cva, 6ew, 6gr, 6qi, 6rn, 6wp, 6wt, 6xo, 6yb, 6bbh, 7afo, 7fq, 7gq, 7mf, 7nh, 7nt, 7rl, 7si, 7zn, Too many 8's, 9's, 1's, 2's es 3's.

Canadian—1am, 2bg, too mani 3's, 4ah, 4ch, 4eo, 5bz.
Mexican—1aa, 1n, 1af, 1b.
Cuban—2lc, 2mk.
Bermuda—BER.
England—2nm, 2cc, 2sz.
France—8ab.
Wl ans all crds.

By 6BJX, E. O. Knoch, 2823 East Sixth St., Los Angeles, Calif.

1af, 1asy, 1atj, (1cu), 1xam, 5xav, 1xv, (2acs), 2adk, 2bgi, 2bqc, 2br, 2cgj, 2cmm, 2cnk, 2kf, 2kx, 2rk, 2wc, 2xbf, (3alx), 3apv, (3auv), 3bjp, 3bta, 3cjn, 3np, 3zo, 4fg, 4gw, 4jy, (4si), (6asr); Hawaii 8alf, 8apw, 8ase, 8ced, (8dcd), 8dif, 8gz, 8ln, (8pl), 8uk, 8ze, a2bk, a3bd, a5bg, c3acu, c4ao, c4io, c5af, c5ba, (c5bz), c5hp, c5hs, c9al, j1aa, (z2ac), z4ag, hva, (Indo China). All reports on my 2 German 30 watters appreciated and promptly acknowledged.

NEWS OF THE AMATEUR OPERATORS

Call 8EX has been reassigned to H. J. Bannon. 486 E. 108th St., Cleveland, Ohio.

J. C. Lisk, 902 S. Elizabeth St., Lima, Ohio, has resumed work on 166 meters, call 8EQ.

8AOA has been reassigned to Ernest Dempster, 977 St., John's Ave., Lima, Ohio. Waves 75-85 meters.

The Wonder *of* Radio!

Crosley owns and operates station WLW, Cincinnati, the first remotely controlled super-power broadcasting station

One tube set

2-Tube Crosley 51

Same as wonderful Crosley 50 with additional tube amplifier. Local and nearby stations on loud-speaker always and distance up to 1500 miles under average conditions. Much greater range with head phones.

Special Sloping Front 2-Tube Crosley 51

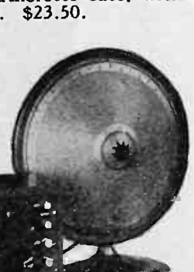
Same as Model 51, with cabinet holding all dry A and B batteries. $23.50.

2-Tube Crosley 51 Portable

The Crosley 51 in a black leatherette case, with nickel trimmings. Space for batteries. $23.50.

Crosley Musicone

A marvelous new development of loud-speaking principles. Diffusion of sound creates perfect reproduction of *all* tones. $17.50.



3-Tube Crosley 52

A larger set for those who want greater reception range on the loud-speaker. Operates on three tubes, using wet or dry batteries. Consistent loud-speaker range 1500 miles or more.

Special Sloping Front 3-Tube Crosley 52

Cabinet contains dry A and B batteries. Same efficient detection and reception as regular 52. $35.

3-Tube Crosley 52 Portable

Same as other 52 models, but in a black leatherette case. Easily carried. All batteries inside. $35.

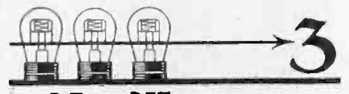
Prices quoted above do not include accessories. Add 10 per cent West of Rocky Mountains.

Crosley, the world's largest manufacturer of radio receiving sets, offers radio's wonder—the Crosley Model 50, one-tube genuine Armstrong regenerative receiver at $14.50. With tube, phones, batteries, antenna wire complete, less than $25.

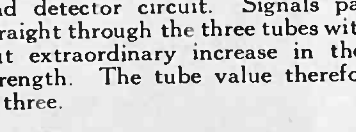
This momentous announcement means that every home in America can at last have the enjoyment and entertainment of high class radio—*the thrill of long distance reception* as well as local—on the basis of real economy.

This Crosley 50 is the latest refinement and perfection of the set which brought MacMillan's North Pole messages in to Leonard Weeks, at Minot, N. D., when all others failed though they cost ten times as much.

This is the set which gets the stations from coast to coast; which gives you more for your money by far, because it is the genuine Armstrong circuit, built by Crosley.



This little diagram shows three tubes using the ordinary radio frequency and detector circuit. Signals pass straight through the three tubes without extraordinary increase in their strength. The tube value therefore is three.



But Crosley's Armstrong regenerative set, with one tube, passes the signals several times through the single tube, each time increasing their strength and giving you much more than the three-tube ordinary circuit, or a tube value of 3+.

That is why the Crosley one-tube set is so much more satisfactory and efficient.

Already, with this perfected Crosley 50, Andie Edmondson, at Stella, Mo., heard 2BD, Aberdeen, Scotland; Paul J. Hall, at Osceola, Neb., heard 2LO, London, England; Eugene Barnhouse, at Brookfield, Mo., hears Winnipeg and Montreal, Can., and Springfield, Mass.; James Gordon, at Fremont, Neb., hears them from coast to coast, from Canada to Texas, even picking up 10-watt KFNG at Coldwater, Miss., and 100-watt WFBL, at Syracuse, N. Y.; Mrs. J. E. Martin, at East Palestine, Ohio, hears KGO, Oakland, Calif.; O. W. Bryant, at Sunset, Tex., gets Hollywood, Calif., 1425 miles; Crosley Station WLW, Cincinnati, 1094 miles; Pittsburgh, Pa., 1361 miles.

Get your Crosley 50 now and learn that fine radio is not costly and difficult, but low-priced, simple, easy and reliable. A Crosley dealer is near by.

Crosley manufactures receiving sets which are licensed under Armstrong U. S. Patent No. 1,113,149, and priced from $14.50 to $65, without accessories.

The Crosley Radio Corporation
Powel Crosley, Jr., President
619 Sassafras Street, Cincinnati

"TINKERIN' POTTS"

Continued from page 23

the bigger stakes, overlooking the surer profits of daily work. It is ever so, in boom towns, built on the froth of hope.

With nothing more than a kit of tools and a willingness to do odd jobs, Tinkerin' Potts stepped into his own, almost overnight. Gila Grande in the space of one short week, began to call on him for everything. He set bones, fixed clocks, ground valves, repaired windows and pulled teeth. When Hamburg Harry walked in his sleep, they called out Tinkerin' Potts to wake him scientifically. When Wild Nellie unlimbered her .45 Colt on Martin's palace, it was Potts who calmed her down until the marshal could be found.

It was but natural that the personal capital of Tinkerin' Potts, which amounted to $1.35 when he arrived, should grow in proportion. Money is spent easily in an oil town and Potts found folks willing to pay for the things he could do. He had been in Gila Grande only one short month when he opened an account at the Citizen's bank and laid two hundred dollars on the counter.

"Might tuck that away in a safe place," he said mildly. "I might be needin' it some day when I get old."

They treated him with the respect due a depositor and Tinkerin' went back to his jobbery with a feeling that he was becoming an important factor in a town, whose name was already in the big league news back east. And thus it was that he came under the attention of the Warto gang—the meanest, wickedest, most ornery outfit of hold-up men and cut-throats that ever picked on an oil town for a grand coup.

Bud Warto noticed him first and mentioned the fact to his trusty lieutenant, Scarface Warren.

"You know, Scar, this here bird Tinkerin' Potts picks up a lot of dinero in a day," he said, as they dallied over their mulligan in their shack on the outskirts of Gila Grande. "I'll bet he knocks down fifty maybe a hundred bucks a day."

Scarface grunted.

"Well, let's take it away from him," he said with characteristic directness.

Bud shook his head.

"I got a better scheme," he said.

He lowered his voice and for the better part of half an hour expounded what lay nearest to his heart. At the conclusion Scarface Warren tilted back in his chair and beamed his admiration.

"I gotta hand it to yuh, Bud," he said. "Yuh got brains."

"Oh, I gotta few," said Bud modestly, wholly pleased with himself, and let it go at that.

In such manner did Tinkerin' Potts join the Warto gang, although he himself was totally unaware of it—at that time. He went about his business as usual, making his daily deposit in the bank when business was good, and every other day when it was fair. With Potts, it was never bad.

Came a day when the president of the Citizen's bank, Homer Harrowby, called Tinkerin' Potts into his private office, broached a box of cigars and made him a proposition. It was a proposition that would have brought Potts summary and unanimous death at the hands of the Warto gang had they known about it. It was nothing less than a plan to equip the Citizen's bank with the latest modern burglar alarm system.

"We have quite a good deal of money lying around here," said Harrowby nervously, "and we feel that something ought to be done to protect it. My idea would be a signal system with a gong that would arouse the entire town—a gong on the outside of the bank, if you get my meaning. Now, the idea is this: Do you suppose you could fix up something like this—say, for adequate compensation?"

Tinkerin' Potts thought he could. There was a mail order house in Los Angeles. He rode thirty miles to Benton and sent a wire. Two days later he had all the information he wanted and the job was his. But a slip of paper which accompanied the few materials he ordered from Los Angeles changed the whole fortune and existence of Tinkerin' Potts. The slip was merely an ad for certain radio apparatus which that firm was selling.

"Hear Chicago on five tubes!" read the ad, with a lot of data designed to convert the most sceptical.

It was Greek to Tinkerin' Potts when he started. But every darned fool is persistent, and about the time Potts had the bank's burglar alarm all wired he became a radio fan. The night Gila Grande celebrated the completion of its first burglar-bandit protective system, Tinkerin' Potts, the man of the hour, was in the back room of his shack trying to master the intricacies of radio-frequency and oscillation as applied to a radio set in a mahogany kimona.

Only Scarface Warren gave Tinkerin' Potts his due on the night of that celebration. The rest of the town overlooked the man that had worked the miracle in honoring the genius who had financed it. Life again—to the core! But Scarface did not overlook him. He burst into the gang's shack on Devil's gulch and confronted Bud Warto in berserk fury.

"Yuh know what that ring-tailed wampus has done now?" he demanded. "He's gone and put a burglar alarm on the bank!"

Bud Warto's feet hit the floor with a bang.

"He's what?"

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Second Annual Co-operative

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August 22-28 --- San Francisco

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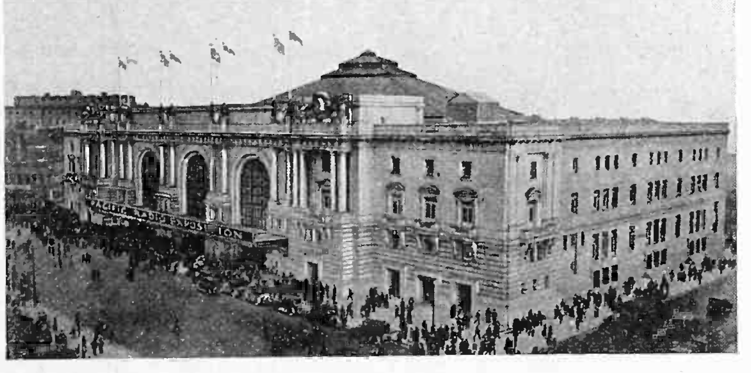

ENTIRE Main Floor Used—80% of Exhibit Space Sold on May 1st

An Exposition of radio merchandise by national manufacturers direct, and of their agents and distributors for the Pacific Coast and Rocky Mountain territory. New designs, new lines, new ideas and new methods—see them at this Exposition and convention. Meet the representatives of factories. Contact with retail dealers of radio merchandise who attend this Exposition from ten surrounding states. Get a definite, broader and necessary picture of the future trend of radio that will be of great value in formulating plans for contact in the west with this rapidly changing business.

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Write for program. Open trade hours, 10 a. m. to 2 p. m. Six days.

The Public!
Open seven days, 2:30 to 11 p. m. Wonderful entertainment.

Manufacturers!
Wire for space application blanks. Profit sharing.

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Heckert L. Parker
Association Mgr.

PACIFIC RADIO TRADE ASSOCIATION

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power which was an unknown factor in Gila Grande, the Warto gang gambled, drank and perfected its plans, under the able leadership of Bud Warto, for its famous cleanup of October 29th—the day the Ladybird well was sold and the money placed in the Citizens' bank.

Bud Warto had been waiting for just that event. When Jake Simpson, the bus driver, tipped off Scarface Warren that Lorimer Wheeler's personal representative was in town to close up the Ladybird, Bud came out of his four months' lethargy and formulated his plans so rapidly that he made his gang dizzy.

"There's a million bucks in that deal," he told his gun-toting thugs. "I reckon a lot of it will be in cash. That guy mustn't get out of town. But the money goes. We grab it, hand it over to Tinkerin' Potts and lay low. There'll be hell poppin' but they'll never find nothin' on us. Potts turns it over to Lamb Mason down in Mesa Perdido and Lamb parks it safe for us in a cache until we get a chance to drift."

Scarface Warren was in on Tinkerin's part. But some of the others were not. There was a growl of dissent.

"Yore plumb loco, Bud," said one. "Yuh ain't figgerin' on handin' that much cash to no ijit like Tinkerin' Potts, are yuh?"

Bud Warto grinned.

"Just that," he said. "We calls Tinkerin' out of town early in the morning. He goes in his little lizzie. In the back is the cash. Tinkerin' won't know it, because we plants it on him. When he gets down to Mesa, Lamb Mason lifts it offen him. If he gets caught leavin' town—he'll have the cash—not us. Anyway yuh figger it, we're safe. To make it safer, I'm figgerin' on ridin' in the posse that starts out after we nick the bank. Get me?"

They did and said so openly with much complimentary profanity. So went the plot—flying in the face of the old adage about the plans of mice and men. And Tinkerin' Potts, the most important member of the gang, on whose shoulders rested the responsibility of the risky getaway, slumbered in calm innocence and ignorance. He would have been stunned at the part he was scheduled to play in the robbery of the Citizens' bank of Gila Grande had it been told to him.

It took two days to close the Ladybird deal. Papers had to be drawn because Lorimer's representative wanted everything shipshape—titles clear and all that. He reached Gila Grande on Tuesday. Scarface wanted to grab the money he carried that day, but as Bud Warto explained, when he struck he wanted not

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only the purchase price of the Ladybird but everything else in the vaults.

Tuesday night, Wednesday morning and afternoon, with Bud Warto on the watch and the gang strolling through the town, negligently indifferent on the outside, dangerously alert underneath. And then about three o'clock the oil men came out of the Union hotel. Harrowby, the banker, was with them, and there was a stranger with a little leather grip. They were all smoking black cigars and Harrowby was leading the way. They followed him, a little group of five or six, several of whom Bud recognized.

With his hat pulled over his eyes, he watched them go into the bank and a slow smile spread over his face. The deal had gone through. The Ladybird was sold. There was no train from Benton until 9 o'clock the next morning. The Lorimer man would have to lay over until then. The money would be in the vaults. Tonight was the night!

He whistled softly as he cinched the saddle on his rangy roan and flecked a glance at the distant hills. A few scattered clouds were whipping in from the distant buttes. Wise in the weather signs of that locality he knew that a thunder storm was brewing. All the better. With thunder . . .

The news of the sale of the Ladybird rippled over Gila Grande like wildfire. Men gathered in back rooms to talk it over, to drink, to reminisce over other similar deals. There was a tendency to celebrate, for they knew the fame of it would go abroad into far places. Harrowby, the banker, with the Lorimer man for his guest that night, closed the bank, tested his new burglar alarm, snapped the control switch and shut the front door.

"There's more money in that bank tonight than it has ever held in its history," he said proudly to the Lorimer man. "Ordinarily I'd be a bit worried. But we've got the bank electrically protected." He jerked a thumb to the shiny brass gong over the door. "Can't touch a thing until I unlock in the morning without awakening the town. And let me tell you this is a pretty bad town to awake—a regular hornet's nest."

The Lorimer man shrugged. His part of it was over. It was of not the slightest interest to him whether anybody robbed the bank or not. He had the proper papers in his pocket all signed. The money was Harrowby's worry.

Nine o'clock in an oil town, where men work like dogs during the day hours, finds everyone in bed. Gila Grande was no exception. With the sun's drop, a nipping wind bit down from the buttes, and everybody turned in early. All but Tinkerin' Potts. He sniffed the air, brought in an armful of grease-wood, and prepared for an intriguing session with his radio. Distant rumbles in the hills told him the air would shortly be wet with a butte storm, which meant good distance work.

He was in the act of locking his door when a non-descript Mexican, of which there were a number in Gila Grande, trotted up to his door.

"eno-oches n'yor Tin'kreen," he greeted and handed over a dirty note.

Tinkerin' Potts carried it into the light. It was from Old Man Peebles down at Calway, a mining spur, ten miles beyond Benson and asked him to come in the morning and see what he could do toward repairing Peebles automobile.

"You come cabaiyo?" asked Potts.

"Si—tonight, senor. Meestair Peebles is mos' hurry to 'av feex—sure."

Tinkerin' Potts considered. Old Man Peebles was good pay. There ought to be at least twenty dollars in that trip of fifty miles over desert country. Deducting time and gasoline . . .

"Bueno!" he said to the Mexican. "I come—manana — early — cinco horas—five o'clock!"

The Mexican nodded, flashed a row of teeth, and swung down the path. Potts standing in his doorway heard the drum of his horse's feet. He sighed. If it rained, it would be a nasty trip. Oh, well—twenty dollars was twenty dollars! He turned back to his room, and locked the door.

By 9:30 o'clock his candle was the only light left alive in the little desert metropolis. An hour later the thunderstorm struck with a roar that resounded in the canyons like the bowels of hell broadcast through a giant cavern. And under cover of the downpour and the thunderous discharge of lightning along the butte, Bud Warto and his gang blew the vaults of the Citizens' bank and looted them of more than a quarter of a million dollars in gold, banknotes and negotiable securities.

As Bud Warto predicted, it was childishly simple. Snake Wilson blew the vault and Bud himself, standing in his stirrups, cut the wire to the brass gong of the burglar alarm with a pair of lineman's pliers. Snake puttied up the crack in the vault door, poured in his "soup", muffled the fall of the great steel front with a pile of rugs ripped from the floor of Harrowby's office and touched it off.

Harrowby himself heard the blast that ruined his institution, as did his wife.

"That thunder is sure playing hob tonight," he said sleepily. "I'd hate to be on one of those sheep ranches up in the hills."

"M-m-m," murmured Mrs. Harrowby, who had been raised in New England and did not think much of Western thunder.

In fact, most of the town heard the blast, rolled over on its collective side, and went to sleep again, with the din of downpouring rain in its ears. All but one. That one was Tinkerin' Potts, sitting alert and watchful in his little shack on the edge of town.

Listening to the chatter of a score of amateur stations, he was struggling with the static that always accompanies those mountain storms. With every blast of thunder, came a crack in his radio set. Tinkerin' Potts being Tinkerin' Potts had noticed something peculiar about those discharges, viz., that within a few seconds after the sharp hiss in his receivers would come a thunder clap.

Sound, he knew, travelled at so many feet per second. It was a simple matter to work the thing out. The hiss was the lightning discharge and registered instantly. A few seconds later came the thunder clap, audible outside his receivers. And so, having nothing else to do, he figured out the distance that the storm was from him. That is, he did up to a certain point.

There had been no hiss for a few seconds. Suddenly came a terrific reverberation—a dull roar that rattled his shack. It suddenly struck him there had been no accompanying hiss in the receivers. With the headband tightly clamped over his ears, he was aware of a new quality in that jar that was different from the thunder claps. It was a vibration, a shock. His pale colorless eyes squinted thoughtfully.

"By gory," he muttered. "That jarred like an explosion." Suddenly a thought struck him.

He jumped to the door, threw it open and peered down into the town. The lightning blared for an instant on the hills and it seemed to him that he saw a group of figures down near the bank. The bank!

Unarmed and hatless he started to run through the rain toward the spot. In the dark he stumbled and fell, but he kept on. Just at the edge of the main street, he heard the drum of horses' feet and huddled back in the dark. There was a brilliant flare as the lightning flamed along the butte and in its light he made out three figures he knew—Bud Warto, Scarface Warren and a man known as Wilson. They were riding like mad, out toward the Llano Estuvado—a rough, inaccessible portion of Oaju valley.

Tinkerin' Potts dashed over to the bank. The door was ajar. He peered in. The acrid smell of explosive reached his nostrils. He peered up at the silent gong, and in a second it all dove-tailed together—the jar, the dark, the milling figures, the open door and the silent bell. The bank had been robbed by Bud Warto's gang.

The marshal, Ed Waters, lived at the Union Hotel. Five minutes later he was being shaken out of a sound sleep by a mud-caked mad-man, Tinkerin' Potts, who yelled maudlin things in his

Continued on page 62

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ear. After a bit what Potts was saying penetrated and he began to climb into his clothes. He would have questioned Potts further, but the latter had gone again into the night on some errand of his own.

Tinkerin' ran back up the hill to his house, an idea burning in his brain. In front of his radio set, he put it into effect. He broke the ground lead and from some of the bits of brass and other junk, he rigged out a crude key. Then he turned up the tubes of his set until they oscillated, and out into the storm through the night for whatever distance it would carry, he broadcasted a call for help.

"CQ! CQ! CQ!" he called with the steady true hand of a trained operator—bridging with his skill, the crudeness of his makeshift key. "Pls answr emergncy SOS help!" he sent in tiny whistling waves that sped in widening circles to all points of the compass—not strong, but carrying astonishingly to unexpected distances.

Crosby, eighty miles away, was the county seat. There were a number of amateurs there—members of the American Radio Relay League, handling traffic across the mountains east and west. Into the ears of one of them—5QQMG—came this strange aggregation of letters in a steady drone. He was an expert operator and he recognized a quality in the transmission that told of professional sending accomplished under difficulties.

"I—I," he answered. "Your signals CSA. Who? Who?"

Tinkerin' Potts could have wept at that reply. Instead he again turned up his lamps, and as steadily as he could, spelled out the story of the crime at Gila Grande with his piece of a key, and his straining set.

"Usng rec set to trans," he sent. "Pls notify sheriff bank gila grande robbed gang headed toward lawson bud warto leader hurry potts."

It was the train operator's fist showing through the sending that did it. The operator at 5QQMG would have thought it a joke of some kind but for that. But he recognized the steady touch of a man who knew his key and as he acknowledged the faint and hardly readable message he reached for his fone.

SHERIFF Martin Reale did not know Tinkerin' Potts either by name or reputation. But he knew the bank at Gila Grande, and there was a picture of Bud Warto over his desk on a police circular. Warto had several names on that circular—one of them a cognomen under which he was known all over the state—Two-Gun Ike, the bandit. And that name, coupled with the message by radio, brought back unpleasant memories to the sheriff's mind.

Three months before, he himself had fallen a victim to the radio craze. The day he put a radio set in his office, with which to alleviate some of the dullness of official life, was the day Two-Gun Ike picked for a raid on the Blanco Verde pay-roll, and not only that—Two-Gun had left his trail directly through the town of Crosby.

"When I come through the town," Two-Gun told a crony, "Grandma Reale was settin' in his front window listenin' to a radio concert. He's a hell of a sheriff, he is—a riproarin' go-gettin' piute on wheels."

The deadly insult had fed back to the sheriff together with Two-Gun's remarks, and over the months had rankled. Hence it was, when Tinkerin' Potts' message was given him from Gila Grande he rode out at 2 o'clock in the morning with a posse in a fast machine for Lawson, the converging point of two county roads, to intercept the toughest gang in the state. He'd show Two-Gun Ike, alias Bud Warto, what kind of a "rip-roarin' piute" he was!

There were probably fifty persons awake when Bud Warto and his gang trotted down the main street of Lawson and dismounted in front of Cyclone Bill's soft drink emporium in the early dawn.

"We'll git a drink and some hot chow and wait for the day's news," remarked Bud with a wink at Scarface as he slid stiffly from his horse. The six trooped into the place through the swinging doors. There, lined up against the bar, over which nothing but soda water was supposed to pass, was Sheriff Martin Reale and his deputies, comprising the county's crack shot-gun squad.

Right there Bud Warto knew something had gone wrong with his calculations.

"Stick 'em up, Bud, and keep 'm there!" said the sheriff coldly.

With six cocked shotguns covering him and his men there was nothing else to do, and Bud submitted with what grace he could.

"Whatcha think we been doin' now?" he demanded with some truculence.

Sheriff Martin never batted an eye.

"We're aimin' to ride back to Gila Grande and find out—after we shake yuh down!" remarked the sheriff, and proceeded to search them for the loot from the Citizen's bank.

They went back to Gila Grande in machines, with deputies beside them—back to a town seething with excitement, milling in the streets, and threatening all manner of things to the gang that had looted the Citizens' bank of all it possessed. Sheriff Martin halted his cavalcade on the outskirts.

"I'll go on ahead and see what's doing," he said to his chief deputy. "Don't dare take these boys down there from the looks of things. They'd git hung before we could git things straightened out."

He drove on alone,—and found Harrowby, a frenzied being, the center of recrimination and excitement, almost mad with fear and worry. It was almost an hour before the sheriff brought order out of chaos—got men to listen to his questions and talk sanely of what had happened, got even a chance to see the shattered safe. And then—he met Tinkerin' Potts and heard from him how his aid had been enlisted.

The sheriff was a politician and a good campaigner. When he had it all in hand, he jumped up on a box and made a speech—his hand on the shoulder of Tinkerin' Potts. He told of the midnight call for help and how it had reached him after Potts had recognized Bud Warto and raced for his shack and his radio set. In the middle of it, a little Mexican crowded forward, chattering, gesticulating.

The sheriff halted and the Mexican poured a torrent of Mexican-Spanish into his ear—telling all he knew because he thought Tinkerin' Potts was about to be hung.

"Where?" snapped the sheriff suddenly.

The little Mexican pointed and began to jump up and down.

"Come on—all of you!" shouted the sheriff.

Led by the little Mexican the entire town followed the sheriff, who still clutched Tinkerin' Potts by the arm, up the hill to Potts' shack and around to the rear. There the Mexican lifted the lid of the tool-trunk that Potts always carried on his flivver and brought out—the loot from the Citizens' bank.

There was a gasp of amazement from Potts and a growl of menace from the crowd. The sheriff waved them back.

"Boys," he said. "The thing is as plain as day. The Mex came up here last night and gave Potts a phony note to take him out of town—sent here by Warto. The stolen money was cached in his machine—the one safe place in town. Potts was to have been stuck up by Lamb Mason on his way to Old Man Peebles and the money taken. This was to give the gang a chance to make a clean get-away with no trace of the loot if they were caught. Mason was to connect with 'em later and turn over the money when it was safe."

He paused as a gasp of wonderment went up from the crowd.

"Boys," he said, "I got a nice little surprise for you. I got Warto and his whole gang. Thanks to Tinkerin' Potts we've got the whole works—gang, money and everything. If ever a hombre deserved the thanks of the community for pullin' off a brainy stunt—here's the maverick!" And he slapped Tinkerin' Potts, the man-of-all-work, a resounding whack on the back.

They carried him back to town on their backs, did Gila Grande, and Sheriff

Reale hurried back to the waiting calvacade, lest some exuberant enthusiast discover what was parked on the hillside and organize a necktie party in which Gila Grande would have unanimously participated.

This is about all there is to the story of Tinkerin' Potts. After he had collected the rewards paid by the state and county for Bud Wardo's capture, and accepted the donation of the Citizens' bank, and the emoluments of the Bankers' Association, and the private purse made up by the populace, and the check which the Lorimer interests sent him, he built the finest house in town and took life easy.

REGENAFORMING

Continued from page 18

ground one end of the untuned primary but do not connect the ground to either side of the filament battery or to the grid return of the first r. f. tube. With ordinary antennas and under ordinary conditions, the regenaformer gives perfect satisfaction as to selectivity. As is generally known, the more selective the receiver becomes, the less space on the dial is allotted to a given station, and tuning is made slightly more difficult. Too great selectivity may not be desirable.

The neutralizing condenser should be slightly larger than some of those used with the regular Neutrodyne sets; several manufacturers are selling one adapted to the regenaformer especially. This condenser should be mounted near the r. f. tube socket and behind it, with stator plates connected to the grid of the r. f. tube, and rotor to a tap taken off the regenaformer coil at about 17¼ turns from the filament end of the secondary winding. With home-built made-over sets there may arise some difficulty in neutralizing, owing to difference in the constants of the circuit. It is suggested that trial be made of the rotor lead of the condenser to the filament end of the secondary of the regenaformer (coupler) secondary, also to the grid end of the secondary, as well as to a tap taken about 17 or 18 turns from the filament end. The neutralizing condenser should make up for slight differences in the location of the tap, where different size of wire is used.

With UV-199 and similar tubes in the r. f. socket, neutralizing seems to be easy or entirely unnecessary. With tubes like UV-201-A in the r. f. socket, neutralizing may be a nuisance. Probably the UV-201-A gives greater volume both as r. f. amplifier and as detector than the UV-199. It is certain that a marked increase in volume over the 199 is had by use of 201-A in audio amplification. But even with UV-199's throughout and a short antenna, this circuit should give loud-speaker volume on distant stations with two stages of audio, and on locals with one stage of audio. This means the "you can hear it down stairs" kind of loud-speaker volume and not the "put your head in the horn" type.

A by-pass condenser will probably be found necessary across the primary of the audio transformer and across the *B* battery as well. With some audio transformers, .0005 mfd. will be found right but others may require .002 mfd. The use of one of the new type approximately 2-1 ratio audio transformers in the first stage audio, with some other high grade transformer in the second stage, is suggested. A filament control jack in the last stage is a great convenience and either this or a rheostat should be provided to turn out the filament of the second audio when listening in on one stage of audio. Some transformers produce a howl in the phones when the second audio is not in operation but the tube is lighted. Fixed ballast resistances which vary the resistance to suit the tube automatically, such as the Brach, or Amperite, of type to suit particular tube, are convenient instead of variable rheostats but tests of the voltage delivered at the tube sockets should be made to be sure the ballast resistances are working properly.

Neutralizing may generally be accomplished as follows: With rotor of coupler set at right angles to stator:

1. Tune in a loud station, preferably one at a low wavelength .
2. Remove r. f. (left hand) tube and insert a bit of paper under one filament tube prong.
3. Insert the tube back in socket.
4. Move neutralizing condenser knob until the signal is as faint as possible.
5. Remove paper from under r. f. tube prong and operate set. If touching the grid of the r. f. tube makes a clicking or thudding sound in the phones, try a slight change of the setting of the neutralizing condenser. A very little oscillation in the r. f. tube will make a distorted signal.

To summarize, the regenaformer hook-up without the exact parts specified for the receiver by its originators may be used to excellent advantage in construction of a stage of neutralized tuned r. f. with regenerative detector. The main essentials are that the coils used cover the ordinary radiocast wavelengths when tuned by the usual variable condensers, and that the coils be mounted as directed in Fig. 1.

Note the data of Fig. 1 give spacing of the coil centers at about 8 in. The usual method of mounting coils on rear of condensers may be followed or the coils mounted to a baseboard, but care should be taken to have the axes of the coils at right angles to each other.

RAIDING THE RUM RUNNERS

(*Continued from page* 13)

inputs, which are not likely to be exceeded in actual practice. The disadvantage of the grid leak type of detector, however, is that the output level assured is much lower than that obtained from the negative grid bias type of detector. The use of one stage of audio-frequency amplification brings the output level up to the requirement for the operation of head telephones. That is to say, this kind of detector and the audio-frequency amplifying unit constitute a couplet which operates satisfactorily since the relative output levels are such that overloading occurs at the same point in both the detector and amplifying vacuum tube. As means of boosting detector efficiency, a by-pass condenser of .001 of a microfarad capacity was provided, this operating to keep the output circuit of low impedance to the carrier frequency.

The intermediate-frequency oscillator is of the tuned grid inductively coupled type. It may be switched on and off by manipulating a key in the plate supply. Maximum efficiency was not sought in designing this oscillator, since this objective is not desirable because it functions at the frequency of the amplifying unit. Great output from this oscillator was not the end to be achieved, rather the problem was to reduce the coupling extending from this oscillator to the detector to a value that would avoid overloading the detector tube. A by-pass condenser served to reduce the input to the second detector tube from the intermediate frequency oscillator to five-tenths of a volt at the grid of the second detector, which is approximately the value for maximum signal strength. The capacity of the variable condenser was made only a small portion of the entire tuning capacity because it was desirable to have a frequency adjustment of only four or five thousand cycles.

Having this oscillator adjustable over a range of this order of magnitude is of value in differentiating between signals from two stations very close together in carrier frequency, as the high frequency adjustments of the receiver may be set for the optimum strength of the desired station and the intermediate frequency oscillator adjusted so that the beat notes of the desired and undesired station may be most advantageously adjusted. The coupling between the intermediate frequency and high frequency oscillators is reduced to the lowest possible degree in order that the harmonics of the intermediate frequency oscillator will not beat with the fundamental of the radio frequency oscillator when it is adjusted over its operating range. With the intermediate frequency oscillator turned on, beat notes will occur for only two settings at the high frequency oscillator condenser, corresponding to the frequencies 50 kilocycles above and below the carrier frequency.

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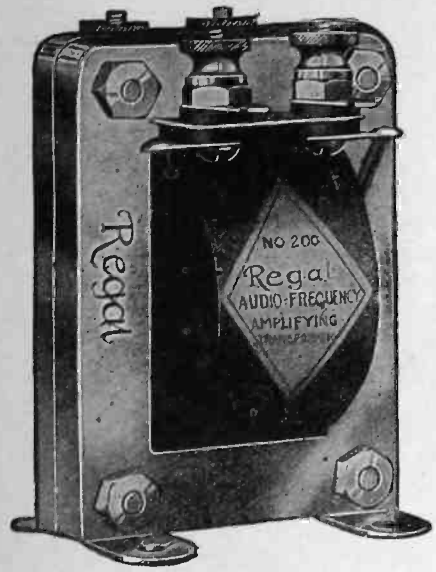

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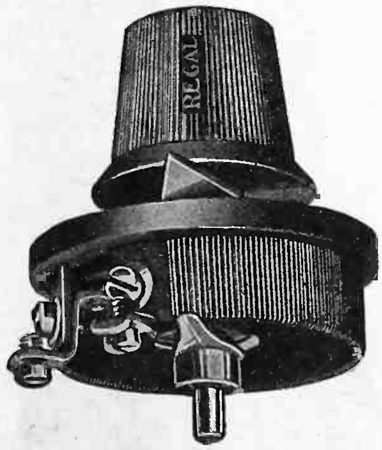

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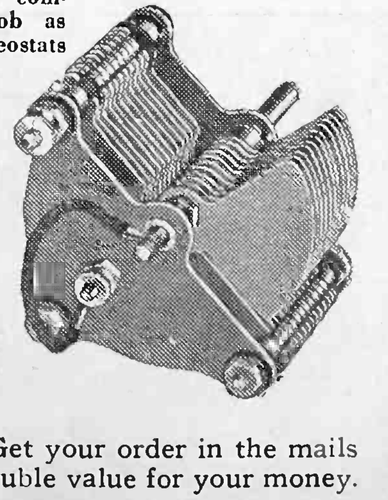

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SEE PAGE 80

Prior to the development of this receiver a satisfactory intermediate-frequency transformer had been devised. The frequency characteristic covers only the operating range but it is also very important that audio frequencies and radio frequencies be not transmitted by the intermediate frequency transformer. It was found that when four of these transformers were used in an intermediate frequency amplifier the characteristic obtained was quite different from the fourth power of the characteristic of a single transformer. This is to be expected because the input impedance of a vacuum tube is a function not only of the grid to filament capacity but it is also affected by the make-up of its plate circuit. The input impedance of a grid leak detector tube is also very different from the input impedance of an amplifier tube.

A satisfactory overall characteristic was obtained by balancing out some of the inter-stage coupling capacity. The balancing capacity is not only used to stabilize the amplifier and to reduce any tendency toward internal oscillation but its proper adjustment determines the shape of the amplifier characteristic. The amplification of this receiver is controlled by means of a potentiometer whose total resistance is closely related to the value of the balancing capacity. The proper combination of these two values results in the desired characteristic. The volume control shown is adjustable in ten steps having a voltage amplification ratio between them of approximately 2.5 to 1. The selectivity is greatest when the maximum amplification is used. This is a very desirable characteristic as when a signal is so weak as to require the maximum amplification of the receiver a high degree of selectivity is desirable. The selectivity of the receiver is intentionally made considerably less than might be obtained in order to be able to receive signals when the carrier frequency changes slightly or is not absolutely accurately set by all transmitters.

This uncommonly selective superheterodyne receiver may be operated either from a storage battery or dry-cell batteries. The transmitter and receiver show what may be expected if the design is based on the results of intelligent coordination of theoretical and laboratory work. The practical operation of the system shows that the range over water is considerably in excess of requirements, which seems to indicate that the shorter wavelengths will be very satisfactory for this class of service.

MARCONI-BELLINI-TOSI DIRECTION FINDER

(*Continued from page* 32)

the circuit is completed by placing a variable condenser in shunt with the search coil.

This is known as the Aperiodic Aerial System, and is one of the latest de-

velopments of the Marconi-Bellini-Tosi system. It is particularly valuable in eradicating the frequent and critical operation of balancing the loops by tuning each one separately to keep them in phase, as was hitherto necessary.

As the loops are fixed, maximum intensity can only be obtained when the transmitter is directly in the plane of one of the loops. However, the search coil functions, though in much smaller compass, in much the same manner as a rotating frame, and directional effect obtained by means of the search coil working on the magnetic fields set up by incoming signals in the field coils of the *A* and *B* aerial loops.

THE BATTERYLESS RECEIVER

(*Continued from page* 17)

a maximum capacity of .0005 mfd. A .00025 mfd. mica condenser permits the high frequency in the antenna system to reach the ground via the slider of the 200 ohm potentiometer.

The first vacuum tube amplifies the high frequency currents and delivers them to the crystal detector through the radio frequency transformer. The transformer is tuned by an 11 plate condenser of .00035 mfd. capacity, this control and the condenser in the antenna circuit being the two tuning controls of the receiver. The crystal detector, which is of the fixed type to avoid extra adjustments, delivers it's output to the first audio frequency transformer, the secondary of which is connected back to the grid of the first vacuum tube. This tube amplifies the audio frequency output of the transformer and delivers it to the second vacuum tube. This tube gives further amplification and delivers the audio frequency output to the loud speaker.

A small balancing condenser of .00005 mfd. capacity, of the midget type is connected between the secondary of the radio frequency transformer, at a point 12 turns from the low potential end, and the grid of the first vacuum tube. This condenser provides neutralization of the elements of the tube and once adjusted does not need further attention.

It is not absolutely necessary to use the receiving circuit described above. Almost any good arrangement of one stage radio frequency amplification, crystal detector and two audio stages will do, as long as the filament circuit is wired according to the approved method as shown in the circuit diagrams.

In the power end of the circuit, 110 volts A. C. is brought in to the primaries of two bell ringing transformers, one wire going through the main switch to provide control over the set. These two transformers step the 110 volts down to 8 volts, one transformer being connected directly to the filaments of the two vacuum tubes through a 6 ohm rheostat, and the other transformer providing voltage to light the filament of the rectifier tube. A UV-201-A or C-301-A tube with the grid and plate connected together is used as the rectifier or a Western Electric 217-A rectifier tube will do as well. A rheostat of 20 ohms is provided in the filament circuit of the rectifier to obtain the proper adjustment of filament voltage.

The third bell transformer is connected in the circuit in a unique manner. The secondary is used as a primary winding and is bridged across the secondary of the transformer supplying the rectifier filament. The primary of this transformer is then used as a 110 volt secondary and supplies the high voltage for the rectifier. The purpose of this arrangement is to insulate the rectifier tube from the 110 volt line, for if the tube was directly connected to the line a dangerous condition would result in that an accidental ground on one side of the line connections would blow the house fuses and might cause a fire in the set. With the insulating transformer in the circuit this danger is obviated.

In the set illustrated a toy transformer having a variable secondary was used, thus providing voltage regulation for the rectifier circuit. The secondary is variable in 1 1-2 volt steps so that the turns ratio of the transformer may be varied to provide a voltage lower than 110 to the rectifier tube if desired. The rectifier tube delivers approximately 110 volts of pulsating d. c. to the filter system, the windings of which reduce the voltage to 90, the correct amount for the receiving circuit.

Electrical balance is obtained in the filament circuit of the receiving set by means of the 200 ohm potentiometer, the grid return and negative plate connections being tied to the slider of the potentiometer and the outside terminals of the potentiometer being bridged to the filament circuit.

As this rectifier system rectifies only half the alternating current wave, the question naturally arises as to whether another rectifier tube should be used in order to have full wave rectification. Such a procedure is not necessary, as the filter will deliver a d. c. voltage quiet enough for all purposes. This system of half wave rectification is rapidly coming into general use, as is shown by the appearance on the market of the new Western Electric 25-A power amplifier. This amplifier consists of an audio frequency stage, the plate potential for which is supplied by a rectifier tube operating on half the alternating current wave, and the filament current from a 4.4 volt secondary winding of the power transformer.

The general layout of the panel is shown in Fig. 2, the panel being 7x18x 3-16 in. It will be noted that only the shaft hole for each air condenser is shown in the layout, the reason for this being that air condensers other than those shown in the illustration may be used in the circuit and as most condensers are now accompanied by a drilling template, the holes for the mounting screws can readily be marked on the panel.

The baseboard should be of good grade non-warping wood and is 12x18x¾ in. The panel is fastened to the baseboard with ¾-in. wood screws placed along the bottom edge of the panel, and does not need brackets or other extra supports if the screws are driven in tightly. On the panel are mounted the air condensers with associated coils, the main line switch, balancing condenser and output jack.

The assembly of the apparatus on the baseboard is shown in the pictorial wiring diagram, Fig. 3, the power apparatus

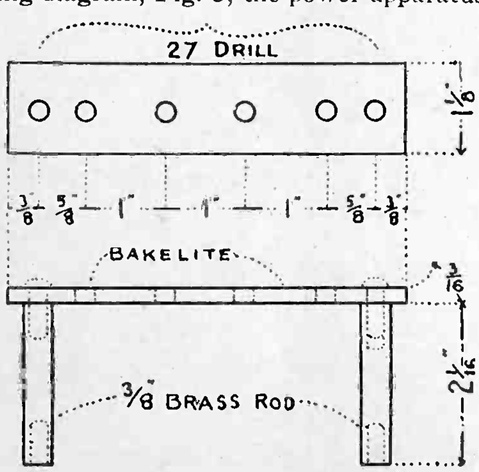

Fig. 4. Mounting for Binding Posts.

being mounted at the rear and the receiving set equipment to the front of the board. A set of four binding posts mounted on a small bakelite strip is

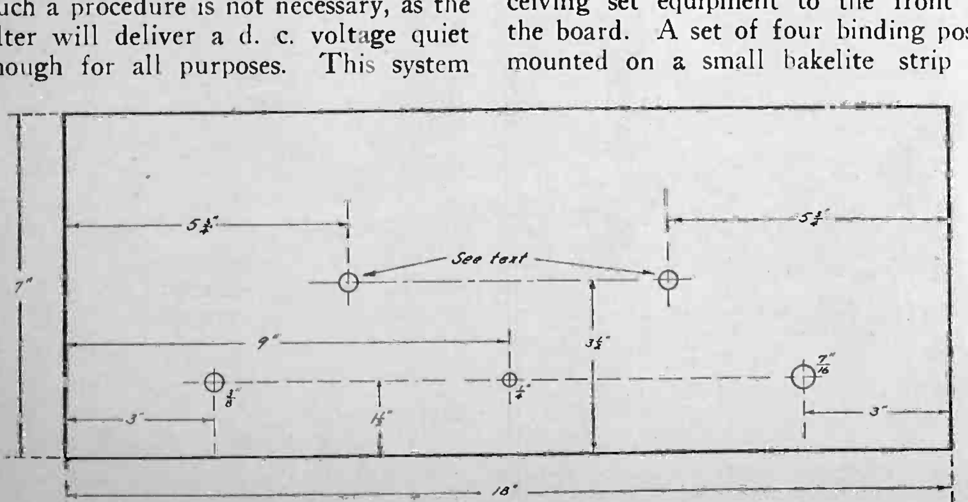

Fig. 2. Panel Layout.

TURN TO PAGE 80

placed on the baseboard directly back of the line switch, to provide terminals for the 110 volts A. C., antenna and ground connections. The details of this binding post mounting are shown in Fig. 4. The fixed crystal detector is mounted on the baseboard directly under the tuned radio transformer, but can be reached easily with a soldering iron if it is placed as shown in the pictorial diagram.

In wiring the set, it is well to do as much as possible of the baseboard wiring, particularly the filter and rectifier tube circuits before mounting the panel to the baseboard. The two bell transformers are each provided with a pair of heavily insulated wires as primary terminals, and these two pairs of wires should be connected in parallel with a piece of twisted lamp cord for connection to the binding post strip. This set of connections should be soldered and thoroughly taped to make it safe, and if the constructor feels that he is not capable of doing a first class job, he should take the baseboard to a good electrical shop and have the primary transformer connections made by an experienced electrician. After the primary connections are finished, twisted pair wires should be run from the two secondary windings to their respective sockets. Any good twisted pair wire of at least 20 B & S gauge will do, twisted lamp cord being especially recommended for the work. For the high voltage connections to the rectifier tube and filter circuit, tinned copper wire of No. 16 B. & S. gauge was used, with a good grade of spaghetti for insulation.

The builder of current supply sets is cautioned against using audio frequency transformers as power transformers in place of correctly designed power apparatus. The use of the former will result in many exposed terminals in the set, all of which have a potential of at least 110 volts, and unless these terminals are thoroughly taped and protected, dangerous shocks and hazard of fire may occur.

After all the power wiring is done, the panel may be fastened to the baseboard and the rest of the wiring completed. For the high frequency end of the circuit bare bus-bar wire was used, spaghetti-insulated only where there was danger of two wires touching each other at some exposed point. The employment of spaghetti for conditions other than above is a useless waste of money and does not add to the efficiency of the set.

After completing the wiring, it is advisable to connect it to the 110 volt lighting supply, with the tubes removed from the sockets, and turn on the current for a few minutes to detect the presence of short circuits, if any. A short circuit in the power apparatus would be accompanied by a loud humming noise in the transformers, and they would soon become too hot to touch. If such a condition occurs the wiring of the rectifier and receiver tube filaments should be thoroughly checked, especially with regard to the socket springs, which occasionally become shorted together.

Those desiring to construct their own radio frequency coils will find the following dimensions satisfactory for the present radiocast wave band with the average antenna system:

The antenna coil consists of 50 turns of No. 20 D. S. C. wire wound on a 3-in. tube. The coil is tapped at the 25th turn, in order that those having a very long antenna may tune to the radiocast wave band. The radio frequency transformer can be made as follows: In a piece of 3-in. bakelite or hard rubber tubing 4.-in. long, cut a groove ½-in. wide and deep enough to accomodate the primary winding, which is 24 turns of No. 30 D. S. C. wire wound hap-hazard fashion. If the tubing is 1-16-in. thick the groove can be made 1-32-in. The secondary coil consists of 77 turns of No. 20 D. S. C. wire, one end of which is wound directly over the primary winding. A tap is taken out at the 14th turn to permit connection of the neutralizing condenser.

More detailed data on the construction of the above coils was given in an article by Volney G. Hurd in April RADIO, in connection with a description of the Browning-Drake circuit.

In selecting a fixed crystal, it is a good idea to first test it by placing it in series with a pair of headphones across the antenna tuned coil, thus providing a single circuit crystal set. If the crystal gives loud signals from the local stations and does not get out of adjustment when the apparatus is jarred, it will be O. K. to use in the A. C. layout.

After the wiring is thoroughly checked the set is ready for insertion of the tubes in their sockets. It is best to first place the rectifier tube in its socket and turn on the current. Adjust the filament to a normal brilliancy and short circuit the terminals of the 2 mfd. condenser on the receiving set side of the filter coil with a piece of insulated wire. If a snappy spark is seen, the rectifier is working properly and need not be further adjusted.

Place the receiving tubes in their sockets and adjust the filament voltage to the lowest point consistent with good quality and volume in the loud speaker. With the potentiometer slider set at either end of it's resistance unit a loud humming noise will be heard in the loud speaker, and as the slider is brought nearer to the center of the resistance, the noise will decrease until a point is found on the resistance where the noise is at a minimum.

The rectifier tube filament rheostat should now be varied until an adjustment is found where cutting more resistance into the rheostat will affect the volume in the loud speaker. This means

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that the rectifier tube filament is operating at the lowest possible voltage to give the required high voltage output from the filter and will result in long tube life.

The adjustment of the neutralizing condenser is the next step in completing the receiver. Tune in a local station until it is being received as loudly as possible. Remove the first vacuum tube from it's socket and place a piece of paper over one of the filament springs of the socket. Replace the tube, and undoubtedly the station will still be heard faintly. Adjust the neutralizing condenser until the station signals either disappear altogether or are faintest, and do not again adjust the condenser thereafter. Remove the piece of paper from the first tube socket and the set will now be properly adjusted so that it cannot radiate energy into the antenna, should the first vacuum tube oscillate.

In regard to the selection of audio frequency transformers, a choice must be made at the time of building the set. If low ratio, high quality transformers are used, they are so efficient at the very low frequencies, from 60 to 200 cycles, that they will pass considerable noise due to the use of alternating current in lighting the filament of the first vacuum tube and this noise may be objectionable to the owner of the set, with certain types of loud speakers. If high ratio transformers having turns ratio of 4½ to 1 or more are used, they will not pass the low frequency noise and the set will be quiet in operation, but unfortunately will not give as good musical quality in the loud speaker due to the cutting off of most of the very low frequencies. So the selection of the transformers is left to you. If you want no noise in the loud speaker due to the use of A. C., and can stand slightly poorer quality, use high ratio transformers. If you demand perfect quality of output and do not mind a faint A. C. hum when the music or speech is soft or feeble, use transformers having a 2:1 turns ratio.

If it is desired to have a greater range than is possible with the arrangement described, an extra radio frequency stage with it's tuned transformer may be added ahead of the present set. This will require an extra dial on the panel and another neutralizing condenser, but will not increase the hum in the loud speaker. The same tuned transformer as used in the two tube set may be employed for the additional stage. being mounted at right angles to the other coils in the set to prevent coupling.

RANGE OF RECEIVING SETS

(*Continued from page* 40)

may be set into an equation for determining the range of receiving sets. But they are so many and are so variable that it would be a foolhardy thing to

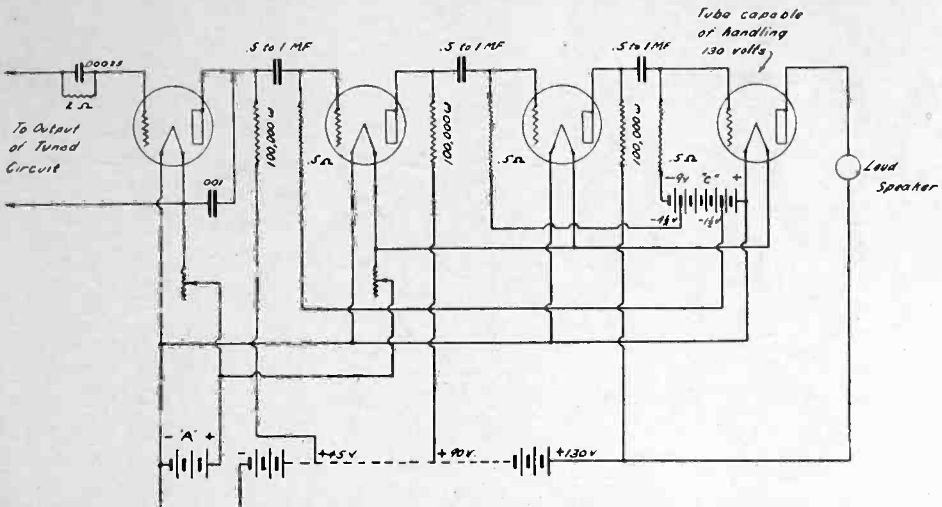
(*Continued on page* 77)

RESISTANCE COUPLING

(*Continued from page* 30)

point on the curved portion of the line during the negative peaks of the A. C. input.

Most receiving sets should have enough stages of audio amplification to give a voltage ratio of from 500 to 1000 times. The curves of Fig. 4 have been plotted for enough stages of each kind of amplification to give some such total amplification. The total amplifications were not measured but were obtained by multiplication of the measured values of the individual stages. Curve I shows a good 2 stage transformer coupled amplifier; Curve II an average poor transformer coupled 2 stage. Curves III and IV are respectively 3 and 4 stages of well designed resistance coupling and curves V and VI are 3 and 4 stages, respectively, of poorly designed resistance coupled amplification. These curves substantiate the statement that, while resistance coupling offers the possibility of excellent results, the amplifier must be designed with great care to obtain these results. A circuit diagram of a well designed three stage amplifier is shown in Fig. 5.



From the foregoing it is evident that perfect quality, which is dependent upon equal amplification of all frequencies, is not obtainable with resistance coupling. It may be approximated by care in design. Otherwise not only is the cost greater for equal volume but also is the quality poorer than in a transformer coupled amplifier. Yet, as shown by the curves, it is possible to obtain better quality from a well designed resistance coupled amplifier than in any other way, although at somewhat greater expense and considerably less efficiency.

THIS WAVELENGTH FREQUENCY QUESTION

(*Continued from page* 33)

usual operating conditions of the receiving set. In the allocation of radiocasting stations, therefore, it was decided that a minimum separation of ten kilocycles should be used. This separation may be constant regardless of the wavelengths of the different stations.

The allocation of radiocast stations is more difficult when they are designated in meters. Take for example a station having a wavelength of 300 meters. If we wish to assign a wavelength to another station such that the two carrier waves will not produce an objectionable beat note, we will require a frequency separation of ten kilocycles. Hence we convert 300 meters into kilocycles, obtaining 1,000, assign to the second station a frequency differing from this by ten kilocycles, say 990, and convert this frequency to wavelength, obtaining 303 meters. Here the wavelength difference is three meters.

Consider two other stations of this same wavelength separation of three meters. Let us say one of them has a wavelength of 410 meters; the other, 413 meters. The respective frequencies are 732 and 726 kilocycles—a difference of six kilocycles. These two stations would therefore produce an interfering audible beat note of that frequency. Thus a satisfactory assignment of meters involves a conversion into kilocycles, hence it is simpler to use kilocycles in the first place.

This isn't supposed to be a sermon on the superiority of kilocycles over meters; nevertheless mention may be made of two other reasons why the use of the former is preferable.

First, the tremendous growth of radio has brought it more closely in touch with the science of electrical engineering. In dealing with the transmission of electrical power over wires, engineers are accustomed to the use of frequency. It is therefore to be expected that the newer art of radio should adopt a term which may be used in common by both radio and electrical engineers.

Second, frequency is more intimately associated with radio apparatus than wavelength. Radio waves cut through your receiving antenna and induce alternating currents in it and in the receiving circuit. Thus when you tune your receiving set to a station, you are making a frequency rather than a wavelength adjustment.

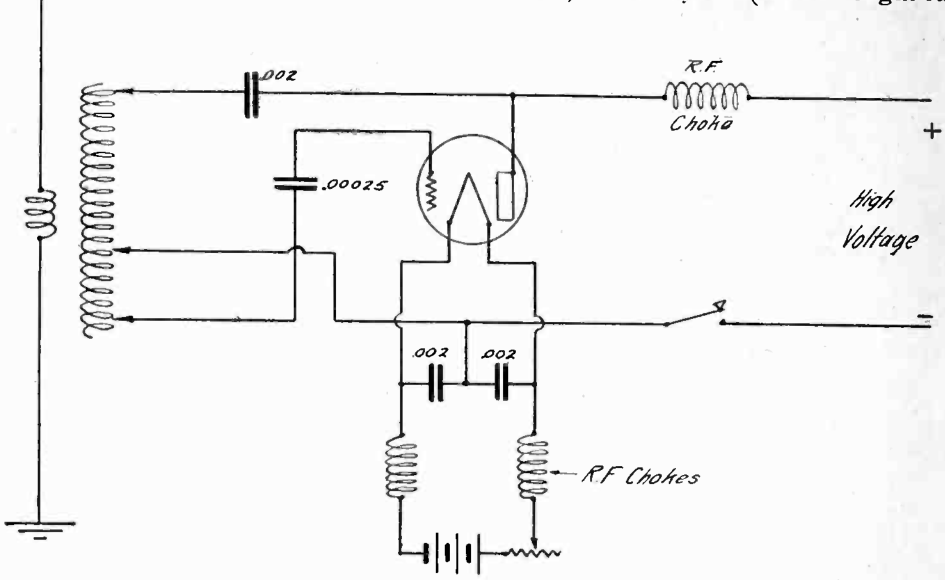
SEE PAGE 80

SEE PAGE 80

NOTES ON SHORT WAVE WORK

(*Continued from page* 34)

and coil. By careful construction "low loss" fashion this can be spread to read from about 3 to 8 meters. Substituting other coils will extend the range. A condenser with a few plates is the best thing, but it is of no use in other work. To calibrate, the harmonic method is a



safe one if you are sure of the station whose harmonic you are using. If time and money are available, the Bureau of Standards or some electrical laboratory can do it for you.

Fig. 3 presents the schematic circuit diagram of the set shown in the picture. The oscillator circuit is the Hartley with 5 turns of 1/8 inch copper tubing wound on a 3 inch diameter. Six inches away is a 2 turn coupling coil also of 3 in. diameter. The only way to vary the wave of this set is to unsolder the leads to the helix and shift them. This of course, assures a fairly permanent job. The grid condenser is .00025 mfds., capacity and the two condensers shunted across the filament circuit are .002 mfd. each. The radio frequency chokes in the filament and plate leads are made by winding 20 turns of No. 20 DCC wire on a lattice work form 2 in. in diameter.

This set oscillates easily using a Navy 5 watter with the base removed. It is surprising how simple it is to get started and if a week's spare time is put on 5 meter work the experimenter will be repaid a hundred fold.

SETS FOR NAVAL RESERVE

(*Continued from page* 20)

54 meters) transmission in South America and in England and on our Pacific Coast, than is reported in various points in the United States much closer. This does not mean that communication with the power of 1½ kilowatts in the antenna is not practicable over shorter ranges because signals of sufficient strength within a 1,000-mile circle show that the signal seldom fades clear out.

"The nocturnal transmission conditions between different pairs of stations vary more over land than over sea, apparently, and very much more than the daytime conditions; nevertheless, daytime conditions show considerable variation. One of the most curious things brought out during the past year's investigation, is the behavior of the high frequencies from 7,000 up to 12,000 kilocycles (a wavelength range of about 40 to 20 meters) between Washington, D. C., and Hartford, Connecticut. Frequencies between 7,000 and 9,000 kilocycles have been reliable the year around in the daytime, working at very low power, distance between these two stations 250 miles. They have also been reliable although subject to far wider fluctuation at night in the summer time, but frequencies in this band absolutely disappear in the winter time during the dark hours, as observed in Washington from Hartford. Observations at Hartford show a fairly reciprocal relation. In the neighborhood of 10,000 kilocycles, (30 meters) Hartford's signals at the present time are usually pretty good in the daylight hours, but disappear promptly and abruptly around 4:30 in the afternoon. Hartford's signals will not return to audibility until the frequency is raised to approximately 5,000 kilocycles (60 meters).

"At 7,000 kilocycles (42 meters) Hartford's signals disappear one-half hour after sunset just as they did one year ago. A complete cycle has been run on these Hartford signals and it has shown that they follow an absolutely consistent seasonal variation the year around. At the same time these same signals have frequently been received at points far south of Washington and almost in line, as well as at occasional points in the middle west.

"One station in Ohio reported exactly similar results to those obtained in Washington, except for one-half hour difference in time, corresponding to sunset time. Several other stations were able to follow the signals well into the dark hours, although they ultimately disappear.

"Tests between Washington and Hartford (transmitting from here on 10,000 kilocycles or a wavelength of 30 meters) show similar effects. On the other hand, this frequency has repeatedly gotten clear across the continent during dark hours with very little power. It also shows reliable daylight transmission up to at least 600 miles, with less than 50 watts in the antenna.

"The Navy is now handling traffic with NBA (Darien) and NPL (San Diego) on high frequencies. The use of quartz-crystal-controlled transmitters now permits just as satisfactory reception as far as regulations of beat tone is concerned, as is possible on long wave stations."

RANGE OF RECEIVING SETS

(*Continued from page 74*)

say that any given type of set had such and such a receiving range.

Other factors make it still more difficult to determine the range of receivers, one of these being the matter of location. There are certain areas which are termed "dead" areas or "shadows," for radio waves cannot penetrate into these areas, or if they do they are always very weak. Thus a very good receiving set will have extremely poor range if located in such areas. The cause for such dead areas may be absorption of the energy of the radio waves by buildings, or natural obstructions. Or it may be due to some peculiar reflection or refraction effects, which prevent the waves from getting into that area.

Then we have effects such as fading of signals. The very finest and most sensitive receivers cannot overcome fading of signals and thus their range will be limited by this effect. There are seasonal and daily variations of signals which also make it difficult to talk about receiver ranges. The same receiver will give different results winter and summer, and day and night. It may have a remarkable range in winter or at night, and extremely poor range in summer or daylight.

In other words the range of a receiving set is an extremely indefinite quantity, dependent upon so many different and uncertain factors that it is foolhardy to talk about any set having a given range. If one wants to determine the range of a set the best thing to do is to try and receive distant stations and after this has been accomplished one can only say that under such and such conditions and at such and such a time the following stations were heard.

TURN TO PAGE 80

SULPHATED BATTERIES

(Continued from page 22)

tirely. This usually will take about five to 15 minutes, and the thermometer in the battery will indicate when the temperature starts to rise abruptly.

As soon as this temperature rise starts, and the battery is taken off charge, set the battery aside for a short while, to allow it to cool down to room temperature, and immediately place on charge, at about half the normal rate. Give it a charge, until the gravity comes up, either to normal or to as high as it will come in about a 10 or 12 hour continuous charge. The battery is now ready for service.

If it is possible, however, this first freshening charge should be now used up, by giving the battery a normal discharge, under normal conditions of current consumption, and then charged again at normal rates. Two or three cycles of charge and discharge will aid very much in bringing the battery up to its point of highest efficiency, but it is not always possible to do this.

It is rarely even possible to bring a a badly sulphated battery up to the gravity reading it had when new or unsulphated. The acid and lead have combined with each other, and quite a bit of both materials are used up, and cannot be restored to normal, no matter how much charging is done, as the white lead sulphate is deposited in the bottom of the cell as "mud". The capacity of the battery is, therefore, reduced by the amount of active material used up in the formation of the sulphate, and the efficiency of the battery therefore lessened that much.

The addition of acid usually will not help, except to allow the high discharge rates necessary in thin plate types of cells. It may, however, be added cautiously by anyone who knows just what he is doing, but he had best be a battery expert before he tries this, or he may ruin the whole battery beyond hope of repair. Better be content with the lowered capacity of the battery, due to the sulphating, and not try to improve on an already rather bad condition, which has been remedied as well as possible.

L. C. CONSTANTS

To accompany article on page 19, this issue.

L=Microhenries C=Microfarads

Meters	Kilocycles	L C	Meters	Kilocycles	L C
10	30,000	.000028	95	3,159	.00254
11	27,270	.000034	100	3,000	.00282
12	25,000	.000041	110	2,727	.00341
13	23,080	.000048	120	2,500	.00405
14	21,430	.000055	130	2,308	.00476
15	20,000	.000063	140	2,143	.00552
16	18,750	.000072	150	2,000	.00633
17	17,650	.000081	160	1,875	.00721
18	16,670	.000091	170	1,765	.00813
19	15,790	.000102	180	1,667	.00912
20	15,000	.000113	190	1,579	.01016
22	13,640	.000136	200	1,500	.0113
24	12,500	.000162	220	1,364	.0136
26	11,540	.000190	240	1,250	.0162
28	10,710	.000221	260	1,154	.0190
30	10,000	.000253	280	1,071	.0221
32	9,375	.000288	300	1,000	.0253
34	8,824	.000326	320	937.5	.0288
36	8,333	.000365	340	882.4	.0326
38	7,895	.000406	360	833.3	.0365
40	7,500	.000450	380	789.5	.0406
42	7,143	.000496	400	750.0	.0450
44	6,818	.000545	420	714.3	.0496
46	6,522	.000596	440	681.8	.0545
48	6,250	.000649	460	652.2	.0596
50	6,000	.000704	480	625.0	.0649
54	5,556	.000821	500	600.0	.0704
58	5,172	.000947	520	576.9	.0761
62	4,855	.00108	540	555.6	.0821
66	4,545	.00123	560	535.7	.0883
70	4,286	.00138	580	517.2	.0947
74	4,054	.00154	600	500.0	.101
78	3,846	.00171	620	485.5	.108
82	3,659	.00189	640	468.7	.115
86	3,488	.00208	660	454.5	.123
90	3,333	.00228	680	441.2	.130

In making up a "trap" circuit to eliminate interference, if a good low-loss condenser is used, better results will usually be obtained with the highest possible capacity and the lowest possible inductance to get to the wave to be eliminated.

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"RADIO," published monthly at San Francisco, Calif., for April 1, 1925.

State of California, County of San Francisco, ss.

Before me, a Notary Public in and for the State and county aforesaid, personally appeared H. W. Dickow, who, having been duly sworn according to law, deposes and says that he is the Business Manager of "RADIO," and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse of this form, to-wit:

1. That the names and addressess of the publisher, editor, managing editor, and business managers are:

Publisher, Pacific Radio Publishing Co., Pacific Bldg., San Francisco; Editor, Arthur H. Halloran, Berkeley, Calif.; Managing Editor, Arthur J. Urbain, Pacific Bldg., San Francisco; Business Manager, H. W. Dickow, Pacific Bldg., San Francisco.

2. That the owner is:

Pacific Radio Publishing Co., Pacific Bldg., San Francisco; Arthur H. Halloran, Berkeley, Calif.; H. W. Dickow, Pacific Bldg., San Francisco; H. L. Halloran, Berkeley, Calif.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

H. W. DICKOW,
Business Manager.

Sworn to and subscribed before me this 31st day of March, 1925.

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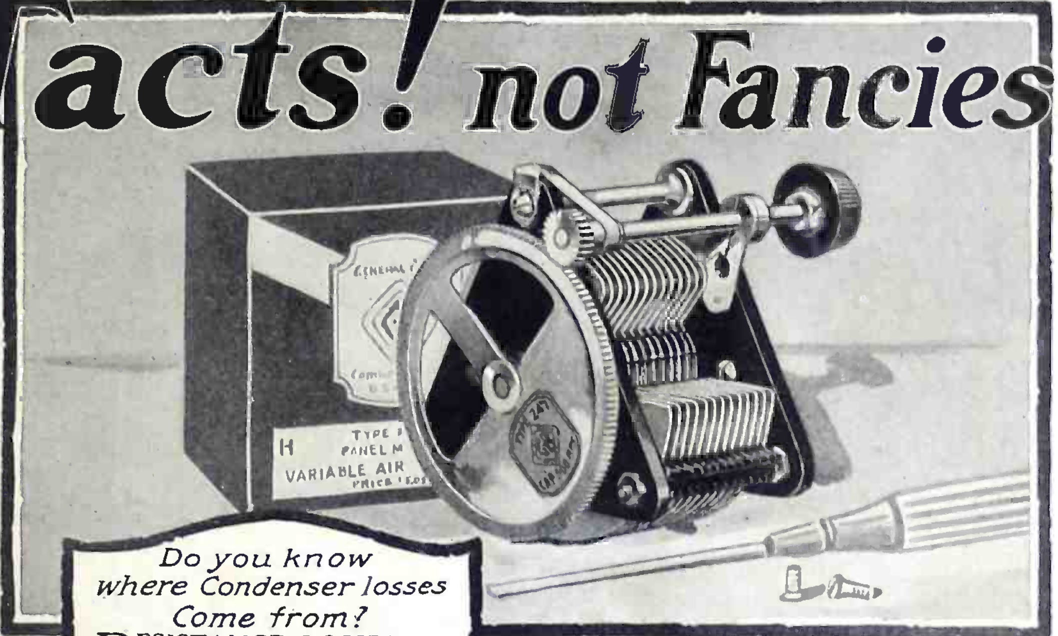

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