RADIO AGE

The Magazine of the Hour

JANUARY 1924

In This Number

Let Our Hook-ups Be Your Guide

Price 25 Cents

Your Radio Problems Solved for 30 Cents in Stamps

IF YOU are constructing a receiving set, a battery charger, a loading coil, a condenser, or a transformer and you need help in the way of clear diagrams and full detailed descriptions of that very thing you may have it by return mail.

We have laid aside a limited number of back numbers of Radio Age for you. Below we are listing the hook-ups and circuit diagrams to be found in these magazines. Select the ones you want, enclose 30 cents in stamps for each one desired.

We advise immediate attention to this as the stock of back numbers is diminishing rapidly.

May, 1922

—How to make a simple Crystal Set for $6.

June, 1922

—How to make a Receiving Transformer.
—Aerials under ground and under water.
—Electric light wires as auxiliary to radio.

September, 1922

—How to construct the Reinartz Receiver.
—Federal Act regulating radio.

October, 1922

—How to make a Tube Unit for $23 to $37.
—How to make an Audio Frequency Amplifying Transformer.

November, 1922

—Photo-electric Detector Tubes.
—Design of a portable short-wave radio wavemeter.

December, 1922

—Home-made battery charger for $3.00.
—Principles of radio receiving equipment.

January, 1923

—How to make a sharp-tuning Crystal Detector.
—Fixed condensers in home-made receiving sets.
—Description of loading coil for simple sets.

March, 1923

—Layout and drilling for Reinartz Tuner, with amplification.
—How to make the Crystal Set do long distance work.
—How to make an Audio Frequency amplifier.
—Symbols used in radio diagrams.

April, 1923

—The Kopprasch circuit.
—How to make a one-tube loop aerial set.
—A two-circuit Crystal Set.

May, 1923

—How to make the Erla single-tube reflex receiver.
—How to make a portable Reinartz set for summer use.

June, 1923

—How to build the new Kaufman receiver.
—What about your antenna?

July, 1923

—The Grimes inverse duplex system.
—How to read and follow symbols.
—Proper antenna for tuning.

August, 1923

—Construction of the Cockaday four-circuit tuner.
—An efficient two-stage amplifier.
—A simple buzzer transmitting set.

September, 1923

—How to load your set to receive new wave lengths.
—Simple Radio Frequency Receiver.

October, 1923

—The Four-Tube Neutrodyne.
—Your First Tube Set.

November, 1923

—The Super-Heterodyne.
—A Three-Circuit Tuner.
—How to Learn Code.

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—Building the Haynes Receiver.
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RADIO AGE

The Magazine of the Hour

(Established March, 1922)

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Our Unique Record

WITH this issue our magazine enters its third calendar year. We established it in the early spring of 1922 with a firm belief in the steadfastness of public interest in radio and results have amply justified our faith. We have attained a substantial prosperity and as you readers have been partners in our enterprise, we believe it not out of place to tell you just how we accomplished it.

In the first place we regarded the selling of advertising space as of secondary importance. The primary object was to print a magazine that radio fans would actually need in their home experimentation and in the construction of receiving sets and accessories on their own work benches. Our growth from 10,000 to present figures with subscriptions and sales increasing rapidly from month to month, proves that our idea—service to readers first—was a sound one.

No inconsiderable financial burden is involved in the writing, editing, illustrating, printing and distribution of 50,000 forty-eight page magazines every thirty days. Outside of printing costs, white paper bills, administration expenses, engraving costs, express and postage there are scores of incidental items to swell the monthly total. Yet, like the Miller of the Dee, we owe no man a penny and our bankers greet us with a daily smile. Fans throughout Canada and the United States have built up RADIO AGE and they are adding to the structure every day. It is a readers' book.

It is inevitable, with such a showing for this publication, that advertisers will want increasing space in which to convey their message to our 100% circulation. That brings us up to the most important point we wanted to make. With new advertising, additional pages will be added to the magazine so that the present generous allotment of space for readers will increase rather than diminish. We never had an ambition to edit or publish a catalogue.

Wishing you a happy and prosperous New Year—

Frederick Smith

—Editor, RADIO AGE

"THE AIR IS FULL OF THINGS YOU SHOULDN'T MISS"

Radio has moved from the laboratory and amateur's work-table out into the refined surroundings of the family living room. In keeping with this new companionship we offer this reliable, long-lived Eveready "B" Battery, in an attractive, new metal case, worthy to stand beside the rich cabinets of fine radio sets.

Eveready "B", 22½ volts, No. 766 with Six Fahnestock Spring Clip Connectors.

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Informative and money-saving booklets on Radio Batteries sent free on request.

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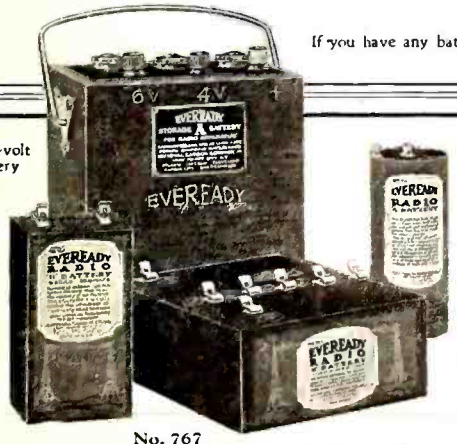
Headquarters for Radio Battery Information

If you have any battery problem, write to RADIO DIVISION, NATIONAL CARBON COMPANY, INC. 202 Orton Street, Long Island City, N. Y.



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You Cannot Keep Radio Secrets from the Women

At the top is Miss Rachel M. Thompson, of Boston. She is a graduate of a radio school and lectures to boys on radio subjects. (Keystone Foto). At the bottom is Miss Catherine Jay Moore, first American girl to pick up English broadcasting stations. (Kadel & Herbert Foto). At the right is another picture of Miss Moore. She is adjusting the aerial on the roof of her New York home.

RADIO AGE
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EDITOR

Tuning Out Interference

By FELIX ANDERSON

Technical Assistant, Radio Age

INTERFERENCE is the bugaboo of the radio pastime. Every time the average listener turns on the filaments of his radio set, he has to contend with this difficult element in the course of his enjoying the delightful programs and entertainment provided by the great institution of broadcasting, and not infrequently has he turned away from the receiving set with some savage invective concerning the inefficiency of his receiver or the inadequate system of wave allocations.

The entire broadcasting system is based upon the assigning of waves as widely different as possible to stations in close proximity, in order to maintain a well balanced system of wavelengths to keep the disorder caused by the clashing of undesired frequencies down to a minimum. In large cities where more than one powerful station is operated, the popular method seems to be an agreement between the various broadcasters as to the division of the periods of the day when certain stations are permitted to broadcast.

This system usually is efficient as far as local broadcast listening is concerned, but to some fans, the thing seems a poor arrangement, due to the fact that he has no chance to listen to programs from distant transmitting stations. Many cities provide a specified night for the reception of out-of-town stations. In Chicago, this "silent night" has proven a popular evening among owners of high-powered receivers who are assured of programs from many directions.

But the average BCL is not satisfied with only one night a week to listen to out-of-town programs, and in spite of the powerful interference created by his local station, will endeavor to reach out-of-town stations almost any time he operates his set.

If his set is one of close tuning properties, the feat can easily be accomplished, but more often it happens to be one of the single circuit type, a type very popular with the newly initiated due to its extreme simplicity of tuning, construction and the exceptional volume it affords, and the result is a bad perspective on the merits of radio listening. With a single circuit set operated in close proximity to a powerful broadcasting station, the business of tuning is likely to be a farce. The signal of the local station can usually be heard over the entire tuning range of the set, and even if a distant station can be tuned in, it is usually so badly distorted and intermingled with noises and squawks from the local station that its entertaining value is lost.

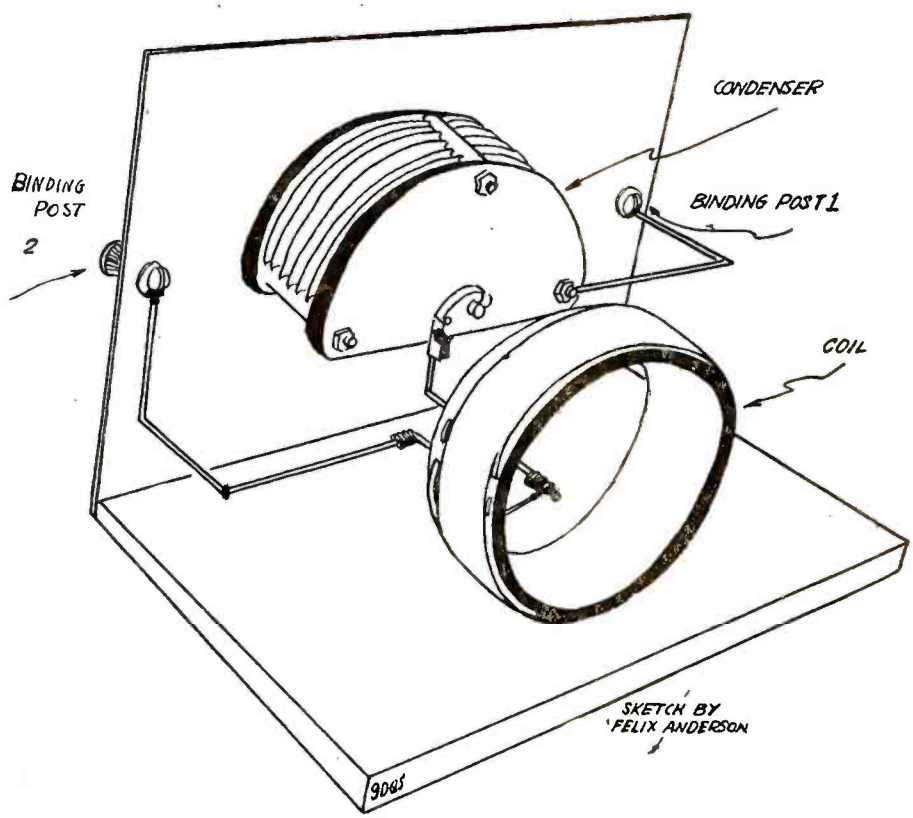


Figure 1. Isometric sketch of the Simple Series Eliminator. The condenser is a 23-plate, and the coil has 40 turns of No. 28 DCC wire wound on a three-inch cardboard tube A filter of this type is useful in assisting to tune out interference from nearby stations.

With the intention of alleviating the nuisance of interference to a minimum, the writer has compiled the following data to be applied to specified forms of interference, squawks, noises, howls, etc., and sincerely hopes that it may be the solution of the problem for many readers.

Antennae

Under first consideration comes our old friend, the antenna. For those who live at a reasonable distance from broadcasting stations and who are using tuners of either the single circuit or four circuit or any other type of set which tunes moderately closely, and who experience only little or occasional interference, it is recommended that they merely cut down on the length of their antennas.

At a slight sacrifice in signal strength, the antenna may be reduced to eighty-five or ninety feet, including lead in, and the selectivity of the set increased materially. This applies to any type of receiver. With a two variometer variocoupler (three circuit) receiver, the operator can then tune out any station at will, providing the interference is not on the same wave as the one to which he is tuning. Usually this slight change will solve the problem for the average BCL who fortunately has been accorded with a location where he may listen to programs from any such stations as he may care to tune.

On the other hand, we have the fellow who lives about two blocks from a five-

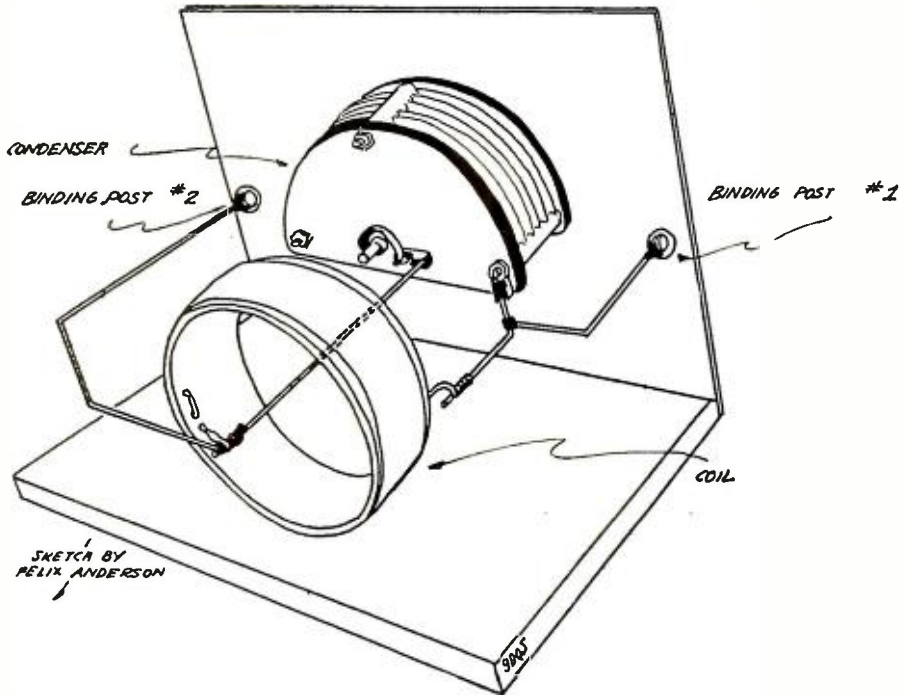


Figure 3. An isometric sketch of the wave trap, showing the method of connecting and arranging the apparatus. The wave trap is a useful instrument for tuning out many kinds of interference.

hundred watt broadcasting station, with resultant harmonics from the guy-wires of the station, the transmitter itself, and from signals reradiated by his neighbors' receivers. His problem is "a horse of a different color," but can usually be taken care of by using what is known as a

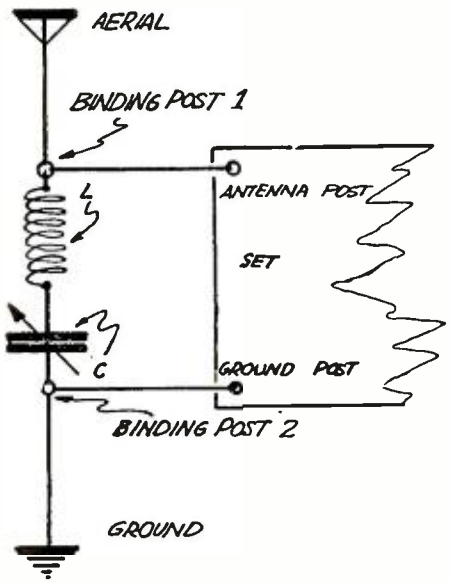


Figure 2. The electrical connections of the Simple Series Eliminator.

Simple Series Eliminator

The simple series eliminator, consisting of a filter or a series capacity-inductance circuit, connected across the antenna and ground posts of the receiving set, is of material assistance where a broadcasting or spark station is strong enough to render the tube inoperative. It is also useful in assisting to tune out spark stations on waves materially longer or shorter than the desired frequency.

This simple unit is composed of a good twenty-three plate condenser, preferably with a vernier, and a one microhenry inductance coil. The coil may be home made by winding about forty turns of No. 28 DCC wire on a cardboard tube, three inches in diameter.

The action of this type of filter is to provide a path whereby the interfering signals may be shunted off to the ground and not enter the receiving set. A filter of this type is not exceptionally close tuning, but will help matters along greatly as stated in the aforementioned cases.

The connections of this type of filter are shown isometrically in Figure 1, and the electrical connections to the receiving set in Figure 2. The binding post shown numbered as Binding Post 1 should be connected to the antenna, and then to the antenna post of the receiver, while number two should be connected to the ground post of the receiver.

Care should be taken in the construction of this unit, as careless construction

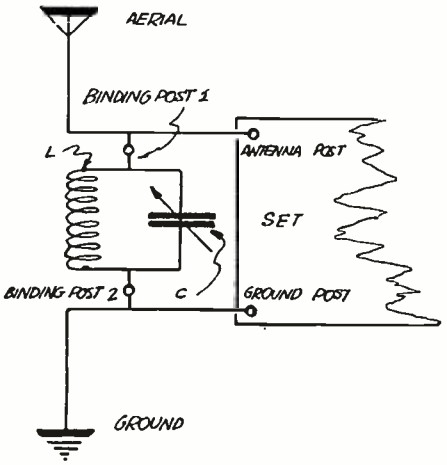


Figure 5. This shows another method of connecting the wave trap to the receiving set.

may result in losses which may offset the merits of the filtering action.

The Wave Trap

The wave trap, sometimes called an "anti-resonant circuit," also is useful in tuning out undesirable signals of the broadcasting type.

The apparata used in this unit are: one twenty-three plate venier condenser, one coil of 42 turns, wound on a three-inch untreated cardboard tube, a panel, cabinet and binding posts.

The apparatus is arranged on the panel as shown in Figure 3, and should be connected to the set as shown in Figure 4. Binding Post 1 is connected directly to the antenna, while No. 2 is connected to the antenna post on the receiving set.

This unit instead of being tuned to the frequency of the desired signal is tuned to the wave of the interfering signal. It will be noted that when the condenser of the trap is turned, the signal will diminish in strength until it disappears and then gradually increase again until it is restored to normal value.

The trap should be adjusted to the point where no signal from the interfering station is heard. The receiver is then tuned to any other wave except

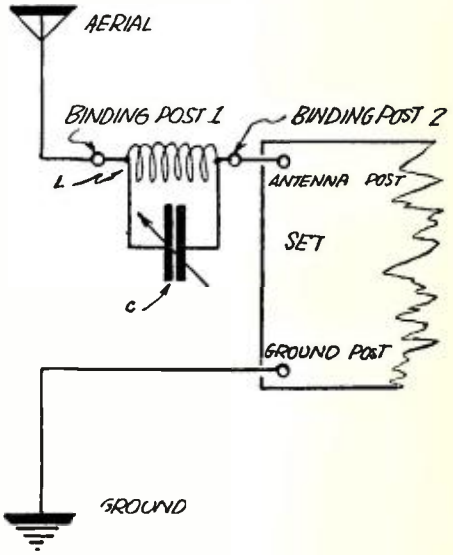


Figure 4. The wave trap is connected in series with the aerial and set as shown herewith. The construction of this unit is described in detail in the accompanying article.

the one to which the wave trap is adjusted.

The action of a filter of this type is that when it is tuned to resonance with the interfering signal, a local current flows around it, setting up a potential across its terminals almost strong enough to counteract the incoming wave from the interfering station. This action virtually obliterates any current of the interfering wave, and very little of it gets into the receiving set. If the station is exceptionally strong, one or more of this type of trap may be placed in the antenna lead, and tuned to the same wave or to separate waves which are causing interference.

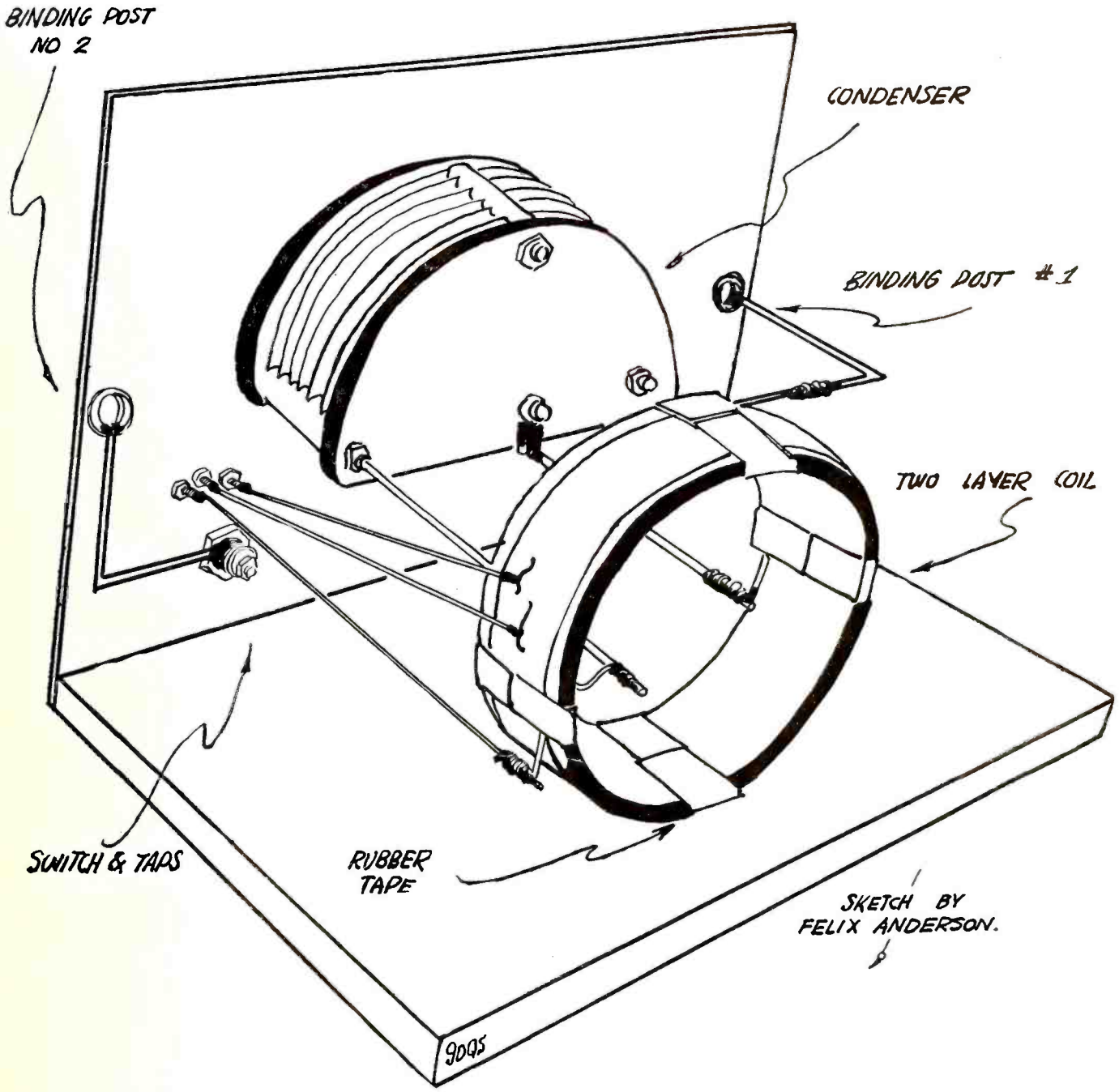


Figure 6. The isometric arrangement of the Eliminator.

The extreme flexibility of this type of filter makes it a popular type of arrangement used to eliminate interference. When connected to the antenna in this manner, however, it is of little use in tuning out spark stations and to gain this additional advantage the filter must be connected into the circuit as shown in Figure 5. The Binding posts, numbered 1 and 2, are connected to the antenna and ground posts of the receiver, respectively. The filter or trap then becomes an acceptor, and shunts the signal, to which it is tuned, off to the ground, allowing the signal we want to pass on to the remainder of the set where it is amplified, rectified, distorted, etc. However, the usefulness of the wave trap is limited to the eliminating interference of stations or signals which are separated by a rather wide band of waves, and cannot be used efficiently where only a few meters discrepancy exists between the interfering and the desired signal. This type of interference is a rather difficult problem, but can readily be handled by a filter of the coupled inductance type.

The filter illustrated isometrically in Figure 6 is about the most efficient possible arrangement available for tuning out interference from broadcasting stations or other stations using continuous wave transmitters. It really weeds out signals not wanted to a degree where tuning may be accomplished to within wavelengths differing by about one per cent of the desired signal, and therefore we will call it an "eliminator."

The Eliminator

The eliminator has many advantages over the other types of filters. Instead of placing the filter directly in the antenna circuit it is coupled to the aerial circuit on the same principle of the variocoupler. The aerial is inductively coupled to the filter with a small coil of wire wound directly outside of the filter coil. The inductive relation between the two coils and the capacity (condenser) are the components used to trap the interfering signal.

The apparatus required in the course of construction of this type of filter are as follows: one twenty-three-plate variable condenser with vernier; one bakelite panel; two binding posts; one switch lever; three switch taps; two feet of rubber insulating tape; one cardboard tube about three inches diameter and three inches long; about seventy feet of No. 28 DCC wire; about eight feet of No. 24 or 26 DCC wire; empire cloth

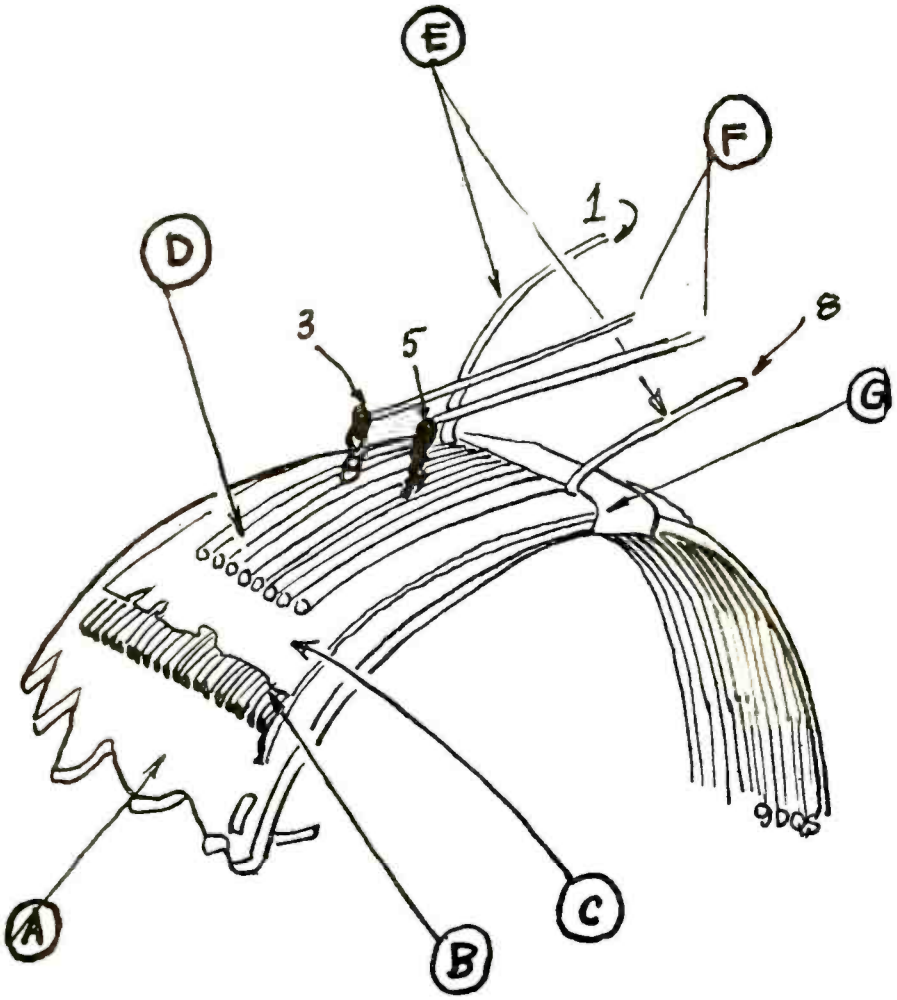


Figure 7. This shows the method of winding the inductances used in the Eliminator. Full details in accompanying article.

or dry writing paper; busbar, solder and other accessories.

Construction

The construction of a filter of this type is a little more difficult than any of the ones described in the preceding paragraphs, but at best, the Eliminator is a simple piece of apparatus.

The cardboard tube on which to wind the coils should be thoroughly dried and some moisture-proof compound should be applied. Soaking the tube in hot paraffine is good, as is shellac or collodion (airplane wing dope).

Punch two holes about three-fourths of an inch from the side of the tube and wind about 40 turns of the No. 28 DCC wire running the finishing end through two more holes punched near the finish edge of the coil. Over this wrap three or four turns of the empire cloth or writing paper and then start winding the primary (antenna) coil.

The antenna coil consists of eight turns of the No. 24 or 26 DCC wire. Wind three full turns, and then bring out a small loop for a tap, wind two more and twist another tap, and then finish the coil by winding the remaining three turns, leaving ends at both the start and finish of the coil for connecting purposes. The taps three and five and the finish end of the coil are connected to the three switchtaps on the panel. Figure 7 shows the winding of the coil in cross section, with the following legend applying to the letters. A is the cardboard tuning, B the 40 turns of No. 28 DCC, C is the layer of writing paper or other insulation, D is the antenna coil, E the first and eighth turns on the antenna coil, and G is a strip of insulating rubber tape used to bind the coil together. Three and five are the taps brought out to the switchtaps.

Connect the forty turn coil ends to the condenser terminals as shown in Figure 6. After making sure that the coils are wound in the same direction, connect the first turn to Binding post 1 and the third, fifth and eighth turns to the switch taps in order. The switch lever is then soldered to Binding post 2. This completes the wiring of the Eliminator. Simple, isn't it?

How to Use the Eliminator

If you are having trouble with broadcast interference, fasten Binding post No. 1 to the antenna, and Binding post No. 2 to the set, and tune the filter to the interfering wave, in the same manner as described for the wave trap. Then let it alone and forget it for the rest of the evening. Connections illustrated in Figure 8.

If you experience trouble with spark, *AC hum*, or *arc light* interference, connect the Eliminator as shown in Figure 9, and notice how much better the set tunes. When using the Eliminator in this way, it will usually entirely squelch the interference caused by a broad spark set.

A combination of the two arrangements may be used as shown in Figure 10, and if it still leaks through, there is something radically wrong with the adjustment of the transmitting stations wave.

General Suggestions

The secret of these filters lies in constructing them carefully, with low loss apparatus. In choosing a condenser, it would be wise to acquire one that has the rotary plates connected to the end mounting, and having but little insulating dielectric which is so placed to assure but little leakage. Verniers of the friction type or gear type are to be desired over those having separate vernier plates.

Above all, do not dope the wire of the

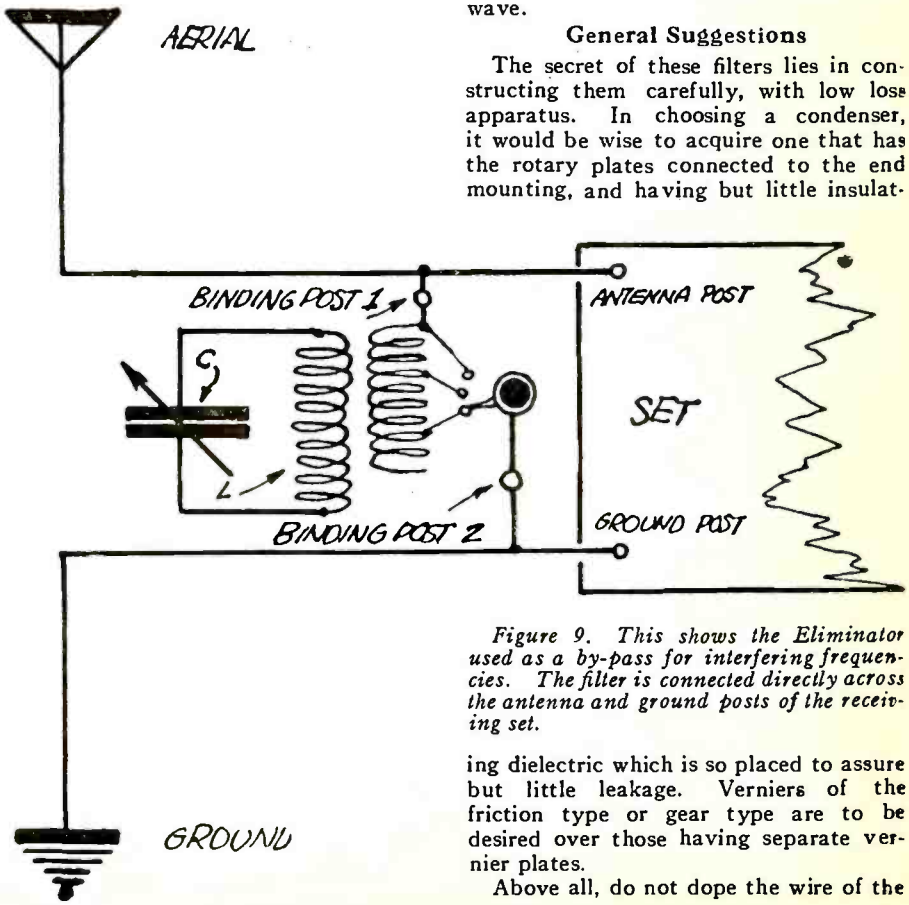


Figure 9. This shows the Eliminator used as a by-pass for interfering frequencies. The filter is connected directly across the antenna and ground posts of the receiving set.

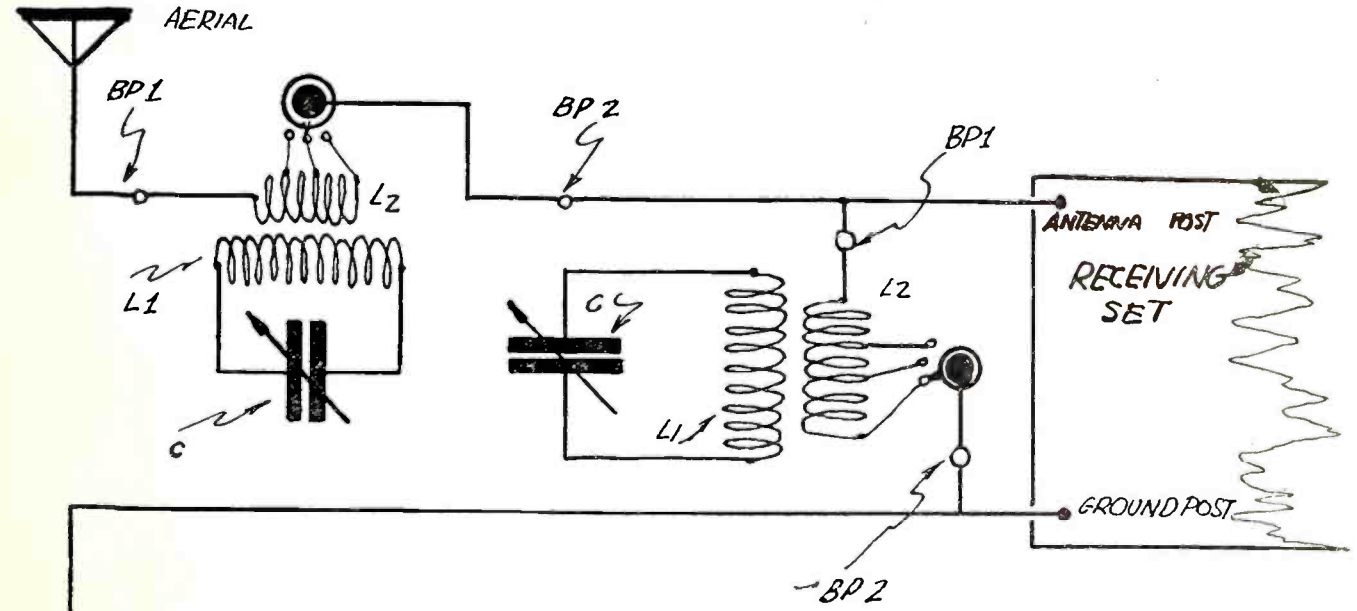


Figure 10. This shows the two filters of the Eliminator type used on a set. With the arrangement shown, interference can almost be considered negligible, provided the filters are well constructed.

coils, and make all connections solid with solder and flux, cleaning the contact points well to cut down the high frequency resistance of the entire unit.

These little details may not be noticeable if you make them one at a time, but counting them together, probably will make a great difference in the tuning qualities of the filter as a whole.

Remember that no man can tune out a station if it happens to be plop on the wave you are listening on. If station ABC is transmitting on the same wave as XYZ at the same time, there is no receiver that will efficiently tune either of them out.

Intelligent operation of these units and familiarization with their various traits is necessary just as much as patience is necessary in the process of learning to tune a new receiving set.

The writer would be pleased to hear from readers who construct any of these types of interference preventers.

Radio Widowers

WEAF has received a number of letters of complaint from anxious husbands who find that their wives are neglecting their household duties because of the radio. One radio listener wrote requesting WEAF's schedule to be changed so that broadcasting only take place on alternate evenings in order that she have ample opportunity to catch up with her regular duties. It is understood that no one is compelled to listen to WEAF but those who do so may gain sufficient profit from the Thursday morning programs especially arranged for women to make up for the time lost on other hours of the schedule.

"An old farmer inherited some money." wrote one of WEAF'S listeners, "and went to the Waldorf to spend some of it." Said he to the clerk, "What time do you have meals?" "Breakfast from 6 until 11, luncheon from 11 until 8 and dinner from 8 to 11," answered the clerk. "My goodness," exclaimed the farmer, "when do you expect me to see the city?"

And then the writer went on to say: "The point is, if WEAF gives such wonderful programs all day and half the night, when am I going to do my housework and shopping? It is all too good to miss!"

Radio Saves Reporter

A somewhat tardy reporter, although it must be admitted, one with initiative, saved himself from being scooped on a local Capital story, through using his head and radio. He may have saved his head also.

It was Sunday. He had tickets to an entertaining matinee. He went intending to leave in time to make the trip to a big cathedral on the outskirts of Washington, get the speech of a celebrated divine, and return to the office to write his story for the morning. But he stayed so long at the theatre, he could not get to the cathedral in time, even with a taxi or an airplane.

Suddenly he recalled that WCAP was broadcasting the ceremonies and that there was a receiving set at the Press Club. He was saved. Rushing to the club, he tuned in, and leisurely made notes during the discourse of the speaker. Later at the office he pounded out a neat half column and went home; saved by the radio—if the city editor doesn't find it out.

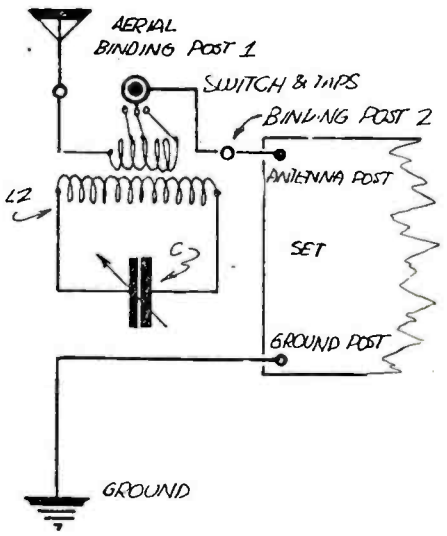


Figure 8. This shows the method of connecting the Eliminator to the receiving set. The Eliminator is the best all-around unit known as yet to tune out interference from any source.

Panel Treatment

For the old panel that you have grown tired of looking at—for the new panel that you know will soon become thumb-printed and for the rest of them, try this stunt to treat the surface and get in return, that dull finish and one that is easier kept neat and clean and something out of the ordinary.

For the first treating, secure very fine sandpaper or emery cloth and rub down until the entire finish is removed. Carefully brush all the dust off after this and with a soft cloth, apply thin oil and rub until it has disappeared.

After this comes the finishing coat which must be applied in only one direction and that, the lengthwise of the panel. Fine steel wool rubbed the long ways of the panel gives or rather leaves the grained finish yet a dull lustre appears. One's own judgment must be used when the panel has been sufficiently polished in this manner.

This application is especially recommended for the amateur who scratches up the panel in boring out the holes for the radio parts. This will cover up a multitude of sins in that direction and must always be done when the panel is unmounted.

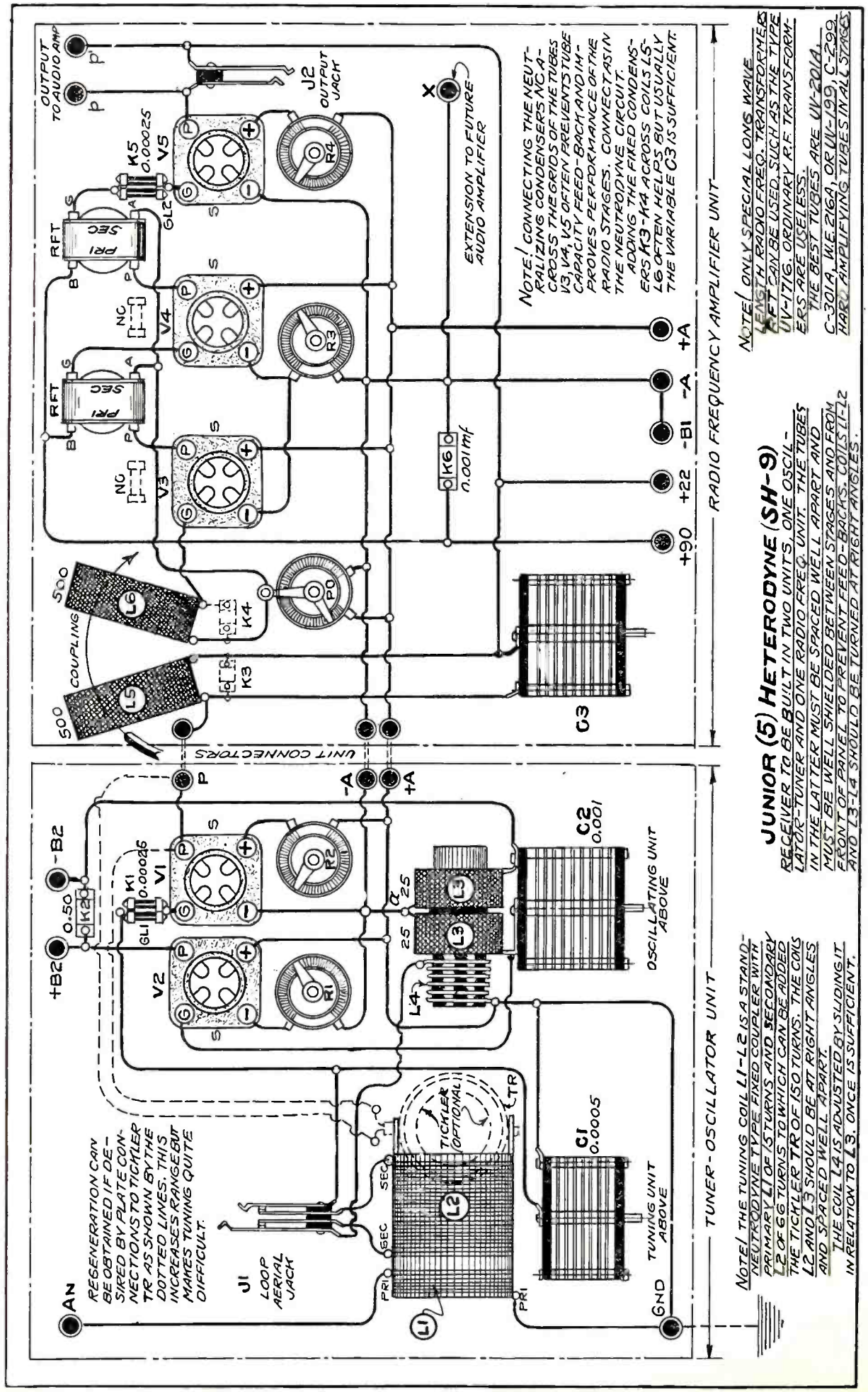


DIAGRAM FOR WIRING AND ASSEMBLING THE JUNIOR HETERODYNE

A Junior Super-Heterodyne

By JOHN B. RATHBUN

DURING the past twelve months we have witnessed a number of rapid and radical changes in radio fashions, particularly in the design of high power multi-tube sets, and from all present indications we are getting all set for still another radical departure —the super-heterodyne circuit. During last December (1922), the majority of the radio experimentalists were busily employed in tinkering with straight radio frequency or with the Armstrong super-regenerative circuits. The "super" circuits in most cases did not live up to expectations and by the first of the year all interest in this receiver had practically died out. The straight radio frequency circuits of that period were far from satisfactory. Hence, when the reflex circuit was announced, the tinkersmiths went at the new problem with great enthusiasm.

After "reflexing" all spring and part of the early summer, and after we were getting up to the point where we could show some real results with the reflex receiver, up popped Hazeltine's neutrodyne. At last we had found a solution for our former difficulties with the straight radio frequency hook-ups and the neutrodyne went merrily on, and in fact is with us today as one of the most prominent of hook-ups. While the neutrodyne proved a far more satisfactory circuit for the beginner than the R. F., or reflex type, yet there was something lacking that discounted it in the eyes of the more advanced students of radio. We soon found that the neutrodyne had very certain limitations and therefore determined to go farther afield to find the ideal in the super-heterodyne. Whether the latter will prove as practicable and popular as the neutrodyne is still a question, but there is one thing certain, and that is, no other existing circuit can hope to equal it in efficiency and performance.

Strictly speaking, the super-heterodyne is far from being a new circuit, but owing to the complication and expense of building it in its original form, it was so seldom spoken of that it is a decided novelty to the radio novice. The very mention of it was sufficient to send goose pimples down the spine of the unitiated until about a month ago when the first real attempts were made at the simplification of the circuit. Very possibly it will be as familiar to the novice within the next month or so as the straight regenerative or reflex circuits—there is no real reason why this should not be the case. At any rate, the super-heterodyne is the new star on the radio horizon and it will therefore be well for us to become acquainted with the general principles of the receiver and its simpler practical forms.

Formerly, when one spoke of the "Rolls-Royce of radio" it brought visions of long vistas of tubes and control knobs—

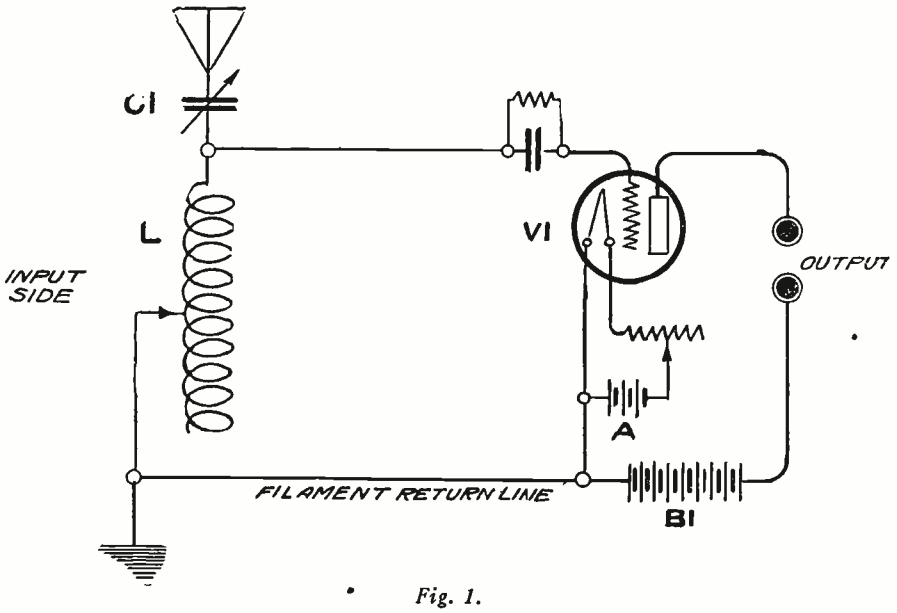


Fig. 1.

a veritable tube exhibit of the first degree. Actually, however, this need not be the case, for the elementary circuit can be made nearly as simple in construction and as easy to control as the more common straight regenerative and at the same time, retain a considerable proportion of its inherent high power of amplification and range. Tube for tube, it will be found far superior to any of the popular high power circuits yet devised, both in regard to signal strength and range. Further, it is not particularly critical or hard to tune, and its great selectivity alone should put it in popular favor even though its other virtues were of the ordinary order.

General Principles

It has long been known that far greater amplification is possible with long wave lengths bordering on 5,000 meters than with the ordinary short broadcasting waves lengths reaching a maximum at about 600 meters. In other words, far greater amplification is attained with a radio frequency receiver on long wave lengths than with short wavelengths. Further, there is one definite wave length on which amplification reaches

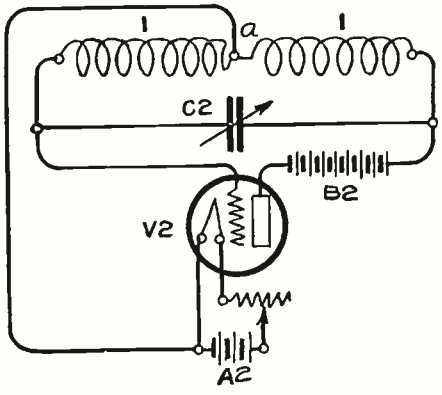


Fig. 2.

a maximum in a given circuit, and if the wavelength is above or below this critical value, the amplification will suffer accordingly. This means that the ideal receiver would be confined to one definite wavelength and that a long one when compared with that of the ordinary broadcasting station.

With these facts in mind it is at once evident that we must provide some means for converting the various short broadcasting waves into a long wave of constant length before the radio energy enters the amplifying circuit if we are to attain the greatest benefit from our apparatus. In other words we must provide a "frequency changer" for converting the 300 meters of Station X, and the 550 meters of Station Y, into one constant wavelength in the order of 5,000 meters. When this conversion has been performed, the converted radio waves pass to the radio frequency amplifying stages for intensification, thence through the usual detector tube and then through the audio amplification stages, should audio amplification be considered necessary. Back of the frequency changer, we have a circuit which is identical with that of the ordinary radio amplification set. We may have as many radio or audio stages as we desire, or rather as many as we can afford. Even one radio stage, detector and one audio stage are possible.

Before going further with a description of the circuit, we wish to call the readers' attention to the relation between "wavelength" and "frequency." The wavelength of a radio wave is the distance between the peaks of the radio wave measured in meters. The frequency of the wave is the number of complete reversals taking place in the wave per second; that is, the number of times that the wave surges back and forth (two trips) per second. Since the radio wave

progresses at a constant speed forward, approximately 186,000 miles or 300,000,000 meters per second, it will be seen that the wavelength must bear a definite relation to the frequency. In short, the velocity of the wave in meters per second, divided by the wavelength in meters, gives the frequency in "cycles per second" or the number of complete reversals per second. In the description that follows, it is much simpler to speak in terms of the frequency than in terms of the more commonly used "wavelength," but in any event the total result will be the same.

For example, a wavelength of 360 meters corresponds exactly with a frequency of 833,333 cycles per second, 429 meters wavelength corresponds to 700,000 cycles per second, and so on. The longer the wavelength the less will be the frequency in cycles per second, the shorter the wavelength the greater will be the cycles per second. One increases as the other decreases, in direct proportion.

Heterodyning

As before explained, we must first reduce the frequency of the rapid broadcasting wave to a frequency of approximately 60,000 cycles per second (5,000 meters wavelength), before passing the energy to the radio amplifying tubes of the super-heterodyne circuit. Thus, if the station is broadcasting on 429 meters wavelength, we must reduce the station frequency of 700,000 cycles per second to a frequency of 60,000 cycles in the amplifier circuit. This is performed by what is known as the "heterodyne method" in which an interference is produced between the incoming radio waves and the waves or oscillations set up by the "oscillating tube" in the receiving circuit.

By allowing the tube to oscillate at a certain frequency, and combining these oscillations with those of the incoming radio waves (at another frequency) we can obtain a resultant frequency equal to that required in the amplifier circuit. For example, let us say that the incoming waves from the station have a frequency of 600,000 cycles per second, and that the oscillations set up in the circuit by the oscillator tube is equal to 500,000 cycles per second. The resulting oscillations of the combined waves will be equal to the difference of the two frequencies or: 600,000 − 500,000 = 100,000 cycles per second. This means that the oscillations have been reduced from 600,000 to 100,000 cycles per second in the amplifier circuit. By adjusting the oscillator tube by means of a variable condenser any desired resultant frequency can be obtained in the same way.

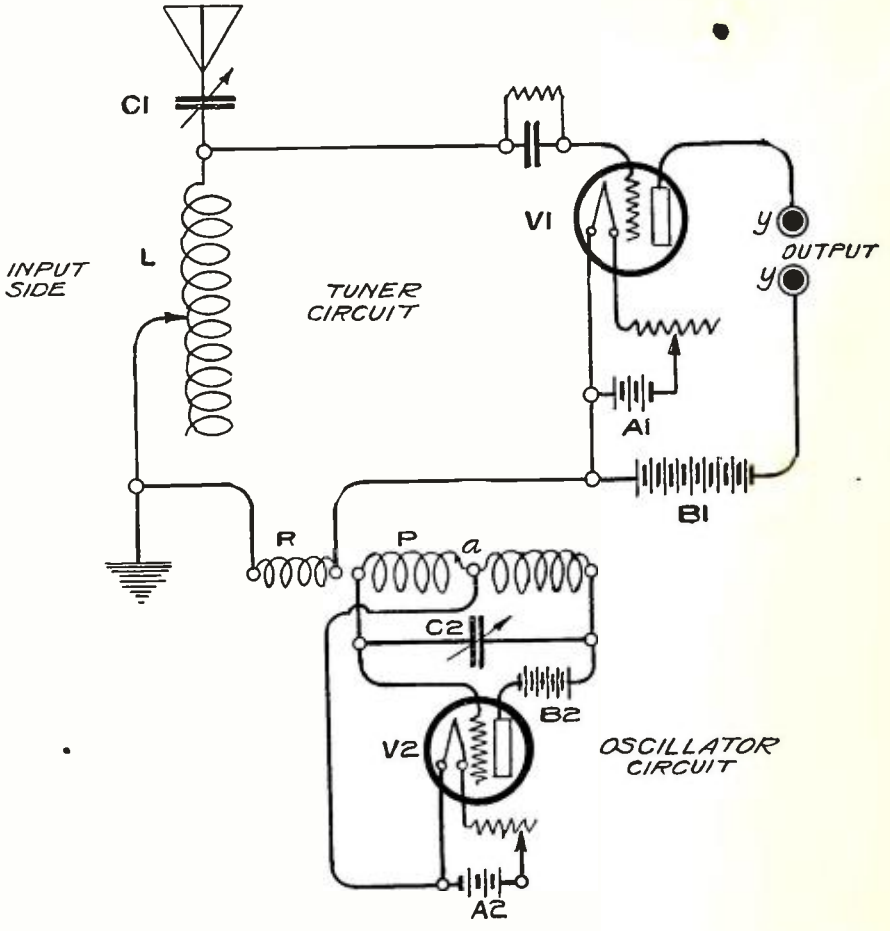


Fig. 3.

The oscillator circuit is the distinguishing feature of the super-heterodyne and is an essential part of the system. Electrically, the oscillator is quite simple as it consists of an inductance coil, an ordinary amplifier tube and a variable condenser, all of which are inductively connected to the usual tuning circuit through a few turns of wire somewhat like a fixed condenser. Varying the capacity of the circuit by means of the variable condenser varies the oscillation frequency of the tube. We now have two principal controls, (1) The tuning devices of the usual type, and (2) The control of the oscillator circuit or of the amplifier frequency.

Simple Oscillator-Tuner Circuit

An ordinary simple tube receiving circuit is shown by Figure 1 where (L) is a simple slide tuning inductance, (C1) is the primary tuning condenser and (V1) is the detector tube. You have seen this typical circuit hundreds of times if you have read RADIO AGE regularly. It is just an old-fashioned nonregenerative circuit first shown alone so that further developments can be more easily followed. This is the "tuning circuit," which of course can be modified by the substitution of a variocoupler for the inductance (L).

In Figure 2 we have the "oscillator circuit" drawn out alone where (I) is the inductance coil, with a connection (a) to the mid-point of the winding. The oscillator tube is (V2), and the variable condenser used for controlling the frequency of the oscillations is at (C2). So far—so simple. The oscillator tube is supplied with the "B" battery (B2) which is entirely independent of the battery (B1) in Figure 1.

Since the oscillations of the tube (V2) must be impressed on the tuning circuit, we show the combined tuning and oscillator circuit in simple form by Figure 3. Here the old tuning circuit of Figure 1 and the oscillator of Figure 2 are coupled together inductively by the coils (P) and (R). This is the fundamental circuit of the super-heterodyne shown in its simplest form. The output (y-y) leads directly to the transformers and tubes of the radio frequency amplifier division, and from this point on the rest of the circuit is almost identical with an ordinary radio frequency receiver. We can have any reasonable number of radio frequency stages from this point on, ranging from one stage to five. A second detector tube follows the radio stages, and then comes the audio amplification stages. It should be noted that

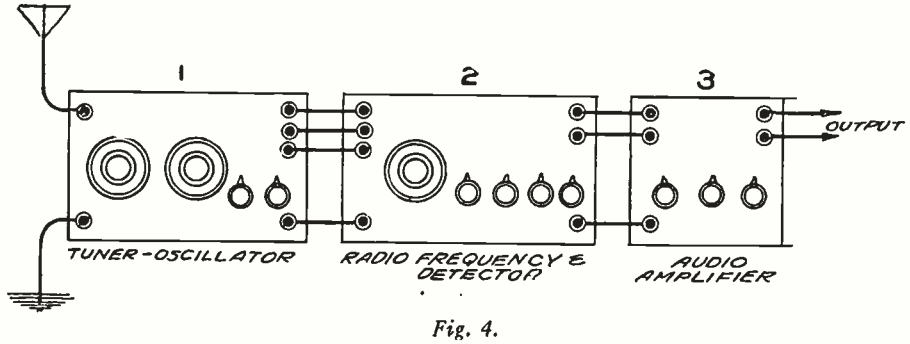


Fig. 4.

the super-heterodyne uses two detector tubes, one in the tuning circuit and one placed after the R. F. stages.

A schematic view of the complete super-heterodyne assembly is given by Figure 4, it being assumed that each of the three principal divisions is contained in a separate cabinet for convenience. In the first cabinet (1) are the oscillator and first detector tubes which give this division the name of the "Tuner-Oscillator Unit." The output of (1) is connected to the input of the "Radio-Frequency Unit" marked (2). Here the radio waves are amplified on the long wave length produced by the first unit, and are then rectified by the second detector tube which is ordinarily placed in (2). The output of (2) is then connected to the input of the "Audio Amplifying Unit" marked (3) where the volume of the sound is augmented by familiar means. The output of (3) then goes to the loud speaker.

It should be particularly noted that almost any type of tuner circuit can be used, either with an outdoor aerial, indoor aerial or loop aerial. Owing to the great powers of amplification possessed by this circuit, the loud speaker can be operated with good volume on stations several thousand miles distance, the exact volume of course depending upon the number of amplifying stages used. For convenience we have shown the ordinary flat-top outdoor aerial in the illustrations.

Radio Frequency Unit

Almost any type of radio frequency hook-up can be worked at (2), resistance coupling, transformer coupling or by tuned impedances. Probably, the transformer connected type with special long wave length transformers is the most common type, but not necessarily the most effective. However, no matter what class of stage coupling is used, there is one thing that we must keep in mind from first to last, and that is, that we are dealing with wavelengths in the nature of 5,000 meters in this circuit and that the ordinary short wavelength transformers and impedances are therefore absolutely useless with the super-heterodyne. The R. F. transformers used in reflex circuits and designed for wavelengths ranging from 200 to 600 meters are a hindrance rather than a help.

Outline of the "Junior"

In presenting the "Junior" super-heterodyne circuit the principal objective is simplicity and economy, with flexibility in regard to future expansion a close second. Starting with five or six tubes as a basis of operations, this being the smallest number of tubes which will insure the performance characteristic of the super-heterodyne, we can afterwards add more radio or audio stages as we may desire without tearing up the tuner-oscillator unit. As with any other circuit, the greater the number of amplifying stages, the greater will be the range and volume, and we can carry this up to ten or twelve tubes if our pockets will bear the traffic.

However, we have assumed that there are but few millionaires among our readers and therefore have confined ourselves to a five tube set, oscillator tube, frequency changer tube, two stages of radio amplification, and detector. If more volume is required, then two stages of audio can be added to the output in the usual manner. As the audio stages are ordinarily installed in a separate cabinet, the addition of these stages will in no way affect the Tuner-oscillator or the radio stages. Regeneration in the tuner circuit undoubtedly increases the effectiveness of the set, but in return makes it very difficult to tune. Every time that the tickler coil is moved, it upsets the rest of the circuit and we must then make a second or third trip over the dials to bring the circuit back into resonance. This feature can be added later if desired, after the builder becomes more familiar with the action of the circuit.

A unit construction has been adopted which makes the set simple to build and makes it much more compact than with the ordinary type of construction. Insofar as possible, the inductances have been mounted directly upon the variable condensers a la neutrodyne. In the near future it is likely that such units can be purchased ready built upon the open market, thus adding to the ease and certainty of construction.

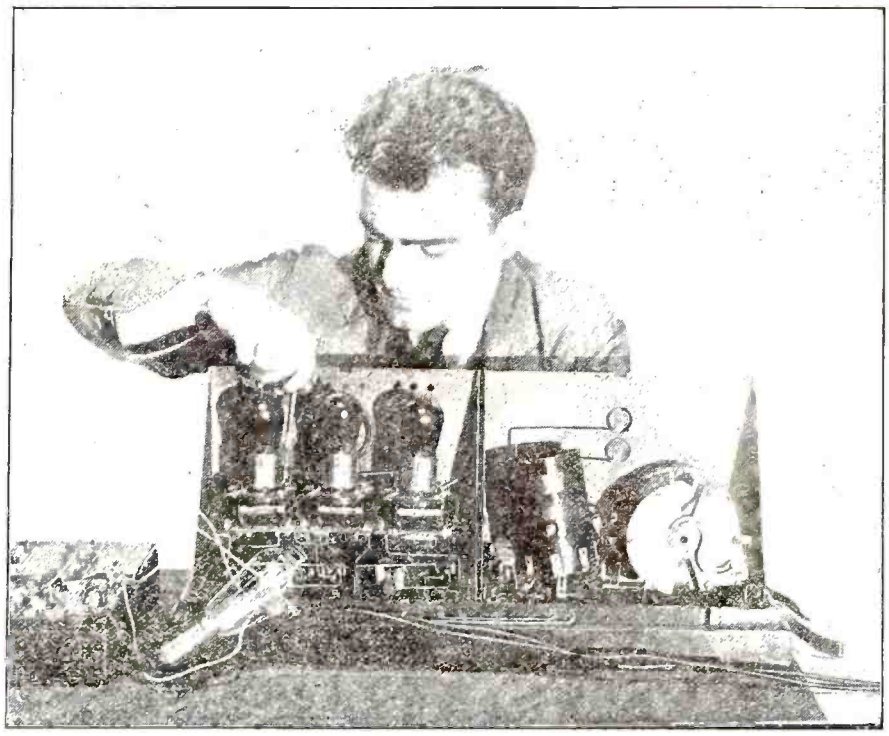
Tuning Circuit

Figure 5 gives the complete circuit diagram of the "Junior" super-heterodyne, and it will be noted that the tuner oscillator unit and radio frequency unit are boxed off in dot and dash lines to indicate the separate cabinets in which the apparatus is installed.

The first circuit to demand our attention is the tuning circuit, and this will be seen to consist of a fixed coupler (L1-L2) of the neutrodyne type which is tuned in the secondary circuit by the variable condenser (C1). The neutrodyne fixed coupler has often been described, but we may say that the primary coil (L1) consists of 15 turns of No. 20 D. C. C. wire wound on one end of a three-inch tube, while the secondary coil (L2) is wound on a 3 1-2 inch tube and consists of 66 turns of the same size wire. The primary winding is now placed inside the tube containing the secondary, and the relation between the coils is fixed by securely fastening the two tubes together at their ends. The tuning condenser is a variable vernier type with a capacity of 0.0005 m. f., and is the only tuning element used.

A UV-201A or a C-301A tube is preferred for the first detector tube (V1). We do not advise the use of dry cell tubes for this purpose. The grid condenser (K1) is the conventional 0.00025 m. f. with a variable grid leak (GL) of the lead pencil mark type. The plate voltage is 22.5 volts.

A two circuit jack (J1) normally connects the coupler into the circuit, but when the loop plug is inserted the coupler is cut out and the loop aerial is automatically connected directly across the condenser (C1). With this arrangement it is a simple matter to change from outdoor aerial to loop and vice versa. For



SAFETY FIRST

Many an amateur radiophan has learned to his dismay that 90 volts "B" battery accidently connected across the filament of the tubes is an expensive mistake. An excellent method for testing, etc. is to hook a 110 volt, regular house lighting bulb in series with the minus lead of the B battery. The bulb acts as a safety valve, allowing the current to pass freely to the tubes on the plate, but should the connection be wrong, only six volts will fill the tube, the excess current being absorbed by the bulb,—result $5 to $40 saved for Mr. Experimenter (Foto Topics).

simplicity, the jack can of course be omitted.

The tuning unit or coupler (L1-L2) can be a commercial neutrodyne coupler, but if home made it is strongly recommended that the coupler be attached permanently to condenser by brass brackets as is done with the neutrodyne sets. This gives compactness which is most desirable in a circuit of this kind.

Oscillator Circuit

Here we get into the distinguishing feature of the circuit, the circuit which produces the oscillations for the heterodyne effect. The inductance (L3) consists of two 25-turn honeycomb coils placed close together with a tap (a) running out from the mid-connection between the coils. They are connected in series and care must be taken that the turns run in the same direction so that they act together and do not "buck." Across the outer ends of the two coils is the variable vernier condenser (C2) with a capacity of 0.001 m. f. (43 plate). One of the outer ends of the inductance is connected to the fixed condenser (K2) which has a capacity equal to 0.5 m. f. or slightly greater.

The tube (V2) is an amplifier tube of the UV-201A type, or even better, a Western Electric 216A. A separate "B" battery (B2) is used for this circuit with a voltage approximating 67 to 90 volts. This battery must be entirely independent of the rest of the circuit, hence is one of the reasons for the high cost of heterodyning.

At one side of the oscillator inductances is the coil (L4) which couples the oscillator circuit to the tuning circuit. It is a coil of about six turns of No. 20 D. C. C. magnet wire, and of course is in inductive relation with the coils (L3). Both sets of coils are supported on a single fiber tube, and the coils (L3) are connected rigidly to the variable condenser (C2) by brass brackets as with the neutrodyne coils. This makes a self-contained and compact unit which requires little space and which is easy to wire.

Radio Frequency Circuit

Coupled to the plate (P) of the first detector tube (V1) are two stages of radio amplification. The two radio frequency transformers are of the special long wave type already mentioned and should have a rated wave length of from 5,000 to 15,000 meters. As these transformers operate constantly on one wave length the requirements are not the same as with ordinary types of transformers, since the latter are designed to cover as large a range of wave lengths as possible. The narrower the band of wave lengths, the greater will be the amplification of the transformers, and without doubt special transformers will soon be on the market which have this most desirable characteristic. The radio frequency amplifying tubes (V3-V4) may be UV-201A or C-301A, and should be provided with rheostats of sufficient resistance to permit of operation on a six volt storage battery. A potentiometer (PO) controls the grid potential of (V3)

It will be noted that the radio stages are coupled to the first detector tube (V1) through tuned coils (L5) and (L6), these coils being so arranged that the distance between them can be varied. Both (L5) and (L6) are 500 turn honeycombs, mounted in a two coil mounting for convenience in varying the degree of coupling. Across each of these coils are the two fixed condensers (K3) and (K4) which have a capacity of 0.0005 m. f. each. These condensers, which should be of the mica dielectric type and accurately calibrated to the specified capacity, can be mounted directly on the coil mounting. This adjustment of the coils is not critical and is easily performed.

The secondary of the last radio frequency transformer is connected in the usual manner to the second detector tube (V5) through the grid condenser (K5) of 0.00025 m. f. capacity and the grid leak (GL2). The plate of this second detector tube is connected to the output jack (J2) and the output binding posts(p-p'). The latter affords a means of connecting a loud speaker into circuit or for hooking on one or two stages of audio amplification as may be desired. It was considered advisable to discontinue the set before the audio stages were added for these can be installed at any time and by conventional audio amplification circuits. We believe, however, that the average constructor will have many thrills with the set the way it is shown before he thinks of adding more stages.

Precautions and Advice

As with every other radio frequency circuit, there is a strong tendency to feed back between stages and to start oscillations in the radio frequency tubes which will not only reduce their efficiency but which may even entirely prevent the functioning of the tubes. For this reason the transformers should be well separated, and as a further precaution the axis of the transformers should be turned at right angles to one another to prevent inductive feed backs through stray fields. For the same reason, the tubes should be well separated from one another and from the transformers as well. Placing well grounded metal shields between the transformers and between the transformers and tubes will minimize such troubles.

It is suggested that the grid neutralizing stunt of the neutrodyne be experimented with on the two R. F. tubes and the second condenser; that is, two of the small "micro-mikes" used for neutralizing the grid should be connected between the grids of tubes (V3), (V4) and (V5). I have not yet tried this arrangement but I believe that it would prove helpful even though it might not be quite so effective as on the shorter wavelengths. In this event we would have a "neutrodyne-super-heterodyne", surely enough name to pull it through if nothing else. The proposed neutralizing condensers are indicated by dotted lines and are given the symbols (NC).

It is of great importance to keep all wires well separated and to prevent running wires parallel to one another for any distance. The sockets should be raised well above the base board to prevent leakage strays from taking place, and if possible, the sockets should rest on a bakelite slab rather than on wood.

We must next be sure that the coils (L3) do not buck each other; or in other words, that the turns on both coils run in the same direction so that the effect is that of a single coil. Coil (L4) can be moved back and forth until the maximum effect is had, and when once this adjustment is had it can be left without further adjustment.

Government Regulation

Radio, which for the first time carried to the continent at large and perhaps Europe and Central America, the President's message, also carried his recommendations for remedial legislation on radio. Echoing Secretary Hoover's request that the laws affecting radio administration enacted in 1912 be revised, the President personally told congress that new legislation regulating radio interference is needed. At present, Secretary Hoover is operating under a sort of "gentlemen's agreement" between commercial, governmental, private and amateur interests, reached last spring during the second National Radio Conference.

Secretary Hoover stated recently that Representative White, who fathered the bill which bore his name last session. will introduce a simplified radio bill this session. The old bill, it is understood, has been reduced to first terms so as to permit of proper interpretation with the development of the art and to give the Secretary of Commerce and his advisory committee liberal and more or less elastic authority over the control of national radio problems. A recent conference between representatives of the government departments was successful in eliminating such points of disagreement as existed heretofore, and the resultant bill was ready to be introduced in the house before the end of this month.

According to Secretary Hoover, the radio interference situation today is far better than it was at the time the original White Bill passed the house last year, due chiefly to the elimination of interference through the voluntary co-operation of the several interests. There is now little interference between the existing broadcasting stations, which are decreasing in numbers.

In general, the President also indorsed the enactment into law of the approved plan of the Joint Committee on the reorganization of the government departments, which places radio under the direction of an Assistant Secretary of Communications, who would have charge of telephone and telegraphs. The post office and the radio section of the Bureau of Navigation of the Department of Commerce would become a part of the Department of Communications, according to the present plan of the Joint Committee.

Before the reorganization is effected, however, all phases of the radio question will probably have been threshed out and its administration may or may not be taken away from the Department of Commerce. The proposed bill, it is understood, carries no suggestion of a transfer of radio to the new Communication Department.

Construction of the Push Pull Amplifier

By FRANK D. PEARNE

THE use of the third step of audio frequency amplification in most any of the standard sets in use today results in distortion of the signal and considerable noise, so much noise, in fact, that the added volume to the signal is of little or no value. These noises are caused usually by the ordinary tube noises in the detector being amplified at the same time the signal is amplified. Even the second stage will sometimes magnify these tube noises to such an extent that they are extremely disagreeable.

If, however, the user would get away from the conventional idea that a transformer of high ratio should be used in the first step, this effect would be considerably reduced. In code reception, more or less distortion does not interfere much with the reception, but when listening to a good musical selection it makes all the difference in the world. It is a well-known fact that the lower the ratio of the transformers used in audio frequency amplification, the less will be the distortion. As each succeeding stage amplifies everything which precedes it, it is only reasonable to expect that if the first stage has a high ratio of amplification and some distortion, that distortion is bound to be amplified in each succeeding stage.

Reversing the Ratios

Therefore, the order of things should be reversed, using the low ratio transformers in the first stages and the higher ratio in the last. This arrangement would cause the first stages to be amplified without distortion, after which it could be stepped up in the higher ratio, with only the distortion of the last stage affecting the loud speaker.

To eliminate the distortion in the last stage and at the same time increase the volume to such an extent that it may be heard two or three city blocks from the receiver, the "push pull" amplifier should be used in the last stage. Until recently, this type of amplification was out of the reach of the broadcast listener, because the special transformers required in its construction were not available. However, during the last month or two, transformer manufacturers have discovered that there is a great field for this product, and it is now possible to get these special transformers made by most all of the reliable manufacturers.

This type of amplifier will produce undistorted signals of enormous volume, providing that the signals presented to it are of good intensity and are clear. It is generally used as a third stage, but owing to its great amplifying power it can be used quite successfully in the second stage if desired.

Connection With Phones

By looking over the accompanying drawing one will notice that the direct current of the plate battery is not applied to the phones, as the secondary of the output transformer is directly connected to them. This greatly aids in obtaining clear reception, as the plate battery noises are eliminated in the phone circuit. The parts may be either mounted in a cabinet, or on a bakelite panel which will lie flat upon the table. The latter arrangement can be made into a very neat appearing outfit, if carefully wired with the parts properly located.

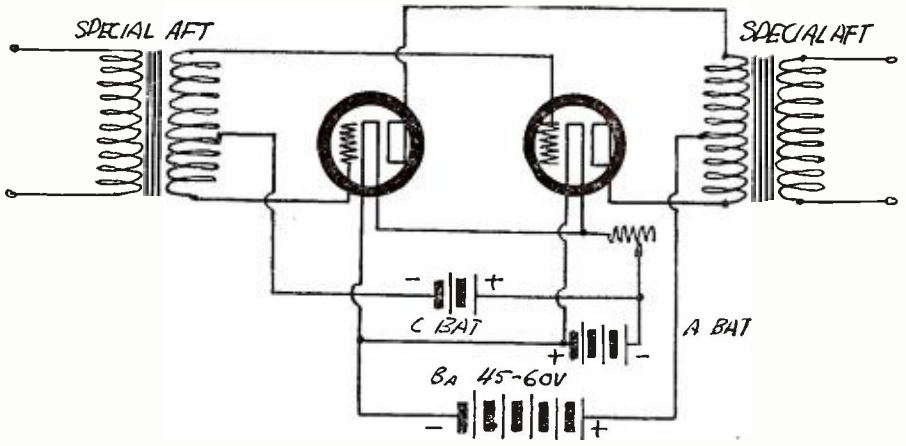


Figure 2.

The material required for its construction consists of the following parts, two push pull transformers, one rheostat, two sockets, two amplifying tubes, one C battery, twelve feet of bus bar tinned copper wire, No. 14, eight binding posts, one bakelite panel, 7 by 10 by 3-16 inches, and four rubber feet.

The resistance of the rheostat will depend upon the type of tubes used. The best tubes for the purpose are the W. E. 216 A and if these are used the rheostat resistance should be approximately 6 1-2 ohms. These tubes are, however, hard to get. The UV-201-A tubes may be substituted in which case, a 25 ohm rheostat should be used.

Making the C Battery

The C battery may be made of flashlight battery cells and the voltage required will depend upon the plate battery voltage used. The pressure of one of these flashlight cells is about 1 1-2 volts and for a 90-volt plate battery, three cells will be sufficient, but if more pressure is used in the plate circuit, the number of cells in the C battery should be increased.

In connecting the C battery in the circuit, care must be used to see that the negative terminal of the cells is connected to the center tap, or the extra binding post on the input transformer. This puts a negative bias on the grids of the two tubes and if the connections are reversed, the amplifier will not work. The No. 14 tinned copper wire is to be used in wiring up the set and any connections which are not made on the binding posts direct, should be carefully soldered to insure perfect contact.

All parts may be fastened to the panel by means of small brass machine screws and nuts and the rubber feet are to be fastened, one under each corner, so that the panel will be raised slightly from the table and the entire weight of the amplifier will come on the rubber feet.

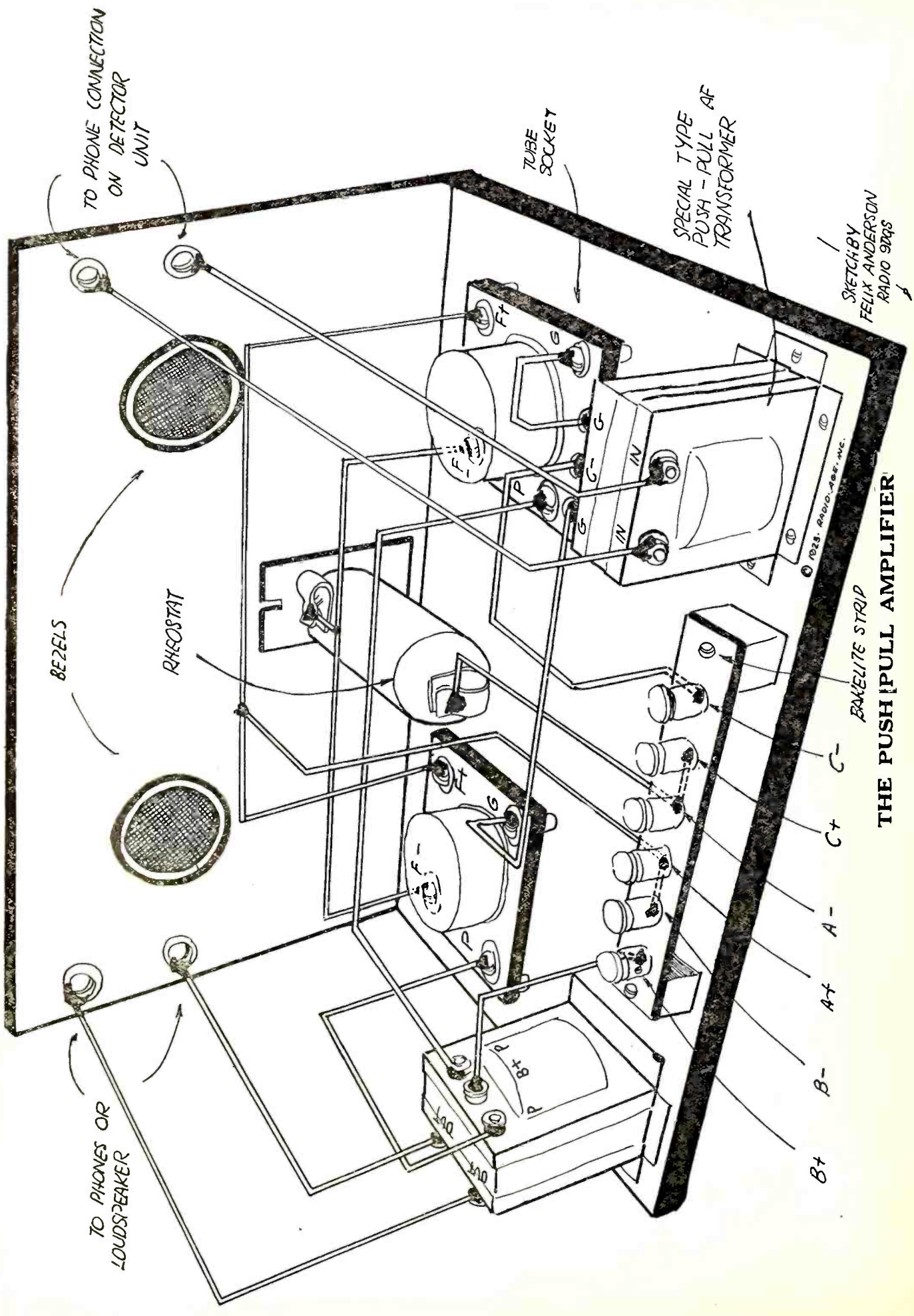
The greatest care must also be exercised in the wiring. The radio frequency wires which are the plate and grid wires must be widely separated and, in fact, it is a good idea to keep the grid wiring as far as possible from any of the other conductors. If this is not done, there may be an audio frequency feed back to the grids, by induction between the wires, which will cause the amplifier to howl.

Results Are Surprising

If these instructions are carefully followed, the result of this addition to any set will be surprising. It may be found that using it as a third stage will give entirely too much volume in the ordinary home, as it will be almost deafening, but will still retain the quality which is found in the lower stages. In this case it can be substituted for the second stage. Even if the push pull is used as a first stage amplifier, the results will be much better than the ordinary one stage amplifier and the music will come in so clear and distinct that one would almost believe the player was in the same room.

After using such an arrangement it will be hard to ever go back to the ordinary method of audio frequency amplification. It must be understood, however, that this type of amplifier will not remedy poor reception, that is, if the receiver does not bring in clear, distinct signals, the amplifier will only repeat what is fed into the input transformer, but with a good receiver, nothing can compare with the results obtained by using this arrangement.

On the next page will be found an isometric drawing, showing in detail the method of assembling the Push Pull amplifier. Readers write to us saying these picture diagrams are more easily read than photographic illustrations.—The Editor.



THE PUSH-PULL AMPLIFIER

The Rosenbloom Circuit

By FRANK D. PEARNE

ONE of the greatest difficulties in the construction of a radio set which some beginners encounter, is the soldering of the connections and for those who cannot do a good job of soldering, the Rosenbloom circuit offers an easy way out. This arrangement was designed by William Rosenbloom, of Revere, Mass., and has so few connections that practically all of them can be made on the binding posts alone. It is very efficient and has very few controls compared to most of the other good sets in use today.

Comments on the circuit, made by those who have used it, are quite favorable, some claiming that for selectivity and sensitiveness, especially when using a UV-200 detector tube, it can not be excelled. Because of the few parts used in its construction, one man was able to assemble a test circuit and had it working in less than one hour. No variocoupler is used which, of course, will dispense with many soldered joints on the necessary contacts and the substitution of a variometer in the primary circuit in combination with a fixed condenser gives extremely sharp tuning with only one control.

The two variometers should be of the basket-ball type to get the closest tuning, although any of the standard wood, or bakelite variometers will work, but the builder is advised to select those having the least distributed capacity.

Condenser

The condenser used in the aerial circuit is a fixed Micon condenser having a capacity of .0005 M. F. which is equal to that of a 23-plate variable, although not adjustable. The variable is not needed here because of the fine tuning qualities of the variocoupler in this particular part of the circuit. In some cases a small 3-plate variable has been shunted across the terminals of this condenser to give a vernier effect, but this is not necessary under ordinary conditions.

It will be noticed that the drawing shows a potentiometer connected across the filament battery leads. The lever of this potentiometer is connected in series with the phones and the plate battery for the purpose of adjusting the voltage in the plate circuit. This also may be eliminated if desired, but when tuning in a weak wave coming from a long distance, it is wonderfully effective, and as Mr. Rosenbloom says, "if anyone doubts its value, he should use the receiver for awhile, with the potentiometer, and then attempt to do long-distance work without it.

Perhaps one of the reasons that some amateurs are so successful in getting long-distance reception and others are not, is due to the fact that some use the potentiometer and others do not. It is one of the most important controls on any receiver, because there is one certain voltage at which the plate circuit will function best, although some results may be obtained with voltages somewhere near this critical point, but for the ideal reception, it should be exact and the potentiometer furnishes the means of getting this fine adjustment.

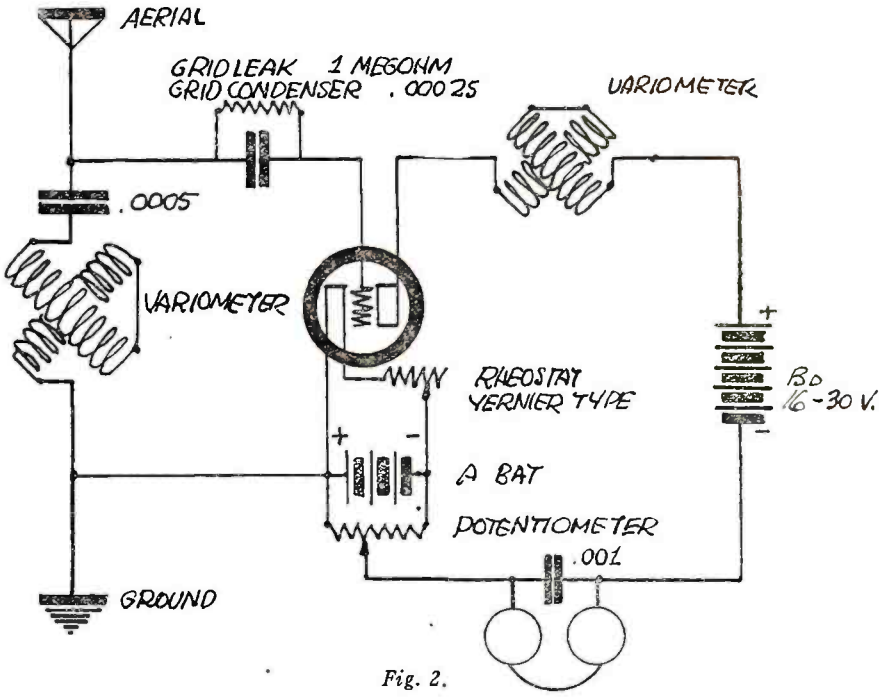


Fig. 2.

The other variometer serves to tune the plate circuit, thus making the circuit regenerative. This regeneration takes place through the tube itself, the plate and grid, acting as a small condenser, through which any change in the plate circuit will react upon the grid, building up the charge upon it, causing the original charge to be sustained for a longer period and giving considerable additional amplification to the signal. The fine gradations of control made possible by the potentiometer are especially evident when the gassy UV-200 detector tube is used.

Old Favorites

Fans who have been experimenting with various circuits have begun to show a definite trend back to hook-ups which they tried out months ago and then laid them aside to try something "new." This suggests the comment that there are only a limited number of fundamental radio hook-ups and that changes in these circuits are often changes for the worse. One of the interesting circuits that did well for those who tried it some months ago is the Rosenbloom. A full page isometric drawing is printed on the next page, showing how to assemble this receiver.—The Editor.

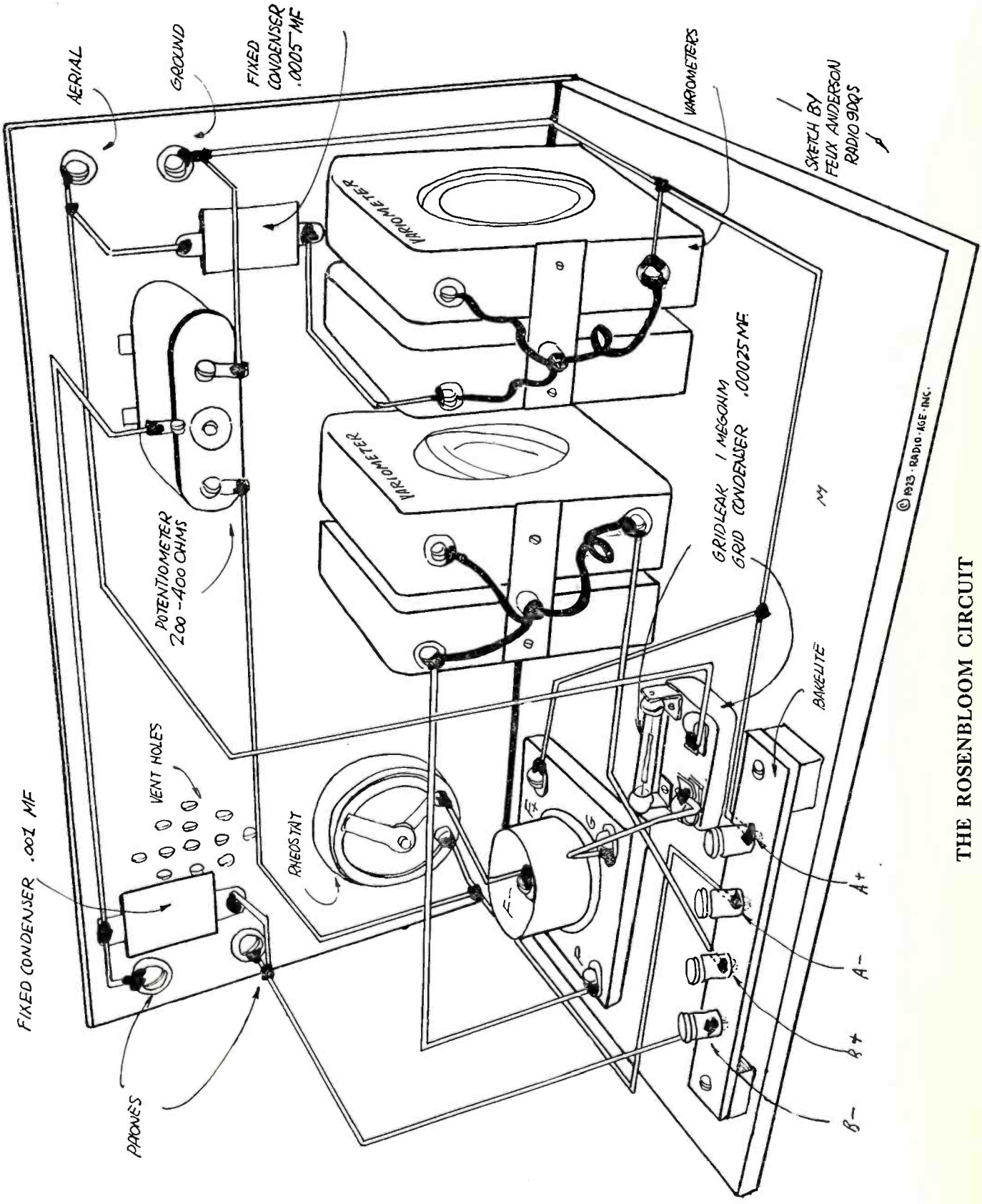
Ground Wire

When the parts are mounted on the panel as shown in the drawing, one should make sure to so connect the variometer which is used in the primary, in such a way that the ground wire will be connected to the end of the rotor shaft which extends through the panels, as this will greatly reduce the body capacity effect. The plate battery should be of the variable type having taps at different voltages, so that any voltage from 16 to 22 1-2 may be obtained.

The condenser which is shown connected across the phones is a mica type fixed condenser having a capacity of .001 M. F. Some arrangement for switching off the filament battery should be used, as the potentiometer, which although having a high resistance of 200 ohms will run the battery down in time, for the reason that a very small amount of current will flow through it all the time, whether the set is in use or not, if some switch is not used in the battery circuit, to open it when the set is not in use. The same end, however, may be accomplished by disconnecting one of the battery terminals when the set is not in use.

The rheostat used is the standard 6 1-2 ohm type, which is always used with the UV-200 tube. The grid leak has a resistance of from 1 to 1 1-2 megohms and the grid condenser has a capacity of .00025 M. F. If any tube other than the UV-200 is used, the grid leak should be variable.

The amateur will find this circuit to be one of the most simple arrangements that can be constructed and he will not be disappointed with the results if the instructions are carefully followed.



THE ROSENBLOOM CIRCUIT

Pickups by Readers

WITH this issue we leave behind us a year's accumulation of new reception records, and challenges, and enter upon an effort to pile up the best record for the new year.

As we look over the mass of letters from the many Pickup fans while reverently filing them away, we are filled with a feeling of satisfaction that our radio brothers have accomplished much, and turning our thoughts toward the future, we wonder what the many readers of this department will accomplish in the coming year. We wonder what kind of receiver will do the most consistent work in getting the DX stations, and we wonder when the Pickup fans will stop breaking records.

We know, fellows, we are in for some keen surprises, and we know that this is going to be one of the big departments of RADIO AGE. Half the fun in radio is building a set from clear instructions, and the other half is telling the other fellow about what the set can do.

If you want to tell it to a real bunch of radio fans, send in the dope to the Pickups By Readers department, and you may be sure that it gets before the kind of fellows who appreciate it.

C'mon BCL's, we're off on a flying start to set new records, and as we fire the starting gun, we simultaneously wish you a HAPPY AND LONG-DISTANCE BREAKING NEW YEAR!

THE PICKUPS EDITOR.

It looks pretty much like the Kopprasch fans have a flying start on the rest of the contenders from the appearance of the letters following:

1305 Dayton Ave.
Springfield, Ohio.

RADIO AGE,
Pickups Department,
Gentlemen:

I am writing you to let you know as to the nature of results I am getting from the Kopprasch circuit published in the April issue of RADIO AGE.

It is, and is doing all you claim for it. We have stations here within a radius of fifty to seventy miles, but they don't come in as strong as the stations two hundred to one thousand miles distant.

I held WGY last Thursday night for three hours and forty-five minutes without one bit of fading, and can pick up WOR, WFAA, WBAP, NAA, KSD, CFCA, WDAJ and many other stations at will. It is the best circuit I have ever tried out, and I speak from costly experience, having had twenty-one of them. The Kopprasch is the bearcat of them all. Long distance stations come in good and strong, and I think considering that my location is one far from favorable, that I have been getting results.

For reception, my antenna is between two tall chimneys and only two wires thirty-six feet long. Tell Mr. Kopprasch that his circuit is certainly a humdinger.

CHARLES H. MOORE.

Mr. Moore uses a one-tube set. His letter really calls for no comment, but will probably arouse the interest of many other BCL's who are using other circuits.

KOPPRASCH CIRCUIT FOR W-D-11 TUBES.

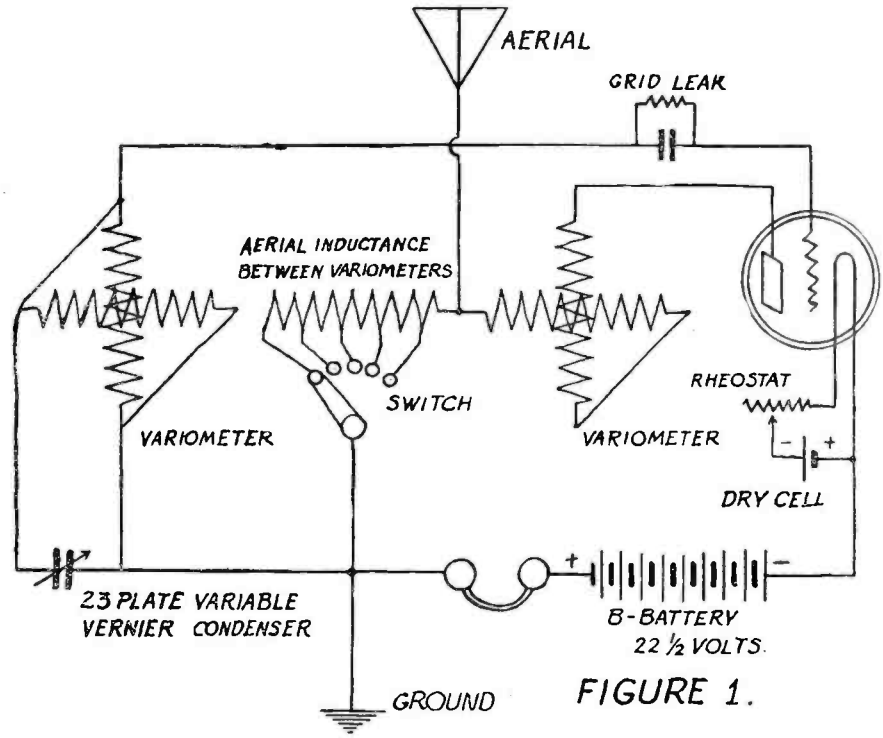


FIGURE 1.

MOUNTING OF VARIOMETERS AND TUBE

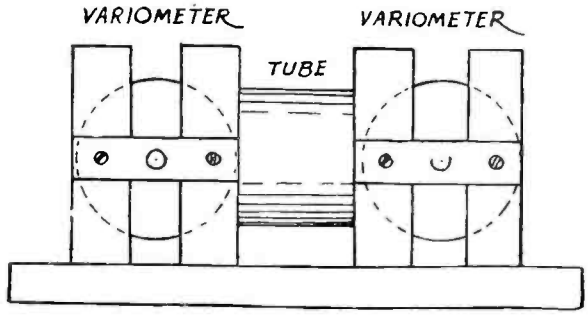


Figure 1. This shows the Kopprasch circuit and the method of mounting the inductance between the two variometers. The inductance consists of forty turns of No. 22 DCC, with taps at every eighth turn, and is wound in opposite direction to the stators of the variometers. Care should be observed that the stators are wound in the same direction. Full details concerning this set appeared in the April 1923 issue of Radio Age.

Hear number two from another fan using a Kopprasch:

2111 St. Paul Street
Baltimore, Md.

RADIO AGE,
Pickups Department,
Gentlemen:

In answer to G. W. Jeffers, of New Jersey, in the November Pickups Department, I would venture that if Mr. Jeffers keeps going at the rate he has been traveling, he can open the window, and get CHILE. And he did it with his little Kopprasch. Let me explain.

With my Kopprasch, built last April, with the WD11 tube using 16½ volts on the plate, I have been able to pile up the following record, some of the work being done during violent electrical storms.

I have twenty-eight stations to my credit, with letters in each case to prove it. I hold as the following my best reception: WOS, WOC, WDAP, and I respectfully beg to ask you to remember that Baltimore is considered a *dead* spot for radio signals, so you will please take this into consideration. I am almost afraid to venture to say what it will do with two stages of AF! My best distance may only be 800 miles, but I don't believe that any other circuit could do even that much in this town.

I hear MacMillan getting messages from WJAZ regularly, as Chicago is one of our standbys. Put me down as a Kopprasch booster.

Very truly yours,
JOHN J. DRECHSLER.

The Kopprasch circuit seems to have a queer habit of working in long jumps. breaking rules regarding dead spots,

The foregoing letters speak pretty well for this circuit. In a postscript, Mr. Drechsler says, "I can tune anything out that I want to." You fellows who have been having trouble with your sets, dig up that April issue and get posted on this circuit.

The users of Cockaday sets are by no means back-numbers this month. Those using this circuit are getting a great kick out of the long distance range it affords as the following will explain:

Madison, Wis.

RADIO AGE,
Pickups Department,
Gentlemen:

I have read several numbers of your journal with considerable interest. I am the enthusiastic owner of a Cockaday Four Circuit Tuner and have read the letters in your last issue as sent by others using the set. Last year I used a regular Armstrong regenerative set with a variocoupler and two variometers. During my vacation last summer I had time to read up on the newer circuits in the radio journals and read the description of the set in RADIO AGE and how to build it. Have had it working since September 16. I can heartily endorse all other users have said about the set and think I have some pretty good records myself.

My set was constructed from parts in the old set with the necessary additional parts. It has the regular arrangement with two stages of audio frequency amplification. Last year I had 137 stations on my map of North America and since setting up the Cockaday set have added thirty-five making 172 that have been heard in less than twelve months as I put in my last year's set at Christmas time. I have heard about 125 of the 172 stations this fall with the Cockaday set and can get easily fifteen to twenty stations any evening if I want to stay with it. The best record I have made was on October 20, when I heard the following stations from 7:30 until 11:20 p. m.:

WOC	Davenport, Iowa
WHA	Madison, Wis.
KFIC	Fond du Lac, Wis.
WDAP	Chicago, Ill.
WDAF	Kansas City, Mo.
WBAP	Fort Worth, Texas
WDAO	Dallas, Texas
WMAQ	Chicago, Ill.
KYW	Chicago, Ill.
WHAS	Louisville, Ky.
KDKA	East Pittsburgh, Pa.
WGR	Buffalo, N. Y.
WEAH	Wichita, Kans.
WOQ	Kansas City, Mo.
WHN	Ridgewood, N. Y.
WTAM	Cleveland, Ohio
WLAG	Minneapolis, Minn.
WOAW	Omaha, Neb.
WSB	Atlanta, Ga.
WBAK	Harrisburg, Pa.
WSAI	Cincinnati, Ohio
9XM	Madison, Wis.
KFKB	Milford, Kan.
KFI	Los Angeles, Calif.
KGO	Altadena, Calif.

The above list of twenty-five stations covers almost the entire length of wave ranges, except KSD, and I have heard them often so the set has plenty of range, and covers most of the United States and Canada, as I have heard six Canadian stations from Calgary to Montreal.

Its freedom from body capacity, sharp tuning and loudness are a joy to every one. My set brings in all of the stations of 500 watts and over on a loud speaker in my 500 mile radius, and KDKA, WGY, WOR, WJZ, WSB, WFAA, WBAP and KLZ as well.

The letters from the fans with the different sets are very interesting. KEEP IT UP.

Yours very truly,
WILLIAM H. WRIGHT.
Associate Professor of Agricultural Bacteriology, University of Wisconsin.

There "ain't" no bacteria on the Cockaday, is there, professor? The fellow who puts in a Cockaday gets blisters on his fingers from holding the pencil in his hand all the time to log the many stations he hears. And what's more, the fellow who uses a four-circuit tuner doesn't let any grass grow under his feet when it comes to getting the long distance stuff.

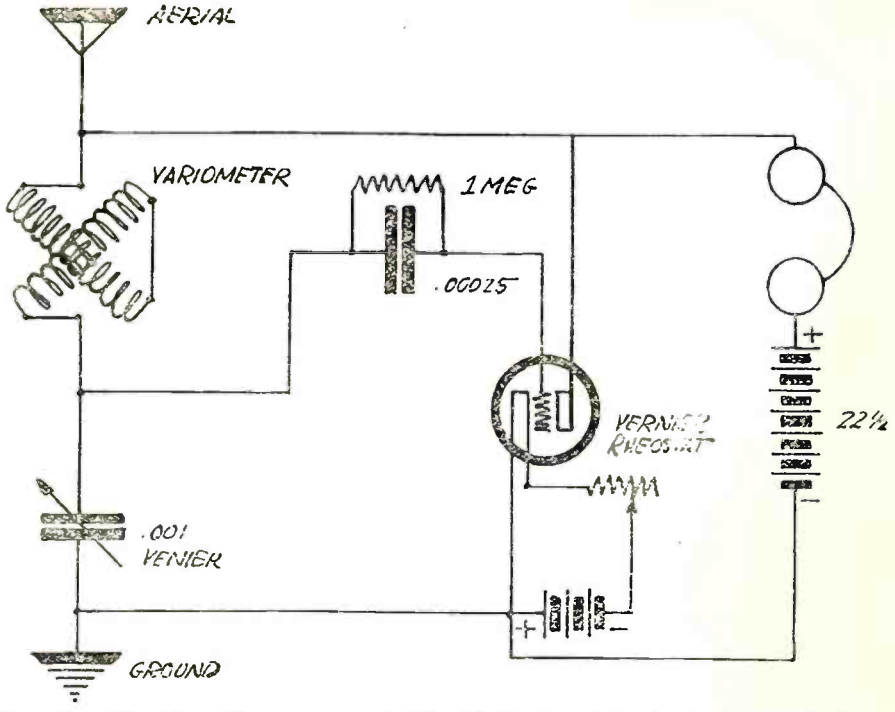


Figure 2. This shows the connections of the first tube set, with which several of our readers have accomplished long distance records.

Memphis, Tenn.

RADIO AGE,
Pickups Department,
Gentlemen:

Just a little line to let you know that on the evening of November 27 I picked up WTAS, Elgin, Ill., and WCAS, Minneapolis, Minn., over a friend's Cockaday. I believe that this is a record for a station of small power, with WMC, my local station, going full blast.

Very truly yours,
JAMES P. COOPER.

The above letter is just one of many we receive, praising the selectivity of the Cockaday set.

The following communication is just another reason why we said that the Kopprasch fellows have a flying start:

242 Vine Street, Council Bluffs, Iowa.
RADIO AGE,
Pickups By Readers Department.
Gentlemen:

I noticed in your reference to Mr. Fleckenstein's list of stations in your November issue, that you want to know how about the Kopprasch fellows. Well, here is from one of them and I kind of think I have him beat. Here is my list for November only: Stations WJAZ WHB, WLAN, WGY, WAAG, WDAF, WOS, WDAG, WSAP, WLAG, PWX, WDAP, WFAA, KPO, WAAF, WOAI, WCK, WHAS, WSB, WCAS, WCAH, KSD, KDKA, WPAL, WLW, WOAA, KLZ, KFI, WAAK, WWJ, WJAX, KYW, WPAD, WWI, WKY, WTAM, WEAH, WOC, WLAJ, WJAD, WOO, KWH, WGR, WMAQ, WEAF, KHJ, WBAH, WHA, WSAI, WJAS, WRM, WGAY, WCX, WMC, WKAA, WCAM, KFKA, WFY, WPAH, WBAP, WCBD, CKCK, KGW, WTAS, KSS, WNAP. The above list was logged just as received, and does not include our local stations WOAW and WAAW, two very powerful stations which I succeeded in tuning out a number of times, and when you can tune out either one of them, you are going some, as they are only four miles off. While I am writing this, I am listening to a very nice concert from WDAP, Chicago.

It may help some of the Kopprasch boys if they will add a 43-plate variable condenser in series with the antenna, hook up stator to antenna and rotor to antenna binding post on set; find it helps a great deal with my three WD11 tube Kopprasch receiver. From the other lists that have been published, I think the Kopprasch is holding its own pretty well; one station I overlooked in my list is CFCN, Calgary, Alberta, Canada. I had them for a short time but was cut out by another station.

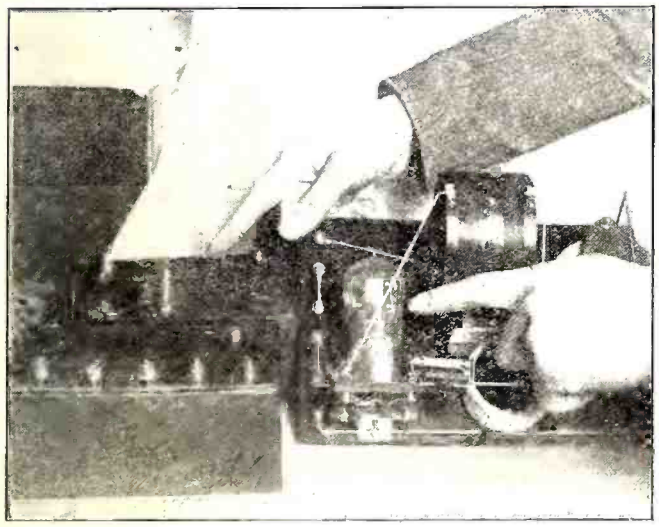
Respectfully,
R. L. SHEWARD.

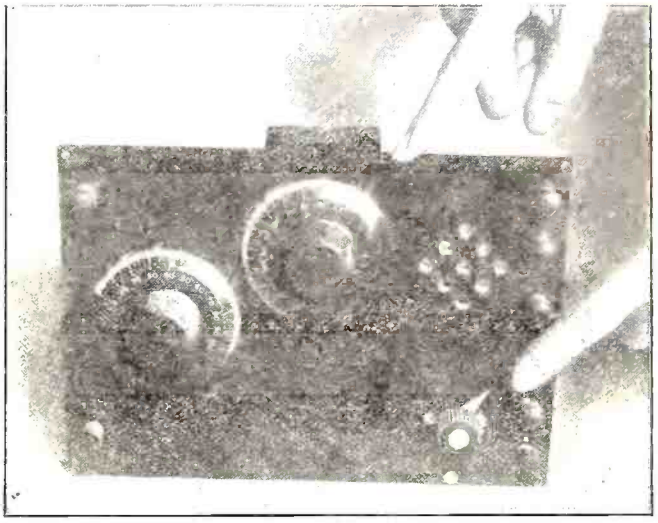
It looks like we misjudged these Kopprasch fellows! While the other fellows were busy writing about how many long distance stations their sets could receive, the Kopprasch users were evidently busy tuning in a few extra ones to make their lists overlap the rest. That's SOME list, if you ask us.

R. R. O. Box 118, Indianapolis.
RADIO AGE,
Pickups by Readers Department.

(*Continued on page 44.*)

Little Things That Help





DON'T ANNOY YOUR NEIGHBORS

Photo at left shows that you should not put too high a plate voltage on the detector tube. If you do, it not only spoils the quality of the radio music but it also makes it impossible to tune your set without causing squeals.

Photo on right shows that you should not turn the rheostat that controls your tube on too full. This will distort the music and cause squeals. It will also greatly shorten the life of your vacuum tube. Don't turn the dial that controls regeneration around too far. The proper place to stop is just before the squealing point. If you go beyond that point the squeals that you will hear will also be heard by everyone in your neighborhood. (Kadel & Herbert Fotos.)

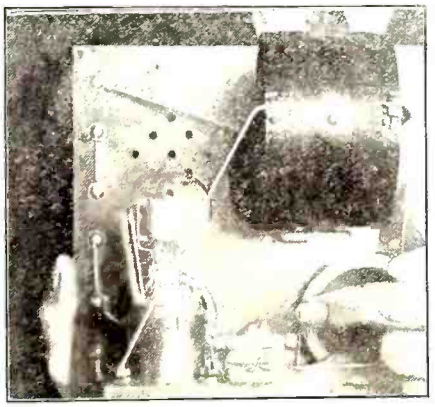
Cause of Fading

When radio first was used for long distance communication it was noticed that signals were not transmitted as far during the day as during the night time. It has also been observed that at night radio signals on the higher radio frequencies or shorter wave lengths vary greatly in intensity from minute to minute. Persons who receive broadcast concerts from distant stations have occasion to notice this variation in intensity of received signals since loud signals may be received from a given distant station at one moment only to disappear entirely for a few minutes and then recover their original intensity.

This and related phenomena have been recorded from time to time and various hypotheses have been brought forward in an attempt to explain them. The phenomena are dependent upon a large number of variable quantities such as the weather conditions, the nature of the country over which transmission occurs, the surroundings of the transmitting and receiving stations, and the method of handling the receiving apparatus. Only by a statistical study in which the results obtained simultaneously at a large number of receiving stations are collected and tabulated, may reliable averages be obtained.

In an attempt to secure some worthwhile statistics of this kind, a co-operative study of radio signal fading was made by the Bureau of Standards and the American Radio Relay League during 1920 and 1921. In these tests from five to ten radio stations transmitted signals in succession on certain nights, according to prearranged schedules. The signals were received simultaneously by about one hundred receiving stations whose operators were provided with forms for recording the variations in the intensity of the signals as received.

The paper gives summary tables pointing out possible relationships between weather conditions and the fading and intensity of radio signals and the prevalence of strays or atmospheric disturbances. On account of the limited number of observations and the large number of factors which influence transmission, the statistical results can be considered as only tentative.



The squeals and howls being sent through the air every night by owners of single circuit regenerative sets and other trick circuits is fast making it impossible to enjoy listening to radio concerts. If the owners of radio sets that cause squeals would operate their sets correctly they would not be spoiling their neighbors' concerts every night. Photo shows proper type grid leak. This is very important. (Kadel & Herbert Foto.)

The general result of these tests, however, substantiates the theory that the sources or causes of fading are intimately associated with the conditions at the Heaviside surface, which is a conducting surface some sixty miles above the earth. Daytime transmission is largely carried on by means of waves moving along the ground, while night transmission, especially for great distances and short waves is by means of waves transmitted along the Heaviside surface. Waves at night are thus free from the absorption encountered in the daytime but are subject to great variations caused by irregularities of the ionized air at or near the Heaviside surface. These variations probably account for fading.

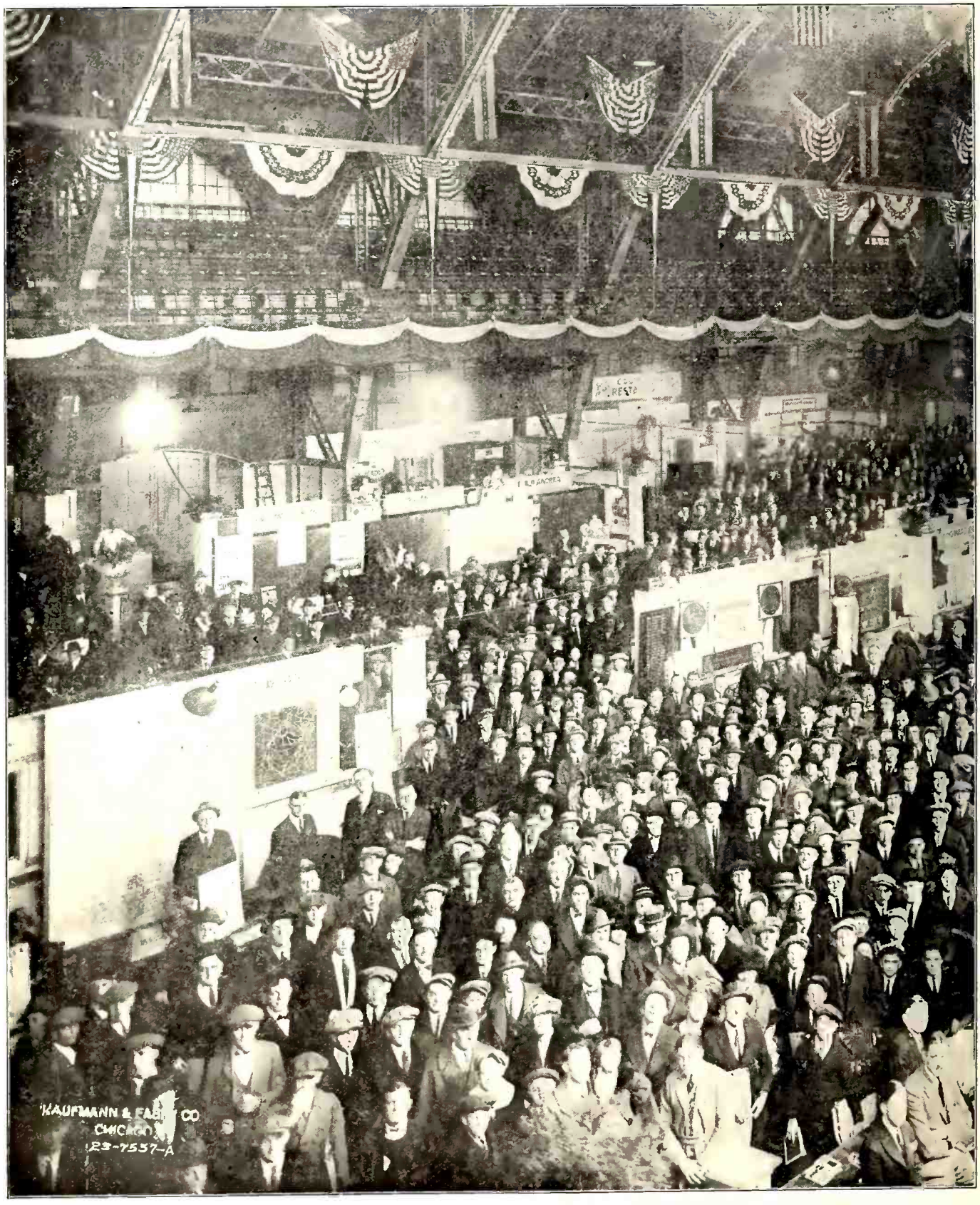
The results of these tests are embodied in Scientific Paper No. 476 of the Bureau of Standards. Copies can be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C. The price is ten cents, cash.

New St. Paul Studio

St. Paul made its debut as a permanent radio broadcasting station on December 12 with the initial program from the new studio just completed in the St. Paul Athletic Club.

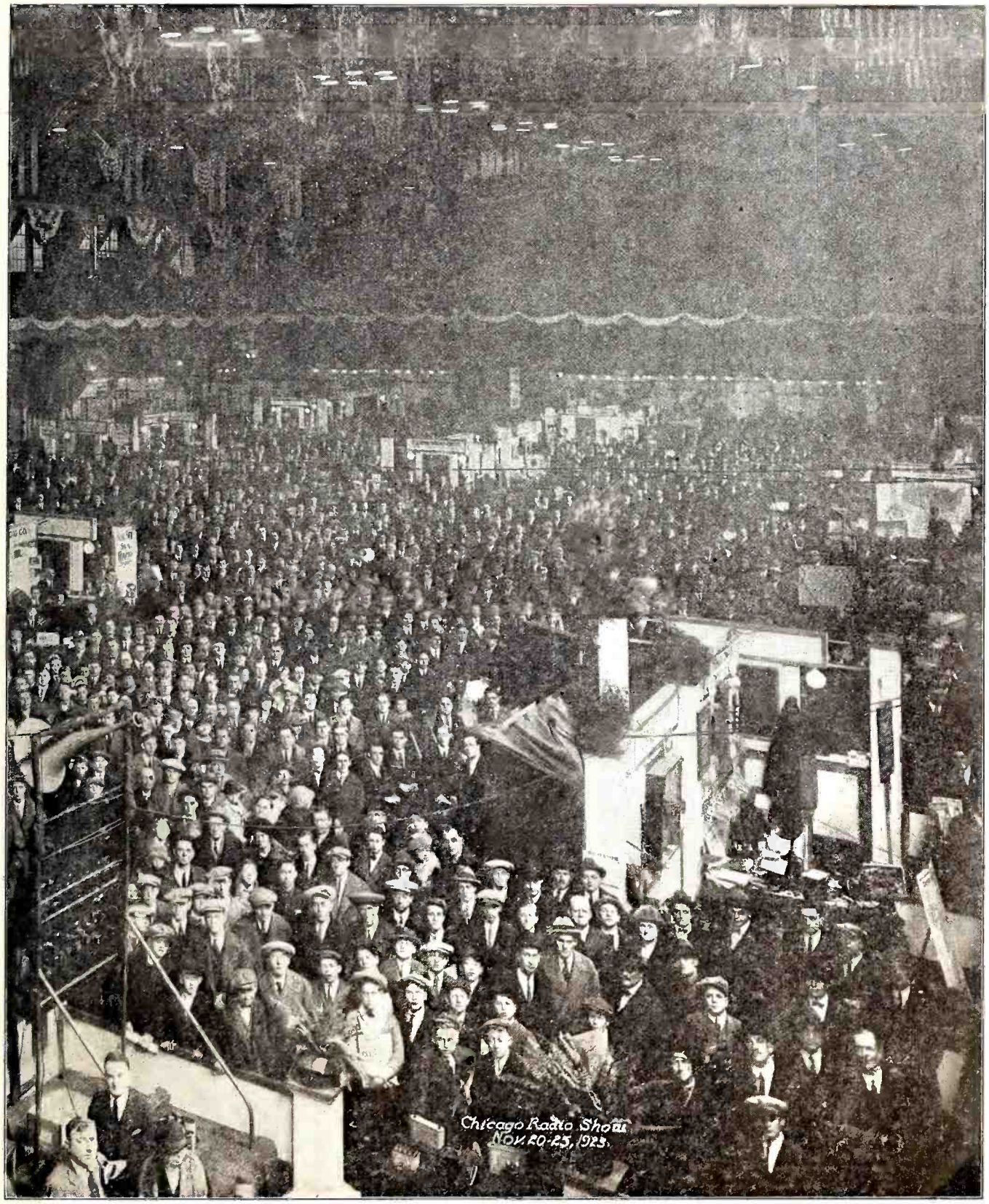
Regular programs are broadcast alternately with those from Minneapolis over WLAG, the Twin City Radio Central, operated by the Cutting & Washington Radio Corp., in Minneapolis, the St. Paul studio becoming a permanent unit of WLAG.

Radio's Great Future Forecast



Two points impressed themselves upon observers at the second annual Chicago Radio Show, held in the Chicago Coliseum, November 20 to 25. One was the tremendous attendance and the other was the eagerness of the throngs to get radio information.

At Chicago's Recent Exhibition



The 1922 radio show crowd was about sixty per cent boys. The 1923 crowd was much greater and was only about twenty per cent juveniles. The older people have taken up the art in earnest and that is one of the reasons for the increasing stability of the industry.

Simple Experiments With Radio Control

By CARL MASSON

THOUGH the Scientists of the world have presented us with many wonders in connection with radio, the speed at which new inventions are appearing, reveals that there are still greater wonders in store for us, pertaining to this branch of science.

Manless vehicles, boats, airships, etc., made possible by radio, have recently startled the world. Radio control will, no doubt, be an important factor, in the near future.

Bearing this in mind, the author presents a group of interesting experiments for the amateur. Realizing that the average amateur has but a scanty workshop, the author has endeavored to make these experiments as simple as possible.

In radio control, it is necessary to have some sort of a relay which will respond to radio waves, at the will of the operator. Recently, much has been done to develop such a relay, but due to complicated parts involved in them, amateur experimenters have left this use for radio untouched.

Fig 1. The Receiver.

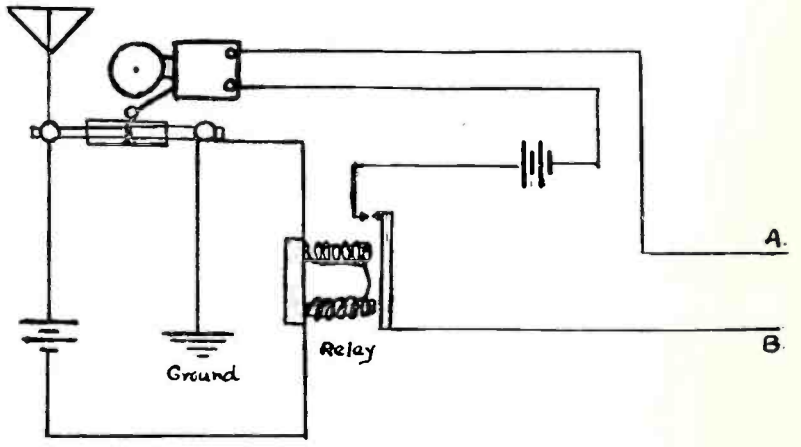
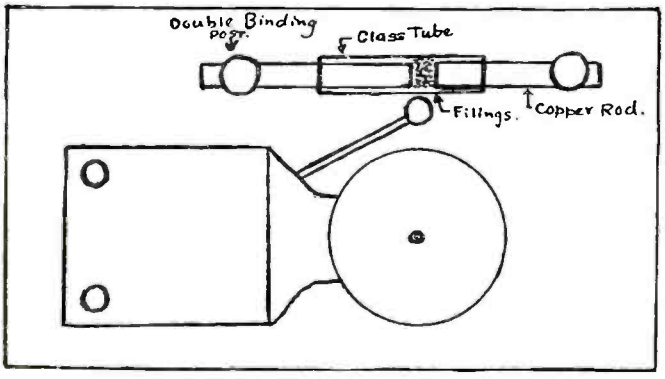


Fig. 2. Assembly of Coherer and decoherer.



Recalling the pioneer days of "wireless" (as it was then called) Marconi's coherer and decoherer suggests a simple relay circuit which might be applied to experiments with radio control.

Fig. 1 shows such a circuit. Since coherers and decoherers have entirely disappeared from the market, perhaps it would be best to describe how to construct them.

To make the coherer, get a piece of glass tubing, 2" long, and about 1/4" in diameter, also 2 double binding posts, and 2 pieces of copper or brass bar about 2 1/2" long and which will fit the glass tube quite snugly. Fig. 2 shows the assembly which is self-explanatory. Between the copper bars, which slip within the glass tube, is a quantity of metal filings, (preferably silver) filling the gap, which should be about 1/8 inch.

Now, when the radio waves pass through the coherer, they cause the filings to cohere—that is, stick together, allowing the current to pass and operating the relay. But when once the filings have cohered, they will remain so, unless some means is provided to decohere them. Hence an electric bell is placed in the circuit as shown in Fig. 1. When the relay allows the current to pass, the bell will ring, and the hammer will tap the glass tube, causing the filings to decohere. An ordinary telegraph relay is used.

Since these experiments are conducted indoors, a small single wire antenna, about 8 feet long, is sufficient. Gas or water pipes serve as grounds.

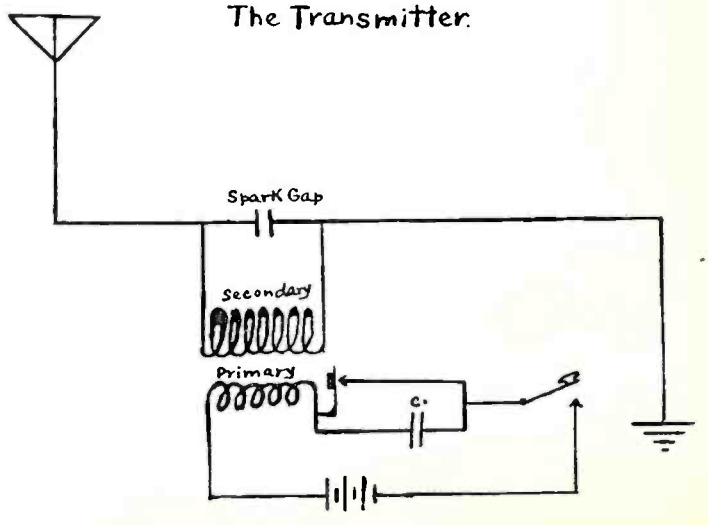
Now for the transmitter by which the control is possible. The circuit is nothing other than that of a simple spark coil sending set. A 1/8 inch coil is sufficient. Fig. 3 shows the circuit. An antenna of about 8 feet is also used in the transmitter.

For the first experiment, connect a toy electric motor in the receiving circuit

(Continued on page 36.)

Fig. 3

The Transmitter.



Substitution of a Tube for a Crystal in a Selective Crystal Detector Circuit

By J. A. CALLANAN

THE construction of a circuit using a crystal detector, as offered in the December issue of RADIO AGE, forms the basis of a progressive circuit in which we are now showing a tube detector.

The tube is going to be a much more sensitive detector and will for that reason afford a far greater receiving range. Our tuning apparatus must be more selective to permit of discriminating reception among the many broadcast stations.

It is presumed that the construction of variocoupler already given has your consideration, although any standard type will serve.

Coupler Modification

An additional winding is indicated. The form can be a cardboard tube 2 1-2 inches long and four inches in diameter for variocoupler of our previous description, or to equal that of whatever size is used. Taking No. 24 double covered, cotton wire begin winding at 1-4 inch from the end of form, having first punched two small holes spaced at 1-4 inch in parallel to anchor wire by lacing through them.

Wind forty turns firmly and terminate with a similar anchorage, leaving leads for making connections. Do not coat this secondary winding with anything. This acts as a deterrent to sharp tuning necessary in the secondary circuit (this is not an important matter in the primary circuit).

This completed coil is then placed end to end against the rotor of the variocoupler and made secure by means of four brass sheet strips cut 1-4 inch wide by 1-2 inch long which are used as connectors, being bolted to the two forms, on the inner side for appearance sake. This will leave a 3-4 inch space bare between the two coils, the tickler coil shaft and bearings being in this free space and the rotor (tickler) free to revolve inside the completed coil.

Mounting Unit

The completed unit is mounted in a horizontal position and supported by three wood blocks as illustrated in diagram B. These are placed at either end of the unit and between the two coils. The unit is mounted 1-2 inch behind the panel to avoid body capacity.

Connections

Proper connections are of vital importance to avoid necessity of shielding resulting in an appreciable loss of energy. We must have as much of the wiring as possible at ground potential.

Connect the antenna lead to the end of the primary nearest the secondary winding and the grid lead to the end of secondary nearest the primary winding.

The terminal of the rotor (tickler) which connects to the plate of the detector tube should be nearest the primary at the maximum dial reading and at right angles at zero reading. As this is a revolution of only ninety degrees the dial need only be graduated through one fourth of its circumference. In revolving from zero to maximum the tickler coil is rotated in a clockwise direction.

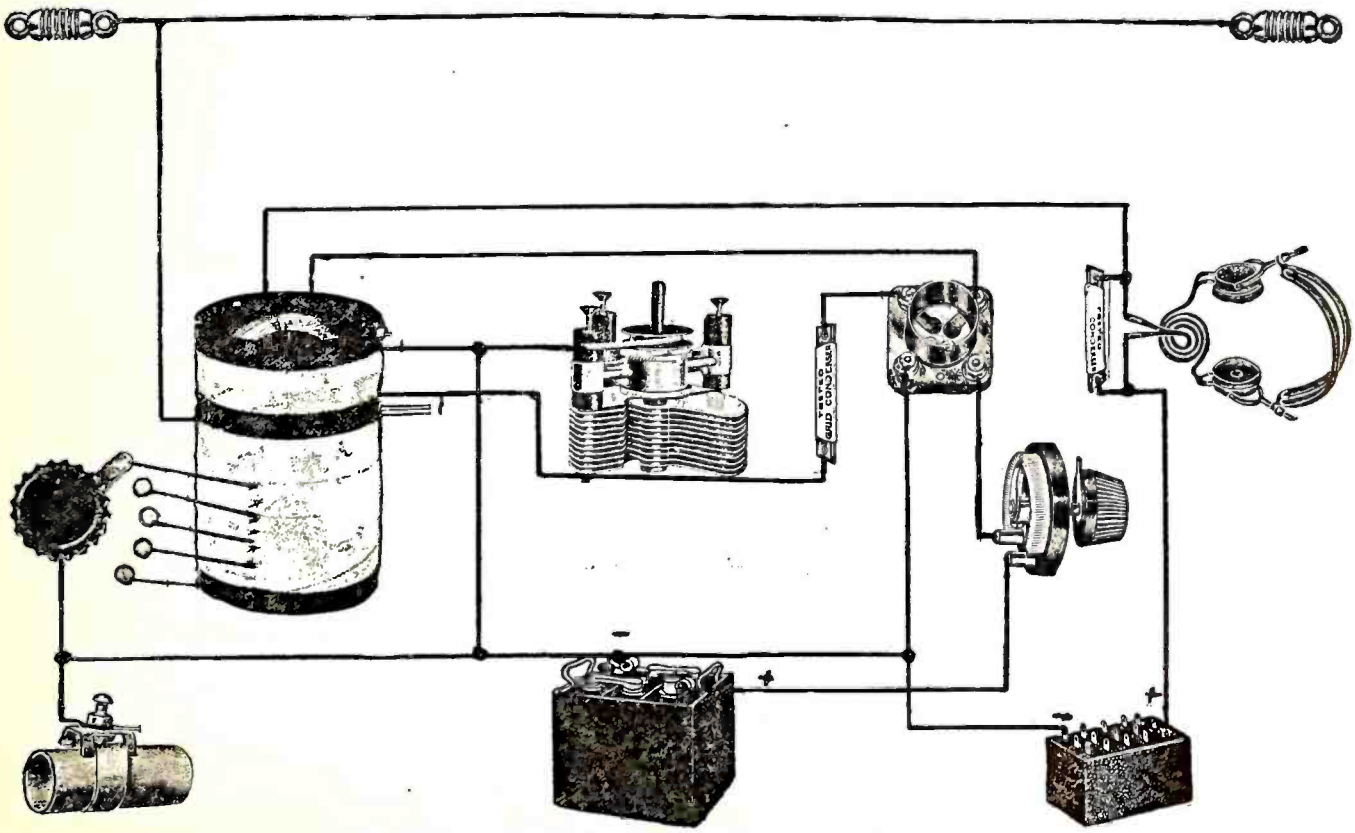
Detector Tube

The detector tube is the heart of the circuit; the greater its sensitivity the greater the possibilities in receiving range. A good, six volt detector tube often affords reception more satisfactory from the standpoint of signal volume and receiving range than a peanut tube (toy tube) with one stage of amplification.

The U V 200 tube with a storage battery for filament supply gives the best results. However, if the expense of storage A battery is at first prohibitive, the U V 201A can be operated on dry cells, eight connected in series of four, two sets in parallel, with much satisfaction. Twenty-two and one half volts plate potential can be employed with either tube, and a maximum of 45 volts with the U V 201A.

A .00025mfd fixed grid condenser (mica) and a two megohm fixed grid leak will serve for either tube cited and should be mounted directly to the tube socket,

(Continued on page 28.)



Picture diagram showing the electrical connections of the Tube Units

How Receiving Tuners Work

By JOHN V. L. HOGAN

IN THE fifth of his series of radio talks delivered through WEAF, John V. L. Hogan, consulting engineer and former president of the Institute of Radio Engineers, discussed the subject of "How Your Receiving Tuner Works."

His presentations have been given most enthusiastic response because of his clear and simple presentation. In the course of his remarks on December 7, Mr. Hogan said:

"The interval that interests us most is from 550 to 1040 kilocycles, for the stations using the wave frequencies between those limits are powerful enough to be heard a good many hundred miles. The fifty individual wave frequencies in this range were chosen at separations of ten kilocycles because any two waves whose frequencies differ from each other by that amount should not overlap or produce direct interference with each other in a good radio receiver. To understand just why this is so we must think for a few moments about what goes on inside a radio receiving tuner.

"Let us begin by noting that at this very moment there are two powerful broadcasting stations in New York City sending out streams of radio waves. One of these is WEAF, where I am talking, and the other is WJZ. The waves from WEAF are of 610 kilocycles frequency; when they reach your receiving aerial, a tiny fraction of a second after they leave here, they generate electromotive forces of 610 kilocycles frequency on your receiving aerial wires. Those electromotive forces, as you would have guessed from their name if you did not already know, are simply forces that tend to move electrons (or electric current) in the circuit where they are generated. Thus, whenever WEAF is sending, its radio waves are doing their best to produce electric currents of 610 kilocycles frequency in your receiving antenna system. In the same way, the waves from station WJZ are trying to generate electric currents of 660 kilocycles frequency in your receiver, for 660 kilocycles is the wave frequency of that station.

"Now suppose that you are anxious to hear the transmission from this station, WEAF, without hearing anything whatever from WJZ. What must you do? The answer is perfectly simple; it is only necessary for you to permit the WEAF waves to produce a strong 610 kilocycle current in your receiver while at the same time preventing the WJZ waves from generating any appreciable current in your set. To hear WJZ without interference from WEAF you would do the opposite of that, or develop the greatest 660 kilocycle current you could while suppressing the 610 kilocycle currents.

"Of course, this raises another question. How can you encourage waves of one frequency to generate strong currents in your aerial-to-ground or your loop antenna circuit and at the same time discourage the waves of all other frequencies? The answer to that lies in electrical tuning, and our next job is to get some idea of how tuning is done.

"You know that practically all receiving sets contain condensers and coils of wire. Sometimes the condensers are of a certain fixed size, and sometimes they are variable, but without some sort of condenser a radio receiving set won't do much in the way of tuning or selecting between waves of different frequencies. So, too, with the coils of wire. These are generally called inductances, or (to speak correctly) inductors. Sometimes the inductors are fixed in size and position; sometimes they are variable by means of switches or as in variometers, so that their effective values may be changed at will.

"Did you ever wonder why these condensers and inductors are used in radio receivers? It is because an electrical circuit that is made up of such a coil and a condenser is capable of being tuned to resonate to or select alternating currents of any particular frequency one may desire. Electric condensers possess the electrical property called capacitance; inductors have the electrical property called inductance. An electrical circuit that contains both capacitance and inductance always is capable of passing more electric current of some one frequency than of any other frequency, for the same amount of generating or electro-motive force. What particular frequency in cycles or in kilocycles per second get through best, depends upon the amount of capacitance and inductance in the circuit. Thus, by changing the amount of capacitance (as you can do by means of a variable condenser) or the amount of inductance (as you can with a tapped coil or a variometer) you can change the frequency to which the circuit is most responsive. This is what you do when you adjust the control knobs of your receiver. The act of tuning is simply making the inductance and capacitance (or the coil and condenser) values of your receiving circuit correct for the production of the greatest amount of current of the frequency you desire to receive. Right now your receiving sets are adjusted to respond strongly to the 610 kilocycle currents generated by the 610 kilocycle waves that WEAF sends out.

"Perhaps this will be still clearer to you if we consider for a moment how very much radio tuning is like musical tuning. A piano string has a certain mass, which in mechanics is very much like inductance in electricity. The string also has a certain flexibility or flimsiness or looseness, which is mechanically the analogue of capacitance in electrical circuits. If we vary the mass or the flexibility of a piano string, we change its pitch of vibration. In a piano, the mass of each piano string is fixed when the instrument is made, but the tension of each one can be varied at any time. If you look inside a piano you will see that the heaviest strings are tuned to the lowest notes and the tightest strings (of any certain size) the highest frequencies.

So it is in radio; among circuits of the same capacitance, those that have the most inductance will respond to the lowest frequencies. If the inductance remains constant, the circuits that have the least capacitance will be tuned to the highest frequencies. Piano tuning is nothing but tightening and loosening the strings until their pitches of frequencies are correctly spaced along the musical scale. Radio tuning is nothing but adjusting the condensers or inductors of a circuit until its best electrical vibration frequency is correctly in agreement with the frequency of the particular wave (in the scale of radio frequencies) that it is desired to receive.

"Now you are perhaps thinking that piano tuning is very different from radio tuning, after all, because a piano string is tuned to send out a note of a certain frequency, whereas a radio receiver is tuned to select an arriving wave of a certain frequency. In my next talk I will tell you how those two apparently opposite properties really go hand in hand. Until then, just bear in mind that when you want to hear WEAF without interference you must let your receiver build up currents of 610 kilocycles frequency and at the same time oppose the building up of currents of all other frequencies."

On December 14, Mr. Hogan said from WEAF: "The coils and condensers in a radio receiver are used to get the effects of electrical tuning, so that the signals arriving at some desired wave frequency can be selected from interfering signals carried by waves of other frequencies. By properly adjusting a variable condenser or a variable inductor (which is the engineering name for a coil) you can cause its circuit to become an easy path for currents produced by the WEAF waves of 610 kilocycles frequency, for example, and at the same time a hard road for currents of other frequencies to traverse. A different setting of the condenser or inductor dial or switch will permit currents of WOR's frequency, 740 kilocycles, to flow easily; and similarly other adjustments correspond to the wave frequencies of other stations.

"The variation of condensers and inductors in a radio set corresponds fairly well to changing the tension and weight of a piano string. Such an adjustment by changing the tuning, changes what is called the "natural frequency" of the radio tuner or the musical string. This natural frequency is the rate of vibration which is the easiest for the tuned system. If we tune a piano string to the frequency of 256 cycles per second, which is the pitch of middle C, it will give off a note of that frequency whenever it is disturbed or struck. That happens because

tuning the string to 256 cycles is nothing more than making its natural frequency 256 cycles, so that its easiest or natural rate of vibration is 256 cycles per second.

"The most interesting thing about this adjusting of natural frequencies is that it works both ways. Not only does a musical string give off a note of its natural frequency when it is strongly struck or plucked, but it will pick up and start vibrating in resonance with a separately-produced sound of its natural frequency. If you tune two strings of a guitar to the same note, that is, so that they have the same natural frequency, you can make a simple experiment to demonstrate this. Pluck one of the two strings and immediately stop it from vibrating by putting your finger on it; you will then find that the second string has picked up the vibrations of the first and is carrying them on, as you can readily prove by touching the second string with your finger and noting that the sound stops. If you try this experiment with the second string a little out of tune from the first, that is what a somewhat different natural frequency, you will find that the second string does not pick up the vibrations of the first. Of course, that is because the natural frequency of the second or "receiving" string is then not the same as the sound frequency of the first or "sending" string.

"You may wonder what this has to do with radio. It is not hard to see how the first string may be compared to a radio sending station, and how the sound waves which the string gives off are in one sense like the radio waves sent out by the radio transmitter. In this same sense, then, the second guitar string is like a tuned radio receiver. This analogy may be clearer to you if we trace it step by step, so let us consider the sound waves first.

"When the first guitar string is plucked, it vibrates at its natural frequency and produces sound waves of that same frequency. The sound vibrations travel to the second string; if this second string is tuned to the original frequency the arriving waves will set it into resonant vibration at their own frequency. If the natural frequency of the second string is not the same as that of the arriving waves, it will respond relatively feebly or not at all.

"Now for the analogous radio case: When the radio transmitter is operated, it oscillates at its characteristic frequency and produces radio waves of that same frequency. The radio waves travel to the radio receiver; if the receiver is tuned to the original frequency the arriving waves will set it into resonant vibration at their own frequency. If the natural or tuned frequency of the receiver is not the same as that of the arriving waves, it will respond relatively feebly or not at all.

"Thus we have a simple acoustic or musical example of what tuning is and how it can be used to select wave-vibrations of any desired frequency. The principles are the same as those that underlie radio tuning, the only differences being in the details. Sound waves are mechanical and usually occur in air; they are of audible frequencies, or say between sixteen cycles and 16,000 cycles a second. Radio waves are electrical and travel through space, not requiring even air to carry them. Their frequencies are ordinarily so high that they cannot be heard directly, or say from ten or fifteen kilocycles on up to thousands of kilocycles.

"The question that naturally comes up now is why, if the musical string will respond resonantly only to a wave of its own frequency, a radio receiver will respond to waves of frequencies different from the one to which it is tuned. We all know that the unfortunate fact is that many radio receivers do bring in interference; a good many of you who are listening to me now are at the same time hearing interfering signals that are carried to you on waves having frequencies quite different from WEAF's value of 610 kilocycles. Yet is is fair to assume that all your receivers are tuned to 610 kilocycles.

"The answer to that question lies in what I called the "pitch sense" or selectivity of the receiver. Some receivers are capable of selecting a relatively narrow group of wave frequencies centering about a single definite value; others let in many wave frequencies in addition to the one which is desired. For instance, a good receiver tuned to 610 kilocycles will admit practically nothing from waves of 600 kilocycles or 620 kilocycles (which are respectively ten kilocycles below and above the central or resonant value of 610 kilocycles). On the other hand, a poorly selective receiver that is tuned to 610 kilocycles may also admit current from waves as much as 100 kilocycles below and above the resonant value or from 510 to 710 kilocycles. As you can easily see, such a receiver when tuned to WEAF might also pick up signals from WJZ on 660 kilocycles although it would probably exclude interference from WOR on 740 kilocycles.

"What causes such a great difference in receiver selectivity? That is a question that bothers very many radio listeners. The answer is that receivers in which there is a comparatively large waste or loss of electrical energy are poorly selective. Receivers that have well designed circuits and component parts and which therefore waste relatively little energy, are highly selective. The most common causes of poor tuning, are (1) bad aerial or ground connections, (2) incorrectly connected crystals, (3) poor tuning coils and (4) badly designed or badly built variable condensers. All of these are easy to remedy, and some attention to them will usually improve the selectiveness of any poorly-operating tuner. Sometimes none of these items is defective, however, and still the receiving set will not tune properly. In such cases there is usually something radically wrong with the circuit arrangement or the layout of the parts."

Denmark Hears Us

Enthusiastic radio amateurs in Denmark are always endeavoring to catch broadcasting from the United States, even though this country lies in a somewhat more unfavorable position to receive American radio messages than other European countries, Consul-General Letcher reports from Copenhagen.

Some of the Danish radio amateurs have made it a practice to "listen in" for Americans at about 3 or 4 o'clock in the morning. Recently several of these amateurs reported "getting" different broadcasting stations in the United States. One station mentioned particularly was "Schenectady" with the call signal, WGY. Orchestra music, soloists and speeches were plainly heard.

Interest in radio continues to increase in Denmark, the general says, and it is estimated that there are now approximately 10,000 radio amateurs in the country.

WRC Listens In

Out of thousands who listen in on WRC, few know that WRC, as well as all broadcasters near the coasts, also listens in constantly, not on its own "stuff," speaking informally, but for ships. As the law requires every hour of the day while the big Class B stations of the radio corporation in Washington is on the air, one operator is listening in on 600 meters, the ship emergency wave, for S O S calls. When one comes in, broadcasting is shut down until the air is cleared, usually by some coastal naval station.

One Friday during the midnight show, the operator on watch at WRC heard an S O S from a ship off the coast of New York, and immediately pulled the switch, cutting off the power in the midst of a number by a local orchestra. Later, when NAH and NAO, naval stations at New York and Charleston, reported "all OK," WRC went on with her show. This was the third S O S call heard while the station was broadcasting, and shows the necessity of keeping a watch on the 600 meter wave. If broadcasting kept up during the transmission of distress calls, it is doubtful if the calls would get through or whether aid would be brought to the ship; the law requires, however, that coastal stations cease operation when an S O S call is heard.

Station WJY Reopens

After a brief period of silence, during which time extensive research and experimental work has been in progress, WJY, the twin station of WJZ at the Radio Corporation of America's dual broadcasting station Radio Broadcast Central located in the Aeolian Building, New York City, has resumed broadcasting during its former periods on Tuesdays, Thursdays, Fridays and Sundays on 405 meter wave-length.

The reopening of the 405 meter channel re-establishes the unique dual broadcasting installation which is an exclusive feature of Broadcast Central, permitting two distinct programs to be broadcast on different wave-lengths from closely associated antennas. The programs from station WJY are of the same high standard which has characterized station WJZ, including symphonic, classical, and popular music, noteworthy speeches and dinners, and events of major interest to the public.

Amateurs Exchange Messages With France

HARTFORD, CONN.—Reliable two-way communication between amateur radio operators in North America and Europe has been carried on frequently since the first two-way contact was made by F. H. Schnell, traffic manager of the American Radio Relay League of this city and Monsieur Leon Deloy of Nice, France, the night before Thanksgiving eve. This proves that international citizen radio communication across the Atlantic is now practicable. One of the thousands of amateur transmitting stations in the United States, using a wave length of 100 meters, can pick out and communicate direct with one of the many hundreds in France and England—this while the ether is humming with the medley of thousands of CW transmitters and broadcast stations are hurling DX music across the continent on other waves.

Two-way short wave radio conversations have been carried on not only between Deloy's F8AB and those operated by Schnell and John Reinartz of South Manchester, Conn. 1MO and 1XAM respectively, but also three other Eastern amateur stations, 1XAQ, operated by S. Kruse and Boyd Phelps of this city, 2CQZ by Robert M. Morris and 2CFB by Floyd M. Weise, both of Elizabeth, N. J. Deloy reported last night by radio that he had heard 9ZT, operated by Donald C. Wallace of Minneapolis, Minn., but that he could not work the American station. He also stated that the signals of 1MO came in stronger than the high power commercial station WSO.

In reply to the first amateur radio message across the Atlantic on 100 meters, General Ferrié, director of telegraphs for the French government sent the following radio to the A. R. R. L. Headquarters: "Many thanks and most hearty congratulations on the results obtained with 100 meter wave, which have permitted the establishment of a new bond between France and the United States." The message was sent by way of Monsieur Deloy's station and was received at amateur station 1MO here.

It is impossible to describe fittingly the great amount of detail, the careful recording of time schedule, the exact precision in the tuning of respective sets that made it possible for the French amateur to transmit on his key the brief "GM, OM," meaning "Good Morning, Old Man" in answer to the clear call, "8AB fu 1MO," that came from America. It was early morning in France when that message was heard though it was exactly 10:30, eastern standard time, in Connecticut.

The receipt of that simple greeting from the darkness out over the ocean to the point where it was nearing daylight on the other continent carried with it a feeling that only an amateur could appreciate and only a ham, that was used to "boiled owl" practices that keep him at his key through long anxious hours, could adequately express for it meant realization of the dreams of all short wave radio fans.

This brings us to the scene at amateur station 1MO, at Hartford, which marked the beginning of the transmission tests with Europe on that night after Mr. Schnell had obtained the sanction of the Radio Inspector of the first district to transmit on 100 meters.

For two nights in succession Schnell had listened to the peculiar note of 8AB like a string of r's run together and just the suggestion of an h like r-h-r-r-r-r-h-r-r- in steady beat and on the previous night he had copied two complete messages so that his fingers fairly ached to grasp the key and hurl 1MO's shrill note in the air. He sat down in front of the transmitter and ran his fingers nimbly over the set tuning it down to the proper 100 meter wave length.

This at 9:25 and he listened for fully fifteen minutes before he heard the French amateur's note calling "A1MO (the prefix A being for America) de F8AB, GM, OM, here messages." Number 3 read:

"Your cable establishing midnight schedule received this morning. I consider it as cancelled by your agreement to my message No. 2, sig. F8AB." At 9:38 this message was ended and Deloy sent:

"No. 4 A1MO, Tomorrow will not be on at this time, pse listen at 0500 and transmit at 0515 sig. F8AB." The figures given represent the transmitting time schedule in Greenwich Mean Time. Not knowing of course whether these messages had been received in the United States, Deloy went on and repeated both of them over a second time, after which he stood by for about ten minutes and repeated them a third time. At exactly 10:27 he signed off calling A1MO, A2BY, CQ de F8AB.

At the moment that the lid went off the amateur quiet period for the benefit of broadcasting at 10:30, Schnell threw over his antenna switch and grasped the key to test the result of many months of planning. Thousands of amateurs could understand his emotion.

"8AB fu 1MO" clicked out into the air and traveled across to France where it struck and vibrated at Deloy's receiving antenna at Nice.

"RRR," he went on "messages received signals QSA." He called and repeated until 10:37 and a moment later the silence broke with:

"A1MO de F8AB rr QRK Your signals QSA vy one foot from phones on Grebe. FB OM Hearty Congratulations.

Two-way communication between the continents had been established but to the great surprise of both operators it was not for a brief second or two, giving them credit for the accomplishment and nothing more but steady and reliable communication that was continued for two hours.

"This is a fine day" called Deloy joyously, it appeared. "Pse QSL No. 1 and No. 2."

"O. K. FB QSA QTC QRV? (Meaning signals loud) I have messages. Are you ready to receive them?"

This was 10:50 and the French amateur came back. "Sure, go ahead with messages, words twice." As he was signing off, Schnell heard him call A1XAM, the station operated by John Reinartz at South Manchester, Conn., only a few miles away saying: "Pse QRX until after A1MO."

Substituting Tube for Crystal

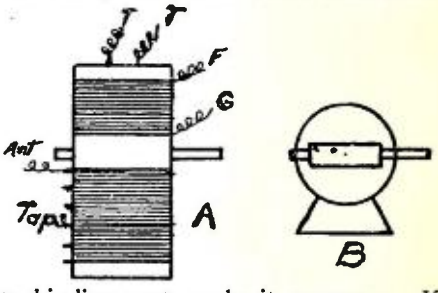
(*Continued from page 25.*)

the socket being placed 2 inches behind the panel.

A .001mfd fixed mica condenser is essential across the phones to by-pass radio frequency as otherwise circuit will not, usually, oscillate.

Wiring

All connections are to be made with either No. 16 or No. 18 tinned copper wire which should not touch panel or base except at points where connection



to binding posts make it necessary. If attention be given to these details the set will be so stable that its controls can be touched without acting as the least deterrent to long range reception.

Tuning

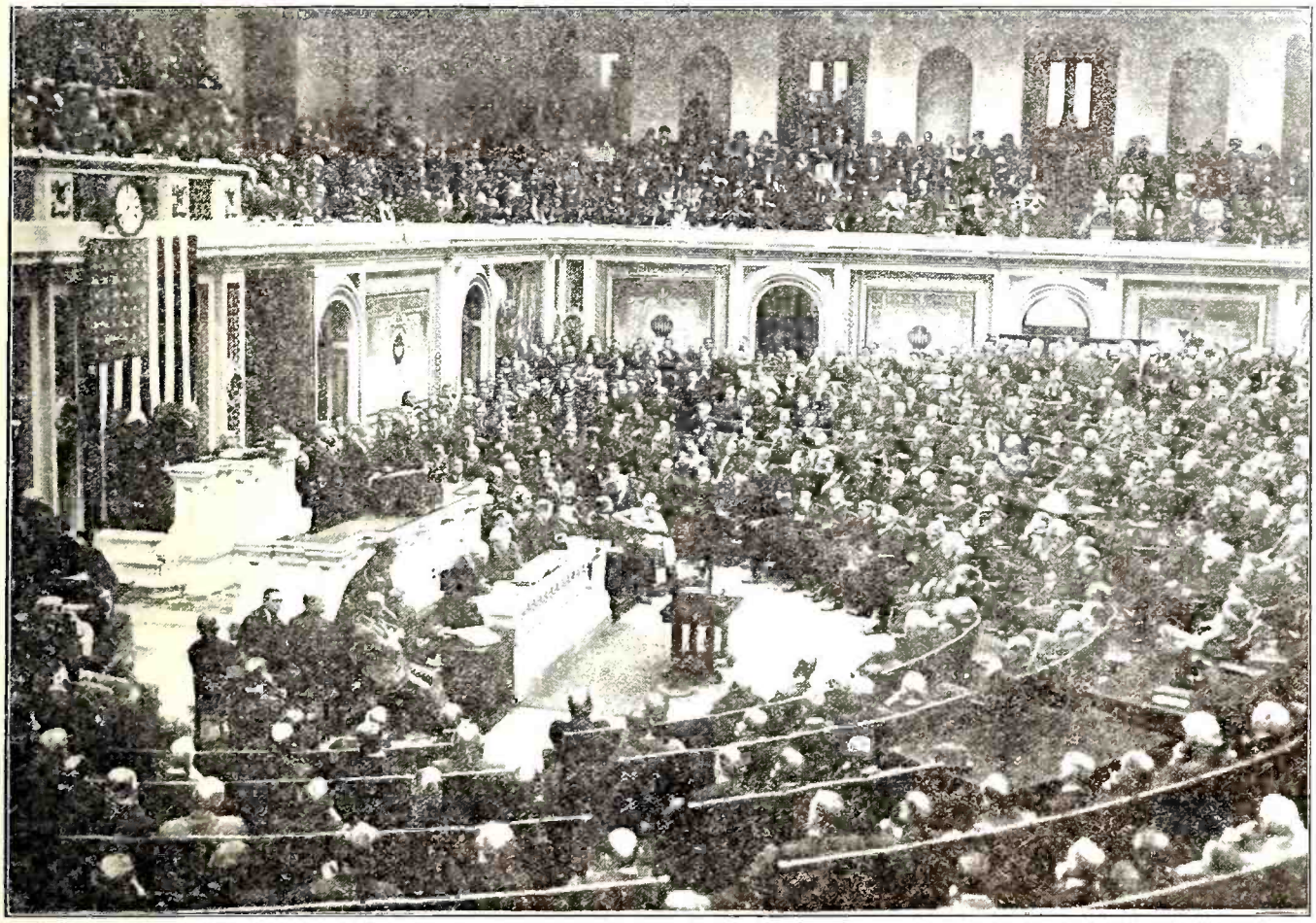
While we have four controls, it is necessary to tune with two, only. To tune: turn all controls to zero. Turn detector tube on until, with a U V 200 tube, a hiss like that of escaping steam is heard (a vernier rheostat is not necessary to make adjustment). Now turn down rheostat until the hiss ceases and set is quiet. Turn switch to the third contact (with a one hundred foot antenna), or to the fourth or fifth contact for a shorter system.

Note that by turning tickler coil to maximum a click will be heard in the phones and if completely turned to maximum a howl will be encountered. Return to zero and increase wave length by turning in condenser plates until a station is received. Volume is then increased by rotating tickler. After having received a station and determined its wave length observation of condenser dial position will show the wave length to which you are tuned.

For long range reception the condenser and tickler are worked together because the point of most sensitive and loud reception is that at which the click in phones is heard and the position changes with the wave length. Never turn the tickler further than to this critical point. To do so merely distorts signal, decreases audibility, and makes havoc with your neighbors reception.

What the Broadcasters are Doing

(News for this department is solicited from all stations)



SPEAKING TO 25,000,000

President Coolidge delivering his first message to congress in the presence of a throng of national notables. For the first time in the history of the United States millions of Americans from coast to coast heard a President delivering his message. His voice was clearly broadcast by radio from local stations and relayed across the continent. Several of the microphones that picked up the President's voice for transmission by telephone to various broadcasting stations are seen in the photo. (Kadel & Herbert.)

WHEN President Coolidge addressed Congress on December 6 his words were heard all over the United States in cities and hamlets and on farms, on the borders of the wilderness and in isolated mountain homes. Radio did this. It made history that day, for it established the efficacy of this means of enabling a President to address the whole people.

The message was broadcast by WCAP at Washington and was relayed by various other stations to the far corners of the United States.

An interesting comment on this achievement was written by Oswald Schuette, editorial writer on the staff of the Chicago Herald and Examiner, which, by the way, is the Chicago morning newspaper that has given its support whole-heartedly and enthusiastically to promotion of radio. We republish the editorial:

TWICE in five days the voice of the President of the United States has been broadcast across the continent by the marvel of the radio.

It is estimated that 25,000,000 people heard each of the addresses. The first was his first message to Congress, delivered last Thursday. The second was his memorial speech for the late President Harding on Monday.

Even in these days, when science finds it difficult to surprise a world accustomed to surprises, there is something miraculous in the thought that the frail human voice of the President at Washington should be carried through the air to the corners of this vast continent.

But there is a far more important aspect to this achievement. That is its effect on the unity of our national life.

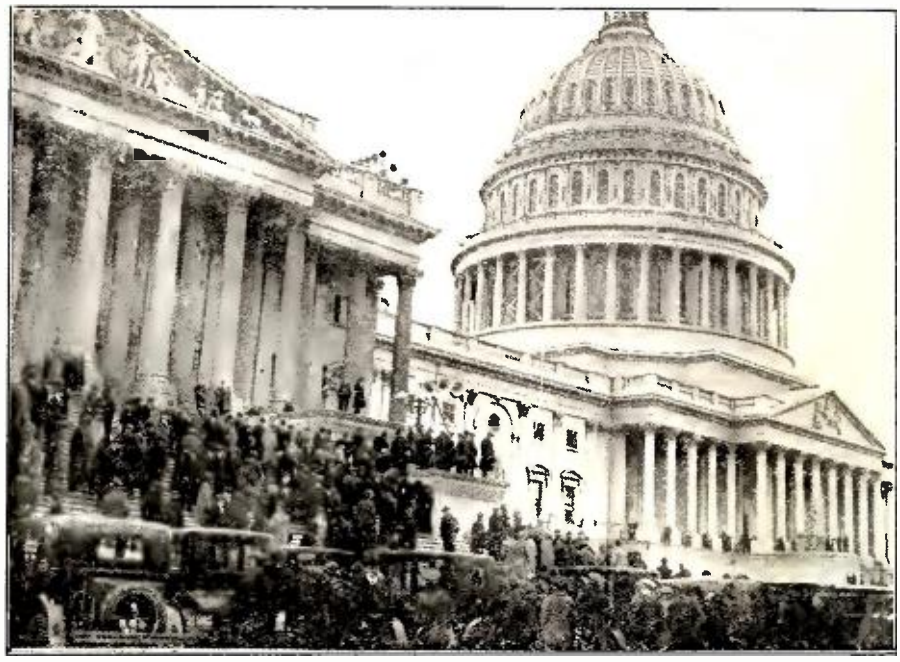
When the United States was established among the nations of the world, the greatest peril which its founders feared was the clash of opposing inter-

ests. New York and Virginia, though but a few hundred miles apart, were so widely separated in the social and economic lives of their inhabitants that there was every reason to fear the new Union would be endangered by this divergence. When President Washington delivered his first message to the first Congress at New York in 1789, it took weeks, and even months, before the printed copies of that address could reach the remote hamlets of Virginia, to say nothing of the farflung boundaries of Massachusetts and Georgia.

What would the fathers of the nation have said if they could have looked into the future to the day when the Constitution they framed would have to stand the strain of the diverging interests of Maine and California, of Florida and Alaska? And what would they have said if, looking into that future, they could have seen the President at Washington speaking, not to an assembled handful of congressmen, but speaking, with his own voice, to 25,000,000 of his countrymen?

From Washington's inaugural to President Coolidge's first address to Congress, 134 years have passed into the crowded history of the United States. From thirteen struggling colonies on the narrow coast of the Atlantic, the nation has grown across mountains and rivers and oceans until it is today the greatest republic in the world. But it is more united today, in all its vast expanse, than it was in its confined limits nearly seven score years ago. It owes that union to many contributing causes.

And the latest of these is the Wonder of the Radio.



A RADIO CLOSE-UP

Large crowds heard every word of the President's address to congress with the aid of radio amplifiers installed outside of the capitol. (Kadel & Herbert Foto.)

33 Broadcasters Quit

WASHINGTON, D. C.—Less than 500 broadcasting stations will be in operation with the advent of 1924, officials of the Department of Commerce predict. These stations will be the best and most popular in the country, and will be more than enough to serve their communities; in some instances there will still be several in a single city.

The deletion of broadcasting stations during the past six months has been quite rapid; the total reaching 149, whereas only 107 opened, showing a loss of forty-two stations. During the past month thirty-three stations fell by the wayside, so to speak, and only fifteen new ones entered the field.

Apparently, as in many lines of endeavor, it is to be a survival of the fittest race. On December 1, there were 549 broadcasting stations still serving the public; forty-seven were the more powerful Class B stations; 281 were in class A; 219 in class C, and two were listed as Class D, or development stations. Officials hope that the 219 class C stations, all of which are operating on the single wave length of 360 meters, will qualify as class B stations, transfer to class A or quit, thus eliminating considerable existing interference chiefly among themselves. The result would be a group of about 100 big stations with distinctive wave lengths, and approximately 350 smaller stations with exclusive district waves.

The broadcasting service in this country, which is of course privately owned and operated, and also leads the world in number of stations, is still holding public interest, the Department of Commerce believes. Moreover, its permanency is assured. Its real value, however, has not yet been fully realized, and will not be until there has been a wider distribution of receiving sets suitable for the reception of varied programs from several stations, permitting the listener to select at will the class of service of greatest interest and value.

The recent changes in wave lengths grouped weaker stations between 220 and 280 meters and gave the more powerful stations the wave lengths between 280 and 546 meters. In this class, the longer waves usually are assigned to the more popular stations. It is only natural that the more powerful stations are the most popular since listeners-in naturally tune in on accustomed channels where they get the big stations with no interference. These stations all broadcast good programs and have a transmitting power which cannot be approached by Class A or C stations. When fans try for smaller stations on the lower wave lengths, unless they have very selective receivers, they immediately get interference from the larger stations and the volume is appreciably less.

The weaker stations are out of luck, so to speak, in another line; they find that the larger stations come into their territory if not their actual stations and get the best talent together with their following. The cost of maintenance is tremendous, besides the initial cost averaging about $125,000 and few small operating companies can keep up the pace. The big electric-manufacturing companies are exempt, of course, as well as some other interests which got off with an early start, expecting no return. These include some big department stores, large municipal daily papers, some national organizations and manufacturing companies, such as comprise the present forty-seven Class B stations. For the small concerns, the maintenance for good operation is a steady drain on the exchequer which they cannot meet and the advertising is not of sufficient value.

Students of the situation today declare there is no need for smaller broadcasters in cities where there are one or two large stations in constant service. The craze to broadcast, which was at first a popular fad, is now established on a positive operating basis, serving a practical need in almost every big community.

While some minor stations may continue in smaller districts where farmers are served, others, such as more prosperous papers, may function despite the cost, just for the intangible goodwill, and some churches and hotels may operate to extend their scope and advertising. Many believe our broadcasters will eventually be reduced to one-half the total today.

Broadcast Program Analysis

A RECENT vote of broadcast listeners taken by three Chicago stations has aided tremendously in arriving at a definite idea of what kind of programs the fans prefer. One of the most interesting disclosures of the vote was the vast size of the listening audience. Another was the fact that only 1.7% of the listeners want grand opera. In view of the almost desperate efforts one station has made recently to take over unto itself the control of opera broadcasts, the latter figure is rather humorous. Two-thirds of the 263,000 who mailed in their votes were men. Almost one-fourth of them wanted classical music and only .2% wanted to hear male quartets.

Believing that an analysis of the vote

would be equally interesting to broadcasters and broadcast listeners Radio Age requested such an analysis from E. F. McDonald, Jr., and he has supplied the following information:

"For a period of twelve days, three Chicago broadcasting stations made the same announcement. These three stations were the Westinghouse Electric and Manufacturing Company, station KYW, the Chicago Board of Trade, station WDAP, and the Zenith-Edgewater Beach Hotel Broadcasting station, WJAZ. Each of these stations asked its listening audience what it desired to hear most. We asked them whether they preferred to hear classical, popular, jazz, instrumental, vocal, religious, political, educational talks or what. We told them that their desire would have a great influence on the future of radio broadcasting. We also announced that each listener could have only one vote and that if more than one vote were sent in, or if the same person sent votes to two of the stations, neither one of them would be counted. We have found no duplication.

"The three stations received in these twelve days a total of 263,410 pieces of mail. KYW brought in 37,900 of these, WDAP 54,811 and WJAZ 170,699. Conservative advertising men estimate that not more than one in fifty of our listeners will respond regardless of what the inducement offered is. This indicates a listening audience of 13,170,500. Taking the figures of the Zenith-Edgewater Beach Hotel Station of 170,699, this represents a listening audience on this one station alone of 8,534,950. Station WJAZ in one day received 20,152 pieces of mail, representing an audience of over a million for a single night.

"I am enclosing herewith a list of the responses received by WJAZ divided into states up to the time we had received a total of 122,000. After this time the responses were coming so rapidly that we could not sort them into states rapidly enough. An analysis of the desires of the listening audience shows us that:

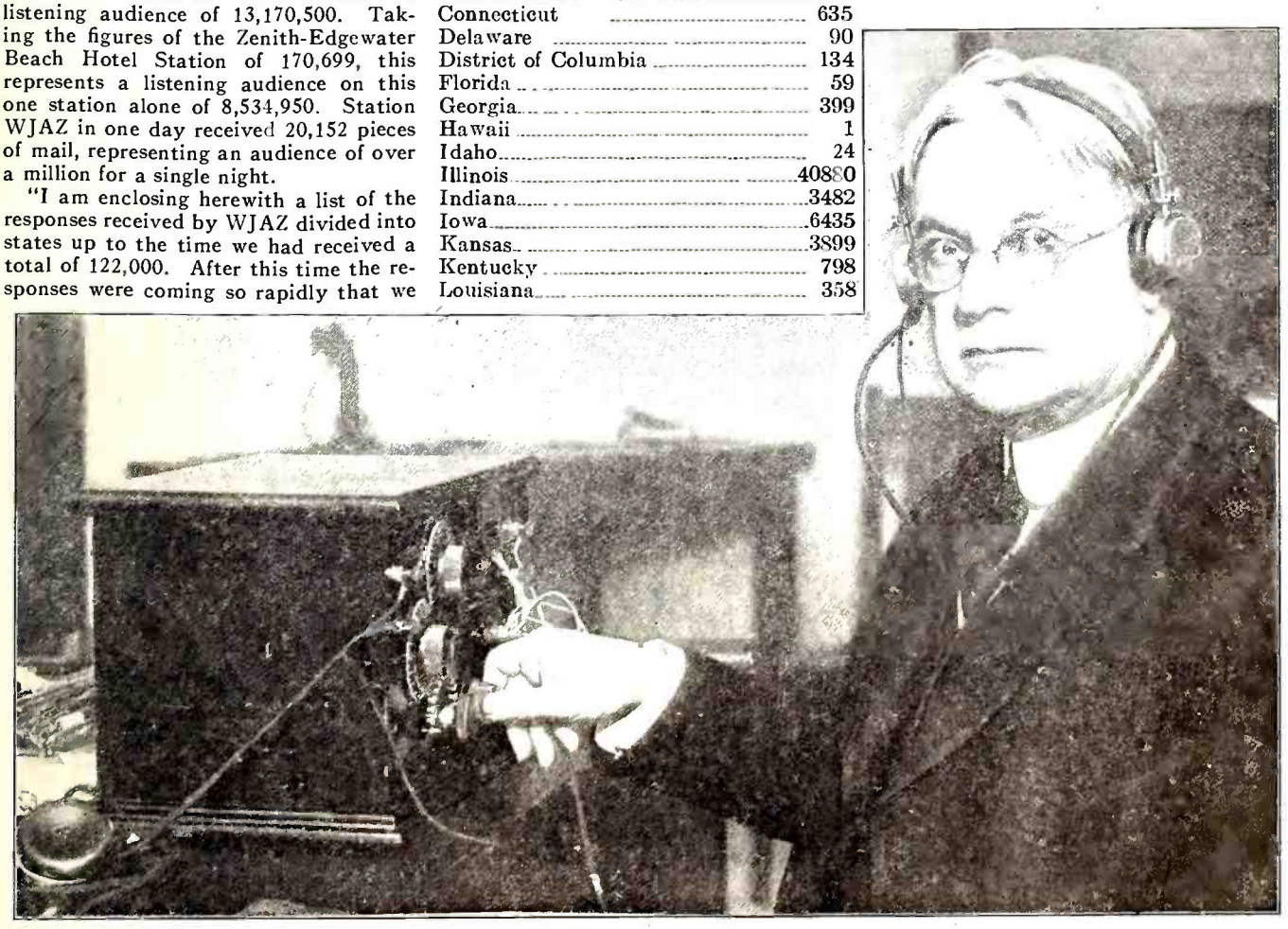
2.7% desire band music.
24.7% desire classical music.
2.9% desire dance music.
.3% desire dramatic music.
1.0% desire Hawaiian music.
18.4% desire jazz.
.3% desire Mexican music.
.3% desire male solos.
5.7% desire old-time songs.
1.7% desire grand Opera.
.9% desire orchestra.
.5% desire pipe organ.
29.0% desire popular music.
.3% desire quartet instrumental.
.2% desire male quartette.
.8% desire mixed quartettes.
.5% desire religious music.
2.1% desire sacred music.
.7% desire saxaphone.
.6% desire symphony music.
2.1% desire vocal selections.

"Of the responses received 32.5% were from women and 67.4% were from men."

Following is a table of the votes by states:

United States

Alabama	425
Alaska	3
Arizona	38
Arkansas	1004
California	315
Colorado	1172
Connecticut	635
Delaware	90
District of Columbia	134
Florida	59
Georgia	399
Hawaii	1
Idaho	24
Illinois	4080
Indiana	3482
Iowa	6435
Kansas	3899
Kentucky	798
Louisiana	358
Maine	123
Maryland	457
Massachusetts	1323
Michigan	3707
Minnesota	4421
Mississippi	416
Missouri	3677
Montana	524
Nebraska	3146
Nevada	12
New Hampshire	148
New Jersey	983
New Mexico	128
New York	6245
North Carolina	271
North Dakota	3429
Ohio	6861
Oklahoma	1992
Oregon	62
Pennsylvania	5964
Rhode Island	98
South Carolina	193
South Dakota	1642
Tennessee	1138
Texas	2971
Utah	6
Vermont	220
Virginia	403
Canada	4076
Miscellaneous	2021
Mexico	12
Cuba	3
Central America	1
Bermuda	1



HIRAM LISTENS TO CALVIN

Senator Hiram Johnson is pictured at his New York campaign headquarters as he listened over the radio to President Coolidge's first message to congress, which was broadcast over the country on December 6. Senator Johnson went to the east to consult with Frank H. Hitchcock, national manager, concerning his campaign for the republication nomination for president. (Kadel & Herbert.)

What is Radio's Future?

An era of simplification of radio broadcasting, with larger and more powerful distributing stations but with few new additions to the "science of radio," was forecast by Bowden Washington, builder of the world's most powerful marine stations and United States naval equipment, in an address broadcast over the North American continent from the National Radio Show at Chicago.

Mr. Washington's speech, delivered from the Cutting & Washington booth, was picked up and relayed by WDAP, Chicago; WLAG, Minneapolis; WJAZ, Chicago; a Cleveland station and Canadian stations.

"I rather think we will have fewer broadcasting stations of higher power, better programs and more powerful receivers," said Mr. Washington.

"The small, independently operated station is doomed. They cannot get programs of the quality obtainable by the large stations, and since the novelty of radio has worn off, people are no longer interested in listening to scratchy phonograph records. The dry cell tube has done a great deal to make the multi-tube set available to a great many more people than ever before; not only by saving the price of storage batteries, charger, etc., but by making tube sets available to those in isolated districts where no means of charging storage batteries is at hand. I also believe that loud speaker operation will be demanded from all but the very cheapest sets, as will the self-contained feature.

"People, for the thrill of a new thing, will put up with a mess of wires, cords and batteries, but I feel that the radio receiver will soon be as necessary as the phonograph in the home, and this mess will not be tolerated. The demand will range from the simple cabinet model to the beautiful period console, an ornament to any living room.

"People who are putting off buying a set, or a better set, because they are waiting for some new and startling development which is coming out next month, or possibly even next week, are in error. Do you realize that there is no violent or radical difference between the radio telephone receiver of 1913 and the broadcast receiver of 1923?

"Radio, like any other engineering art, progresses slowly and logically, with a gradual improvement.

"I have been following radio for twenty years. In 1913 I had a station-spark coil transmitter and coherer receiver—things most of you have probably never heard of. I have been following the art ever since, as amateur student and professional. I have yet to see anything absolutely revolutionary occur.

"The vacuum tube is probably the greatest invention of the last half century. Until I became interested in home radio a few months ago, I was chief engineer of a company operating the radio of 900 merchant ships. A large number of these ships are still doing good work with crystal detectors, and the vacuum tube was disclosed in 1907.

"We read in every column of new circuits—in the newspapers and in every radio magazine—the so-and-so circuit—the something-or-other. To my knowledge, there have been since 1910 but two radically new and useful circuits—the Armstrong regenerative and the Armstrong super-heterodyne. Most of these alleged new circuits are the products of so-called radio experts.

"The present regenerative three-tube set is practically identical with a navy radio compass receiver of 1917—therefore, do not wait for the revolution. Enjoy radio now.

"Another thing that I would like to mention, is the single circuit versus the double circuit receiver. This seems a bitter controversy, yet each has its uses. The single is easy to tune, having two major controls instead of three.

BOWDEN, Washington, radio engineer and designer, is the designer of seven large commercial radio stations in the United States, including WSA (East Hampton, L. I.), the most powerful spark marine radio station in the world, with a maximum radius of 11,000 miles. He was a designer of U. S. Naval equipment during the war, and also of ALLIED army and navy equipment.

The speech printed herewith predicts the future of radio. We believe it may be of interest from that and other standpoints.

RADIO SHOW IN PARIS

A general view of the first great radio show held in Paris. Many exhibits from America and other countries were shown. (Kadel & Herbert Foto.)

Radio fans listening to demonstration of "B" battery practice at the Philadelphia Radio Show. Near the demonstration board the fans may be seen grabbing for copies of the booklet, "How to Get the Most Out of Your 'B' Battery," of which they took 20,000 during the five days of the show.

With the Manufacturers

Phonographs and Radio

In an interview, Mr. H. L. Willson, president of the Columbia Graphophone Company, explained the position of the phonograph industry in relation to radio broadcasting.

"A happy relation is rapidly being established between the radio broadcasting interests and the phonograph industry. In some quarters, when radio first sprang into prominence, there was a feeling that the phonograph industry would be unfavorably affected, but the experience of more than two years has proven that radio may become a great aid to the phonograph industry. In the end, anything that helps to increase the popularity of music helps the sale of phonograph records. Radio serves to popularize music but as soon as a number is rendered at a radio broadcasting studio, no record of it remains. The radio audience is not satisfied with one reproduction. This is indicated by the many request programs which are arranged in an attempt to meet the demand for a permanent record of successful numbers. Famous orchestras sometimes receive as many as 500 telephone requests for certain numbers. Only a phonograph record personally selected can suit the indivudual tastes of this diversified audience.

"Realizing that radio broadcasting is an effective way of bringing new musical numbers to the attention of the public, just as the phonograph is the only successful way to permanently record them, the Columbia Graphophone Company has made arrangements with the American Telephone and Telegraph Company to broadcast through WEAF selections by the same artists who are recorded on phonograph records at our studios. The selections by radio will be played exactly as they are reproduced on Columbia New Process Records. As a result of these arrangements, the radio audience gains excellent program matter while the phonograph industry profits in creating a demand for permanent reproductions of the radio programs."

A New "B" Battery

A new type of "B" battery constructed on the skyscraper principle, so that most of its bulk is raised vertically instead of occupying valuable horizontal space, is now available to radio fans whose table area is limited. The new battery is No. 764 of the National Carbon Company. It gives 22 1-2 volts, and is only 3 1-8 inches wide. Its height is 5 5-8 inches.

It has been the practice of many radio users to install in their home sets the small "B" battery designed for portable sets, in situations where the saving of space or in the first cost were considerations. Some set manufacturers, to provide cabinet space, have done the same thing. Although the small "B" battery is necessary for portable use, its small size gives so short a life that it is properly used only where small space and light weight are of first importance.

The new battery has twice the life of the portable battery, while standing on practically the same size base, and the cost is only about one-fourth more than the cost of the small one. It was developed after months of experimentation by engineers of the National Carbon Company, who knew that many radio users were increasing their battery operating cost in order to economize on space or to save in first cost. The new battery gives much lower operating cost without appreciable sacrifice in table space.

Cascade Regeneration

A radio receiver set which, with a dishpan for an antenna, catches broadcasts from a 500 Watt Station 1,400 miles away, has been developed by Bowden Washington, it is announced by the Cutting & Washington Radio Corporation, Minneapolis.

The receiver, the result of two and a half years of laboratory efforts, works on a somewhat new principle termed cascade regeneration, which renders extremely small antennae highly effective.

With four UV-199's and a dishpan on a chair for an antenna, and another on the floor directly beneath it for a "counterpoise," signals from a 500-watt Western Electric transmitter in Dallas, Texas, were heard 1,400 miles distant on a loud speaker with such intensity as to be unpleasant. The receiver works equally well with a fly screen, a 6-foot wire, a magnavox horn or any small body of metal for an antenna, the announcement said. The receiver is also extremely selective.

Vernier Control

Radio Units, Inc., Webester Bldg., Chicago, has attractive folders describing the "Tiny-Turn," a vernier control which has a high gear ratio and makes tuning easy. They also offer the Duo-Spiral, a loop aerial with long handle and dial to regulate direction. The same company makes a binding post of black and nickel finish which improves appearance of the panel.

Bradley Switch

The Allen-Bradley Co., Milwaukee, Wisconsin, have added a fourth item to their list of radio products, known as the Bradley switch. This is a very com-

The How and Why of the Neutrodyne

By ARTHUR B. McCULLAH

THE ideal condition for amplifying at radio frequencies is to have the grid circuit tuned to the incoming signal that is to be amplified; also to have the plate circuit tuned to the same value that the grid or secondary circuit is tuned to. That is, the greatest efficiency is obtained when both grid and plate circuits are tuned to the same wave length.

One of the properties of a vacuum tube is to oscillate when the grid and plate circuits are tuned to the same value, which is due to the capacity coupling, furnished by the elements of the tube. The tube can be made to stop oscillating by biasing the grid. This can be done with a potentiometer, but this method has not proved satisfactory.

It can be readily seen that if a tube is oscillating at the frequency of the incoming signal, the oscillations from the tube will "buck" the incoming signal, and produce nothing but howling and distorted music.

The method to tune such an outfit, is to detune the plate circuit, so that the tube will not oscillate; that is, to detune the plate circuit, to a point just before the point where the tube will oscillate. With this method of tuning, the signal is relayed from the antenna to the detector, for a loss as the voltage across the tuning circuit in the plate circuit falls off very rapidly. By actual comparison it has been found that the three circuit regenerative system gives by far louder signals than the radio frequency amplifier of this type.

Prof. L. A. Hazeltine surmounted all of the difficulties by neutralizing the inherent capacity of the tube that is so objectionable. The balancing or neutralization of the capacity feedback between the grid and plate circuits is done with a small condenser in the neighborhood of .000015 mfd.

In this system the grid and plate circuits are tuned to the same wavelength, thus the maximum voltage will be across the tuned circuit in the plate circuit of the radio frequency amplifier. The tuning of such a set is not so critical as the tuning of a set that oscillates.

The neutrodyne condenser probably gives more trouble than anything else in a neutrodyne set. A large share of the neutralizing condensers on the market are too small. This makes it impossible to neutralize the capacity feedback; also the full benefit can not be derived from such a set.

A neutralizing condenser can be made that is the right size and will be just as efficient as the ready-made condenser. All that is necessary is two copper plates two inches square, soldered to the ends of two copper bus bar wires, one piece of bakelite 8 1-2 inches by 3 inches by 3-16 inches, two long binding posts (see Figure 1).

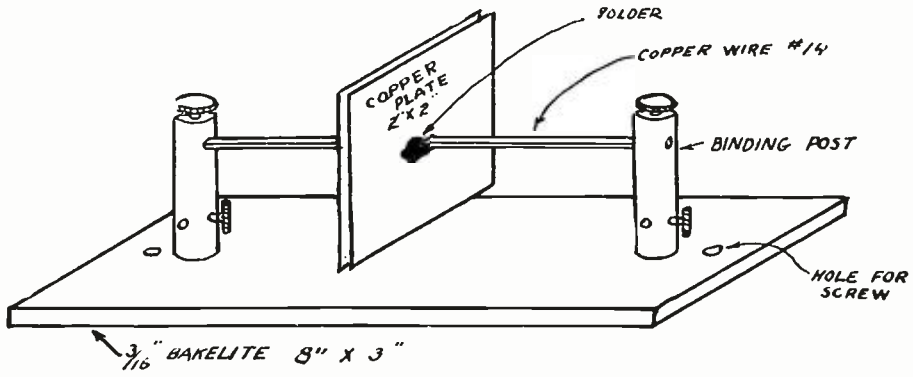


Figure 1. The Neutrodyne Condenser.

Editor's Note: Comprehensive instructions on how to build the four-tube neutrodyne receiver, illustrated with a full page isometric drawing, was published in the October RADIO AGE. Back copies are available at the regular rate of thirty cents for back numbers.

With the Manufacturers

(Continued from page 33.)

pact, completely enclosed, single-pole switch for opening battery circuits. It is mounted by drilling a hole in the radio panel and securing the switch by means of a knurled nut. The switch is operated by pulling or pushing the switch button.

The Bradley switch is nickel-plated and the button is polished black, thus conforming with the standard finish used for radio equipment. The switch will retail for sixty cents.

Rogers Radiometer

A device for tuning out interference is offered by the Rogers Radio Co., Pittsburgh. It is called the Rogers Receiving Radiometer and sells for $3, list. Some of the merits of this radiometer are that it is devoid of self-capacity; its inductance is progressively variable; it occupies small space; it is of moulded condensite; easy to mount and is substantially constructed. Tested and approved by Radio Age Institute.

Combined Battery and Charger

The Philadelphia Storage Battery Company announces a big demand for the $20.20 Philco Charger-Battery combination. It is a charger for "A" and "B" batteries and a genuine "Philco" 50-ampere radio battery, big enough to operate as many as five tubes. Further inquiry may be made of J. N. North, manager of the radio department, Philadelphia Storage Battery Co., 1621 S. Michigan Ave., Chicago.

Battery Demonstrations

A demonstration board which graphically illustrated the factors affecting "B" Battery current drain attracted attention at the Philadelphia Radio Show, which closed November 17. The same board was moved to Chicago for the show there, and went on to Boston for the Boston Show, December 3 to 8. The board was part of the exhibit of the National Carbon Company, and was manipulated by F. T. Bowditch, physicist, the associated company of the Union Carbide and Carbon Research Laboratories, Inc.

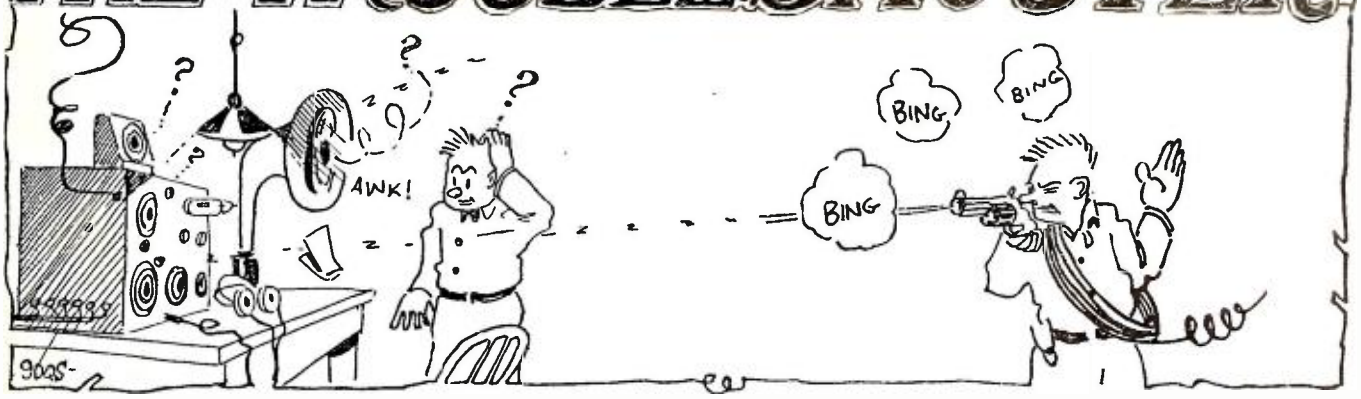
Just how much interest was shown in this battery demonstration may be imagined from the fact that the radio fans took away with them 20,000 National Carbon Company booklets describing battery operation, during the time the show was on. And the fans literally took them as the photograph shows. Each demonstration closed with the announcement that the new booklet, "How to Get the Most Out of Your 'B' Battery," might be had for the asking. Fans at once surged forward toward the booth, seizing the booklets the instant they came within arm's reach. One of these onslaughts is shown in the photograph, made during one evening at the show. The booklets rehearsed the information given by Mr. Bowditch during his talk and demonstration.

The demonstration board stood at one side of the booth and was constructed with a huge ammeter running across the top. As Mr. Bowditch explained the effects on battery life of the number of tubes, "B" battery voltage, use of a "C" battery, etc., the needle of the ammeter swung backward and forward across the dial, clearly visible to the farthest corner of the crowd. The demonstrator was able to talk in a natural voice by means of a unit of the Western Electric public address system in front of the board.

Besides the demonstration board, the National Carbon booth contained two large display stands which carried all the different types of Eveready radio batteries, with large lettered cards explaining the use of each in different radio installations.

In addition to Mr. Bowditch, the National Carbon Company was represented by G. C. Furness, manager of the radio department; A. M. Joralemon, sales manager, radio department; E. E. Horine, radio engineer; and E. Harold Boudwin, Philadelphia representative.

THE TROUBLESHOOTER



THE Troubleshooter Department of RADIO AGE has become a popular section of this magazine due to the fact that fans may write and receive answers to their inquiries with a minimum of delay.

In order that we may keep up the standard of this department and assure our fellow readers prompt service, it has become necessary for us to ask fans who write this department to observe certain rules, in order that prompt replies and concise answers may be sent out.

Non-subscribers may avail themselves of this service if they enclose fifty cents with each letter of inquiry. Do not ask us to answer your inquiries if you do not remit, saying that you are a regular reader, as we cannot do this in justice to our regular subscribers.

When writing, write on one side of the paper only, and do not forget to enclose a stamped, addressed envelope if you desire a personal reply.

Before writing this department, search through your back numbers of RADIO AGE to see if the desired information is not printed therein. It will save you both time and money to do this, because if the information has already appeared in some past number, this department will only call your attention to the issue in which the desired information appeared.

Questions pertaining to hookups of manufactured sets can not be answered. Write the manufacturer for this information.

Do not ask the Troubleshooter department to send you a list of the best apparatus to use in a set. We can advise the type of apparatus in a general way, but cannot specify any particular piece of apparatus. If it is absolutely necessary to specify an instrument vitally necessary in the circuit without intention of advertisement, it will be done.

When writing, don't put down every question you can think of—stick to the particular subject you are asking about as much as possible. If it is a set, tell about how it functions, whether good, bad or indifferent. If you possibly can, enclose a diagram of the circuit you are asking about, as it becomes very perplexing when a fan does not make clear what type of circuit he uses.

Questions are answered in the order they are received, and if your letter is delayed, exercise a little patience. Many letters command special attention requiring reference to our files, and looking up information.

This important service is carried out by our Technical Assistant, Felix Anderson, under the supervision of Frank D. Pearne, Technical Editor of RADIO AGE.

In an effort to start the year right, and settle for once and always the rubber stamp variety of question, we are printing this month questions of general and interesting nature. For the benefit of those who are just starting, we print the following general information:

Antennas:

Most preferred and popular type, is a single wire from 100 to 125 feet in length, including lead-in. For further information see June, 1923, issue.

Grounds:

Use waterpipe, or iron stake driven into ground. SOLDER the connection.

Instruments:

Use instruments that are strong, and well built. Do not expect results from cheap apparatus. Condensers should have positive connections and a gearing adjustment is preferred over any other type of vernier due to its lower losses. Choose a condenser which has the rotary plates connected to the end mounting, and has a minimum of insulation so placed with respect to electrostatic field that its losses are small. Friction verniers are also good.

Selectivity of Sets:

Depends upon the type of set, the location it is operated in, the proficiency of the operator, and the length of antenna.

Tubes:

Dry cell tubes will not give the volume that can be gotten from storage battery tubes.

H. F. H., Jamestown, N. Y.

Question: Kindly inform me where I can obtain a copy of the diagram of the Cockaday Four Circuit Tuner. I have read with considerable interest the comment of your readers on this circuit.

Answer: Full instructions relative to the construction of the above circuit appeared in the August, 1923, issue of RADIO AGE.

A. C. H., Chicago, Ill.

Question: Last week I built my first tube set from the isometric sketch showing back panel arrangement and wiring as given in the October issue of RADIO AGE. To say that it is a good hookup is putting it mildly. I wired my set as per your sketch and was able to get KDKA, WOS, WDAF, and WDAO the first silent night, and I have since brought in KDKA through local stations. It is my desire to build two steps of audio amplification with jacks so that I may use one or two steps and as I do not understand the circuit drawings, I am wondering if you could supply me with an isometric sketch showing arrangement and connections of parts. With many thanks for the help you have already accorded me, I await your further information.

Answer: The August issue of RADIO AGE contained detailed information on the construction and operation of a two-stage audio frequency amplifier with jacks. Inasmuch as the article is illustrated isometrically, you should have no trouble in connecting the set.

E. W. R., Orlando, Fla.

Question: Kindly inform me in what issue details concerning the construction of a battery charger were printed. I note in your questions and answers department you refer to a charger that can be operated from the 100 volt lighting circuit.

Answer: The information you desire was printed in the December, 1922, issue of RADIO AGE, and refers to an electrolytic type of battery charger.

G. A. J., Joliet, Ill.

Question: I am a beginner in the radio game and in the course of my trying to get acquainted with the particulars concerning sets, I have acquired a number of radio parts of which I am enclosing a list. I would appreciate your giving me a circuit which would use these pieces of apparatus and which would really tune in long distance stations.

Answer: In the October, 1923, issue of RADIO AGE you will find a circuit applicable to the apparatus you list and which will do consistent and long distance work. The December, 1923, issue

shows how to add two stages of audio frequency amplification to a set of this kind.

G. W., Hailey, Idaho.

Question: Please tell me how the various dry cell tubes compare as to volume and efficiency; also kindly send me a copy of the Kaufmann circuit.

Answer: The dry cell tubes are all efficient as far as current consumption is concerned. I would list them as follows, their efficiency rating in the order named: C 301A, UV 199, WD 11, WD 12, DV 6. Complete description giving detailed information on how to construct and operate the Kaufmann circuit was printed in the June, 1923, issue of RADIO AGE. A diagram of the two stages of amplification appeared in the September, 1923, issue.

R. H., Belleville, Ohio.

Question: Kindly inform me where I can obtain a copy of the three-circuit regenerative set, the type which uses two variometers and a variocoupler. I would like to have if possible the isometric sketch type showing the panel layout.

Answer: A complete description of the Armstrong three-circuit regenerative set appeared in the November, 1923, issue of RADIO AGE. This issue shows the isometric sketch you desire. A diagram of the circuit in connection with a two stage audio frequency amplifier appeared in the September, 1923, issue.

M. S. B., Minneapolis, Minn.

Question: Early last spring I constructed a radio set using the Kopprasch circuit. I am not able to recall in which issue it appeared. This circuit uses two variometers with an inductance between them. The set I made was dismantled by another person and I now want to rebuild it, using the above circuit. Will you kindly oblige me with another copy of the issue in which it appeared?

Answer: The circuit you have in mind appeared in the April, 1923, issue of RADIO AGE. A diagram of the circuit with a two-stage audio frequency amplifier was printed in the same issue.

D. R. C., Logansport, Ind.

Question: I am using a single circuit receiver with two stages of audio frequency amplification. Why is it that I cannot get as good results when I use more than ten volts on my detector and forty volts on my amplification? Please show me if there are any changes in my hookup that would better my results. Please tell me if there are any improvements I can make on my tuning arrangement. The coil consists of 90 turns of bank winding tapped at every ninth turn. This coil is wound on a three and one-half inch tube. The tickler coil has sixty turns of 26 DCC wire on a tube slightly smaller.

Answer: Probably the tube you are using as a detector is defective. If it has too much residual gas remaining, the tube will not function well. Put it on the amplifier stage, and if it turns blue on 45 volts, you can be sure that it is too "soft." You might decrease the number of turns on the tickler, making the coil have about 50 turns. The set should oscillate freely with this number of turns. The other improvement I would suggest is to place your phone condenser across the terminals of the transformer on the first stage of amplification. I am enclosing herewith a diagram showing how this is done. This issue contains information relative to increasing the selectiveness of your receiver.

L. E. D., Kansas City, Mo.

Question: I am a subscriber and wish to get information regarding a Reinartz set I am going to build. In your September issue, on page 5, you show how to load up a Reinartz set. As I look at the connections, it seems to me that when you switch in the loading coil you switch out the other coil and all the other switch points. The drawing does not show any connection between the two coils. Is it possible to wind a Reinartz coil large enough to take care of 600 meters? That is I want to reach this wave and higher without resorting to exterior loading coils. If this can be done, kindly advise me as to the specifications of such a coil.

Answer: We rather prefer the arrangement shown in the September issue to a larger coil, as you will decrease the dead end loss of the additional turns used to bring the wave of the set up to six hundred meters. You might use larger condensers. The arrangement shown in the September issue allows the outer coil to be used independently from the inner coil and when not in use, it is cut out of the circuit entirely. Cutting out the coil in the above manner increases the efficiency of the set to a noticeable degree.

W. K. R., Kennobert, Sask., Can.

Question: Kindly inform me where I can obtain a description of an amplifier to be added to a single tube Reinartz receiver.

Answer: This information can be had from either the August issue of RADIO AGE, or can be obtained from the Reinartz booklet advertised elsewhere in this issue.

G. D. I., Tulsa, Okla.

Question: Please give me a diagram of the circuit and a list of parts necessary to properly assemble the Haynes DX Receiver.

Answer: Detailed information of the construction and operation of the receiver you have in mind appeared in the December, 1923, issue of RADIO AGE. A diagram showing the addition of a two-stage amplifier was also shown in this issue.

A. L. K., Watertown, N. Y.

Question: Have been reading your July number of RADIO AGE, and I find it to be of mighty interest. I haven't been able to get this magazine on our news-stands, so please enter my subscription. I have an Armstrong three-circuit regenerative set at present. but I desire to get away from a regenerative type of receiver. Will I make a mistake in making a Reinartz set as in Figure 1 of your July issue? Would you please advise me something along this line?

Answer: You apparently have the wrong conception of the Reinartz set when you infer that it is not regenerative. The Reinartz is one of the sets which makes use of this regenerative action, due to the plate coil being directly coupled to the antenna through the feedback condenser. If you intend to build a set of the non-regenerative type, we would suggest your constructing one as described in the September issue of RADIO AGE in which the tubes you mention could be used to advantage.

B. W. E., West Burlington, Iowa.

Question: Kindly inform me where I could obtain information relative to the adjustment of a Neutrodyne Receiver. I am using one at present, and I am having trouble in making it work properly.

Answer: Detailed instructions concerning the operation, construction and action of the Neutrodyne Receiver was published in the October issue of RADIO AGE.

Experiments In Radio Control

(Continued from page 24.)

(Fig. 1) at A—B. Then, having set up the transmitter, say 20 feet or so away, press the key. You will find, perhaps after a little adjusting of the coherer, that the motor will operate simultaneously with the transmitter. An electric bulb may be supplemented in place of the motor, if desired.

As an illustration of how explosives can be ignited at a distance by means of radio, here is a novel experiment: Connect a small piece of No. 36 bare German silver wire in the circuit at A—B. To this wire attach the fuse of an ordinary fire-cracker. Press the key of the transmitter, and the German silver wire will heat, and light the fuse, causing the fire-cracker to "go off."

Another interesting experiment is the taking of flashlight photographs, without the presence of any person. Having set the camera as you would for a time exposure, connect the German silver wire in the circuit as in the preceding experiment, allowing it to touch the flash powder. Thus you can take photographs at a distance.

Numerous other experiments which are needless to mention will suggest themselves to the experimenter.

Radio control will some day be commercially practical. Picture in your mind, huge, crewless, liners, laden with freight, sailing the seven seas, bound to a course at the will of the operator in the control station miles away, and this one possibility of radio control, will cause you to realize what it will mean to the progress of our world.

Radio Year Book

Radio, with other forms of communication is included in a general survey of the economic situation of the world, just issued by the Department of Commerce. This review which is known as "The Commerce Yearbook," and is available from the superintendent of documents, was prepared under the direction of D. J. Reagan, of the department. Concerning radio it states:

"The principal developments in international radio during the year 1922 were in the form of concessions secured, plans made and work prosecuted on various stations designed for international traffic. The station at Monte Grande near Buenos Aires, of which the Radio Corporation of America is part owner, was taken over from the German company which had started its construction and the plans were altered to provide direct communications with the United States, as well as with Europe. The concession was secured for a similar high-power station in China, with smaller stations to act as feeders. This latter concession was issued in the name of the Federal Telegraph Company, which made arrangements to work with the Radio Corporation of America. The Radio Corporation secured the contract for the construction of a high-power station in Sweden, and proceeded with the construction of the station at Warsaw for the Polish government. These two stations furnish additional radio circuits direct to New York.

"In Central America and on the Caribbean coast of South America, the Tropical Radio Telegraph Company developed a general plan for a radio network to cover the countries bordering on the Gulf of Mexico and the Caribbean Sea. A new station was erected at Tegucigalpa, and the power of the New Orleans station was increased.

"International radio communication during 1922 showed a large increase in receipts from transoceanic traffic, the Radio Corporation of America reporting gross receipts of $2,914,000 as compared with $2,138,000 in 1921. It is evident from these figures that radio has taken its place beside the ocean cable as a reliable means of international communication. They indicate also the possibility of operating high-power radio circuits at an actual profit—something that has never been accomplished before.

"The most remarkable development in radio, however, was the great increase in the number of radio telephone broadcasting stations and in the number of receiving sets in use by the public. During the summer months of 1922 there was a slackening in the demand for radio apparatus and apparently a period of stagnation in the market. This proved to be only temporary, since, with the advent of the fall, the number of receiving sets in use increased even more rapidly than before and the requests for transmitting station licenses came into the Department of Commerce in even greater numbers. A remarkable increase appears in the gross sales of the radio corporation for 1922—$11,286,000 as compared with $1,468,000 in 1921.

What's What In Radio Industry

THE Federal Trade Commission on December 3 submitted to Congress a report of facts with respect to the radio industry. The report contains the results of the investigation made pursuant to House Resolution 548, Sixty-seventh Congress, fourth session.

An attempt has been made to collate the data with respect to the various phases of the inquiry as outlined by Congress in the resolution. In Chapter I, the facts concerning the development of the industry are presented which include the organization of the Radio Corporation of America, the most important factor in the industry. In Chapter II, the agreements between the various companies, respecting the hundreds of patents covering radio devices and apparatus, are discussed, which agreements are set out in full in the Appendix. In Chapter III are discussed the various traffic agreements respecting international radio communication and which are also set out in full in the Appendix. Chapter IV is devoted to a discussion of the practices relative to the manufacture, sale, and use of radio apparatus and parts. This naturally includes an outline of the sales policy of the Radio Corporation and the facts as to its sale of vacuum tubes, which product has been termed the heart of radio.

The Commission desires to call attention to certain facts disclosed by the investigation which may be summarized as follows:

British Holdings

The Marconi Wireless Telegraph Company of America was the first company in America formed for the purpose of engaging in the transmission of messages by wireless. It was organized November 22, 1899, with a capitalization of $10,000,000, of which about 25 per cent was owned by the Marconi's Wireless Telegraph Company, Ltd., a British Corporation.

In the United States and territories, this concern had the exclusive right to use and exploit the patents controlled by the British Marconi Company, among which were the important Fleming tube patents. The Marconi Company erected high power wireless stations at New Brunswick, N. J., Belmar, N. J., Marion, Mass., Chatham, Mass., Bolinas, Calif., Marshall, Calif., Kahuku, Hawaii and Kokohead, Hawaii. In the ship-to-shore communication business it practically had a monopoly when it was taken over by the Radio Corporation in 1919. Some of the wireless apparatus used was manufactured at its plant at Aldene, New Jersey, where it also manufactured radio parts, which it sold to amateurs and experimenters in radio, while the equipment for its high power stations was purchased from the British Marconi Company.

There were only two other companies in the United States engaged in the operation of a radio communication service, the United Fruit Company and the Federal Telegraph Company. The United Fruit Company, which operates a fleet of vessels in connection with its tropical fruit business between the United States, the West Indies, Central and South America, obtained a few radio patents and a license from the Marconi Company under certain of its patents. Its vessels were equipped with wireless apparatus and stations were erected in Boston, Massachusetts, New Orleans, Louisiana, and a few points in Central America from which a commercial service was maintained. The Federal Telegraph Company of California was organized in 1911 and operated a ship-to-ship and ship-to-shore service on the Pacific Coast.

Prior to the war, broadcasting for entertainment purposes had not been developed and the radio apparatus required in receiving and transmitting sets were sold to the concerns engaged in the communication field, the United States Government, and amateurs and experimenters in the radio art. The principal manufacturers of apparatus and parts were the Marconi Company of America, Federal Telegraph Company, DeForest Radio, Telephone & Telegraph Company, and the Wireless Specialty Apparatus Company, a subsidiary of the United Fruit Company. None of these concerns manufactured what is now termed the modern vacuum tube and which is considered so essential by the industry. Only the Marconi and DeForest Companies manufactured vacuum tubes which because of certain defects were not considered of much importance.

The DeForest Company manufactured tubes for only a short time since it was infringing the Fleming tube patents of the Marconi Company. The device then used for rectifying purposes was the crystal. Crystals and crystal receiving sets, efficient for short communication, were manufactured chiefly by the Wireless Specialty Apparatus Company. The Federal Telegraph Company manufactured the Poulsen arc, which is used in high power stations, for its own use and sale to ship owners and the Government. The three important manufacturers of electrical apparatus, the General Electric Company, and the Westinghouse Electric & Manufacturing Company, prior to the war did not sell radio apparatus, although they had done considerable research and development work. Some of the apparatus manufactured, however, was adapted for both radio and general electrical purposes.

Radio Corporation

Although engaged primarily in the manufacture of electrical machinery and apparatus, the subject of radio was of interest to the General Electric Company since many of its patents were also adapted to the radio art. Among its developments is the Alexanderson alternator, which is a machine for generating high frequency current, useful especially in long-distance communications. The first of these machines was installed in 1917 at the New Brunswick, N. J., station of the Marconi Company. Shortly thereafter the British Marconi Company commenced negotiations for the exclusive rights to the machine but because of the war negotiations were suspended. After the signing of the armistice, negotiations were resumed but were practically concluded after a conference in April, 1919, between Rear Admiral Bullard, Director of Communication of the Navy, Commander S. C. Hooper, of Bureau of Engineering of the Navy Department, and officials of the General Electric Company. The officials of the Navy Department suggested that an American radio corporation be formed to which the rights in the machine be sold and thus enable it to compete with British interests. A contract was proposed which provided for the organization of a company in such a man ner that the control thereof would re main in the control of American citizens At a conference in May, 1919, with officials of the General Electric Company, Secretary Daniels stated (1) that he was in favor of government ownership of radio, which he intended to urge upon Congress, and (2) that he doubted his power to execute such a contract except with the consent of Congress. No such

authority was granted so the contract never became effective. The General Electric Company, therefore, began negotiations for the purchase of the British Marconi Company's holdings in the Marconi Wireless Telegraph Company of America with a view of organizing a new company to carry on the radio business.

The Radio Corporation of America was caused to be organized by the General Electric Company, October 17, 1919. Its original capital stock was $1,000 but at the first meeting of the stockholders was increased to $25,000,000. On December 31, 1922, there was outstanding 3,955,974 shares, preferred stock, par value $5.00 per share, and 5,734,000 shares common stock, no par value. Of this amount, the the General Electric Company owns 1,875,000 shares, common, and 620,800 shares, preferred; the Westinghouse Electric & Manufacturing Company, 1,000,000 shares, common and 1,000,000 shares, preferred; and the United Fruit Company 160,000 shares, common, and 200,000 shares, preferred. The remainder is held largely by the former stockholders of the American Marconi Company. The companies mentioned are represented on the Board of Directors with the Exception of the American Telephone & Telegraph Company.

On November 20, 1919, the Radio Corporation entered into an agreement with the Marconi Wireless Telegraph Company of America, whereby the Radio Corporation issued to the Marconi Company 2,000,000 shares of its preferred stock in exchange for the physical properties, patents, licenses and good will of the Marconi Company.

License Agreements

The Radio Corporation has entered into agreements with the various companies which own or control practically all patents covering radio devices considered of importance to the art. The number of patents involved approximates two thousand. Agreements of this character have been entered into with the General Electric Company, Marconi's Wireless Telegraph Company, Ltd., American Telephone & Telegraph Company and its subsidiary, the Western Electric Company, the United Fruit Company and its subsidiary, the Wireless Specialty Apparatus Company, The International Radio Telegraph Company, the Westinghouse Electric & Manufacturing Company, and the Radio Engineering Company of New York. With certain minor limitations, the Radio Corporation under these agreements has secured an exclusive divisible right to sell and use the radio devices covered by the patents involved or by patents which these companies may acquire before the termination of the agreements. The agreements with the American Telephone & Telegraph Company and the Western Electric Company are to terminate in 1930 while the remainder are to terminate in 1945. Provision is made for the mutual exchange of information relating to radio, and, in most instances the Radio Corporation has granted to the other company a license under its patents to make and use devices in the particular

field in which the other company is interested.

The Radio Corporation, under these agreements, is made the selling company for practically all radio devices to be sold the public under the hundreds of patents involved. The General Electric Company and the Westinghouse Electric & Manufacturing Company are to manufacture and to sell to the Radio Corporation only, these devices and apparatus, the Radio Corporation agreeing that sixty per cent of its annual requirements would be purchased from the General Electric Company and forty per cent from the Westinghouse Company. Until the expiration of the Fleming patents in 1922, the Radio Corporation had an absolute monopoly in the sale of vacuum tubes. On the expiration of these patents, the DeForest Radio, Telephone & Telegraph Company which had retained a right to manufacture and sell, commenced the sale of such tubes to the general public. In the sale of receiving sets, the Radio Corporation has competition from seventeen concerns licensed under the Armstrong patents, although their sale of sets for use in conjunction with tubes is being contested in the courts at the present time.

It is contended that their sale and use under the present patent situation constitutes an infringement of the tube patents of the Radio Corporation which, if upheld by the courts, will prevent all competition in the sale of complete sets, since the Western Electric Company is manufacturing and selling only transmitting apparatus for commercial purposes.

Ship-to-Shore

In communication by radio between ships at sea and the shore, the Radio Corporation is the dominant factor. Its chief competitors are the independent Wireless Telegraph Company, Ship Owners' Radio Service Company, Wireless Company of Port Arthur, and Gulf Radio Service operating on the Atlantic Coast and the Federal Telegraph & Telephone Company and the Kilbourne and Clark operating on the Pacific Coast. The question as to the right to use tubes, the patents to which are under the control of the Radio Corporation, in apparatus furnished the ships and land stations is also involved in litigation, suit having been instituted by the Radio Corporation against the Independent Wireless Telegraph Company on this ground. The U. S. District Court for the Southern District of New York recently dismissed this bill for lack of parties since the DeForest Company, the owner of the patents involved and which had retained a personal license to make and sell, was a party to the proceeding in name only. If the contention of the Radio Corporation should finally prevail, competition from the other ship-to-shore service companies will be eliminated until there is a change in the patent situation. The Tropical Radio Telegraph Company, a subsidiary of the United Fruit Company, is also engaged in a ship-to-shore service in the Carribean Sea, but is affiliated with the Radio Corporation.

Overseas Communication

The Radio Corporation is the only concern now engaged in transmitting and receiving radio messages between the United States and foreign countries and contends that in order to function properly it must of necessity secure a monopoly in this field. The company has secured a virtual monopoly and controls all the high power stations with the exception of those owed by the Government. In addition, it has entered into traffic agreements with the various foreign Governments and radio companies, the majority of these agreements providing that all messages intended for the United States shall be transmitted only through the facilities owned by the Radio Corporation of America. Agreements of this character have been made with Marconi's Wireless Telegraph Company, Ltd., covering the British possessions, and the Governments of Norway, Germany, France, Poland, Sweden and the Netherlands. An agreement of a similar character between the Marconi Company and the Japanese Government was assumed by the Radio Corporation when it purchased the assets of the Marconi Wireless Telegraph Company of America and traffic by radio between the countries established.

In 1921, the Radio Corporation entered into an agreement with Marconi's Wireless Telegraph Company, Ltd., a British concern, the Compagnie Generale de Telegraphie sans fil, a French concern, and the Gesellschaft Fuer Drahtlose Telegraphie m. b. H., a German concern, respecting radio traffic from South American countries which was afterwards extended to Central American countries. Steps have been taken to establish service between Brazil, Argentina, Columbia, Venezuela and the United States. This agreement was made subject to the rights of the United Fruit Company in Cuba, Colombia, the Panama Canal Zone and Central America, and its agreement with the Radio Corporation whereby it agreed not to establish or operate stations for wireless communication outside the allotted territory.

The Federal Telegraph Company of California, which is engaged in a ship-to-shore communication service on the Pacific Coast, in 1921 entered into a partnership agreement with the Chinese Government providing for the erection of stations in China and the establishment of a transoceanic service. This agreement was assumed by the Federal Telegraph Company of Delaware, which was organized by the old Federal Company and the Radio Corporation. An agreement between the various companies holding concessions in China was also proposed. The agreement was apparently not executed and the correspondence with the Navy Department shows that the department would oppose any agreements of this character unless they were first approved by the respective governments. In a letter to the Secretary of State dated December 16, 1921, Mr. Denby, Secretary of the Navy, emphasizes the importance of maintaining competition in radio communication to and from China. The possibility of a monopoly in other fields than that of service is also pointed out, as is shown by the following excerpt from the letter:

"The Navy Department fears that any commitment on the part of the Government to an arrangement favorable to a monopoly by a single commerical company, though limited to a particular service, would but lend a means towards extending monopoly to other services such as development and distribution of apparatus in general, and this is considered absolutely undesirable, particularly in the field of supply and service to ships."

At the present time, the Radio Corporation has in operation communication circuits with Great Britain, Norway, France, Germany, Poland, Italy and Japan. It is expected that the station in Sweden will be completed and ready for operation within the next six months and that the station near Buenos Aires, in the Argentine, will be completed in the near future.

Because of the provisions in these various agreements providing for service through the facilities of the Radio Corporation exclusively, it is not believed that it will be possible for any other company in the United States to conduct an efficient transoceanic service. In fact, a group of newspaper publishers in the United States who sought to erect a station for the receipt of radio messages, after conducting experiments in this country, eventually built such a station at Dartmouth, Nova Scotia. This station is now being operated, its service being supplemented by virtue of an arrangement with the British Post Office. The following are members of the association operating such service:

The Chicago Tribune.
The New York Times.
The New York World.
The New York Herald.
The New York Tribune.
The Philadelphia Public Ledger.
United Press Association of America.
International News Service.
Universal Service.

The association is not exclusive and business for other newspapers is conducted at a charge of one cent per word.

Sale of Apparatus

The refusal to sell or lease apparatus to competitors for international communication purposes is included in the well defined policy of the Radio Corporation of America. It also affixes to the apparatus sold a license notice, the object of which is to restrict the purchaser's use of the device to amateur and experimental purposes. In supplying ships with apparatus, devices and appliances, the ship owners are required to execute an agreement which provides that the apparatus, etc., furnished by the Radio Corporation is licensed only for use on board ships and aircraft in communications destined to or originating on such ships or aircraft.

The Radio Corporation distributes its products chiefly through wholesale concerns handling electrical supplies. In order for a distributor to handle these goods it must furnish evidence that it has the facilities for conducting a wholesale business and give an initial order amounting to not less than $25,000. Independent manufacturers of sets are not sold vacuum tubes and other patented devices for re-

sale in connection with sets manufactured by them. This was a hardship, particularly when there was a shortage of tubes, as the dealers were unwilling to furnish them with tubes. The investigation shows that the shortage in tubes was confined to three of the six types manufactured and prevailed during 1922 and first few months of 1923. There was a marked increase in the demand for tubes as the industry developed as is shown by the orders received by the Radio Corporation which were as follows: 1921, 112,500; 1922, 1,583,021; and for the first nine months of 1923, 2,931,262 tubes. Although the officials of the Radio Corporation admit that they do not carry dealers who confine their orders to tubes exclusively, there is little evidence that the Radio Corporation required dealers to handle their goods exclusively or favored such dealers, in the supply of tubes, as compared with dealers who also handled apparatus manufactured by others.

The DeForest Radio, Telephone & Telegraph Company which is now engaged in the manufacture and sale of a modern vacuum tube, also a ffixes to its product notices with respect to use similar to those used by the Radio Corporation. This company has recently adopted the policy of making the distributors of its products, agents.

The Commission submits no conclusions in this report as to whether the facts disclosed constitute a violation of the anti-trust laws, as the House resolution under which the report was prepared called only for the facts and data "as in the opinion of the Commission may aid the House of Representatives in determining whether . . . the anti-trust statutes of the United States have been, or now are, being violated . . . ; and such other facts as in the opinion of the Commission may aid the House in determining what further legislation may be advisable."

Mooseheart Heroes

Matthew P. Adams, superintendent of Mooseheart, Ill., is the premier bachelor daddy. His brood comprises 1,200 youngsters of assorted ages, races, creeds and sizes, but just as if the number were two or three and he the honest-to-goodness daddy who comes home with a surprise bag of gumdrops or puzzlebook hidden in his pocket, so he is always planning something new and thrilling for his flock of 1,200.

Thomas Mulligan and Thomas Burgess, two important cogs on the Mooseheart lightweight foot ball team, each of whom suffered a broken leg in a game at Morris, Ill., were removed to an Aurora hospital, both feeling fit as Punch but with heavy casts keeping them confined to their beds. After the fractures were reduced all they would have to do for six weeks would be to lie in bed—and on their backs.

Superintendent Adams surprised the two lads when he had a radio receiving outfit installed in their room at the hospital. It is equipped with a quieting device so that other patients will not be disturbed, but the two Mooseheart boys have earpieces so that they get news, music and entertainment going on in the world without even turning over in bed.

Every night they get scores of athletic contests, news of the day, concerts from all parts of the country and then the bed-time story and their red letter days were when university football games were broadcast, play by play. They need pay no attention to "lights out" or other usual hospital rules, for they get radio messages until the early hours of the morning unless they go to sleep.

Mooseheart is the academic and vocational school of the Loyal Order of Moose for dependent children of deceased members.

If your newsdealer has sold out his supply of RADIO AGE you are likely to miss just the hook-up that you have been looking for. To avoid any such chance fill out the coupon in this issue and send in your subscription. Then you will be safe. And don't forget that with each subscription at the special price of $2.00 a year, or $1.00 for six months, we send you free the popular Reinartz Radio booklet FREE. Address Radio Age, 500 N. Dearborn Street, Chicago, Ill.

Turning on Our Loud Speaker

SAY, Mr. Radio Bugg, are you a regular reader of RADIO AGE? Before you file this copy of RADIO AGE, stop a minute and think over what you found in it. Have you ever read articles as clear as the ones you just finished? Did you ever see drawings and circuits more clearly portrayed? Perhaps you have once or twice—but here's your opportunity to be assured of real practical information right along.

Read over the following extracts and letters from our readers, who know and appreciate first-hand radio information; *real* practical radio. Here's a shining example of just what RADIO AGE has done for one of our readers and it shows how we can help you:

RADIO AGE,
Gentlemen:

Being an admirer of RADIO AGE, I just built the three circuit receiving set designed by Felix Anderson as it was published in the November, 1923, issue of your publication.

I have built nine different sets from supers to various other types of sets, published in other radio journals, and they turned out to be jokes. I won't mention the names of the other magazines but I will say that the sets I built came out of every radio journal I could buy, and I think I got them all. I was almost heartbroken, as it cost a pretty penny to be fooled like that.

So I resolved I would try one more and I did, which was the above mentioned set, and while I am writing this I feel like jumping up and down and hollering.

You may publish this letter if you wish, as I think your readers would enjoy knowing that it is a feeling of great joy to know that at last one can get radio from a reliable source, and get information that is straight.

This is the only way I know of expressing my appreciation for such a book.

Very truly yours,
B. R. THOMPSON,
731 West Congress Street, Chicago, Ill.

Ronald Cox, of Beach Haven, N. J., built one of the simple tubes sets described in RADIO AGE, writes as he encloses a record breaking list of stations (see the Pickups section of this issue).

"Your magazine is the best I have ever seen."

Just read over this little extract from a letter of A. E. McElroy of Columbia, Mo.

"I have been reading your magazine for the past several months, and I have been particularly attracted by the exceptionally good, clear, and concise hookups you print."

James P. Cooper of Memphis, Tenn., says:

"I am proud to be a subscriber to your valued and instructive paper."

John J. Drechsler of 2111 St. Paul Street, Baltimore, Maryland, writes us:

"I have RADIO AGE to thank for the many days of pleasure I derived from my Kopprasch set. Gentlemen, kindly accept my humble thanks for your untiring labors."

It's rather pleasant to believe that readers of RADIO AGE are as appreciative as that!

James E. Chandler of Belvidere, Ill., says:

"I am a regular reader of your good magazine, RADIO AGE, and I want to tell you that I find it most instructive and helpful."

George Rollisson of 418 West Elm Street, Hanford, Calif., writes:

"I have read nearly all the different radio journals and am proud to say that RADIO AGE beats them all when it comes to hookups and material."

We get letters from fellows who have just started to read RADIO AGE which run something like this excerpt from the letter of F. M. Swissher of Meadowbrook, W. Va.:

"If you keep making your issues like the November issue, then it is without doubt the best radio book ever published. Keep up the good work."

There is no doubt about keeping up the good work. This month new writers appear on the staff of RADIO AGE, to furnish our interested fans with more and more first rate information. It's pretty hard to find a more capable staff of workers than Frank D. Pearne, Felix Anderson, Carl Masson, Arthur B. McCullagh, Carl Butman, John B. Rathbun, J. A. Callanan, all doing their level best to supply you with first rate radio.

The following is just another reason why you should be a regular RADIO AGE booster. Philip G. Shermerhorn of 67 West 52d Street, New York City, N. Y., tells us:

"May I say that I send in my subscription, partly because of the excellent material composing your magazine, and partly because of the list of broadcasting stations, since this list is an absolute necessity to DX listeners."

Perhaps as you glanced through the magazine you have noticed that we feature a list of broadcasting stations

But our list is different—it is not only a list of stations—it is a *corrected* list, which is kept to date for each issue by special service and news bureaus, and by the watchful eye of our Washington correspondent.

We hope you will pardon us for taking so much of your time, but we know that if we don't tell you about RADIO AGE, in this way, you'll probably never get to hear about it, because the average RADIO AGE reader is so busy copying long distance signals on a set made according to RADIO AGE instructions that he will just point to a magazine on his work bench, and mumble "LET THEIR HOOKUPS BE YOUR GUIDE."

A Public Chat

WJAZ, the Zenith-Edgewater Beach Hotel broadcasting station, was rebroadcasting an outside station the other night, the operator forgot to close his transmitter and a queer thing happened. Some one called him up on the phone and had quite a conversation with him. Thousands of fans thought that they were hearing two broadcasting stations carrying on a conversation. The caller's voice was just as clear as the operator's due to some freak of inductance.

Complete Corrected List of U. S. and Canadian Broadcasting Stations

Complete Each Issue

THE list of broadcasting stations on these pages is brought up to date each month by additions of new stations and deletion of those which have suspended operation. The list is the product of a vast volume of correspondence and its completeness is due in large measure to the assistance of our special news service in Washington, D. C. Suggestions, corrections and additional data will be welcomed from readers and broadcasters.

		Wave length
KDKA	Westinghouse Electric & Mfg. Co. East Pittsburgh	326
KDPM	Westinghouse Electric & Mfg. Co. Cleveland, Ohio	270
KDPT	Southern Electrical Co. San Diego, Calif.	244
KDYL	Telegram Publishing Co. Salt Lake City, Utah	360
KDYM	Savoy Theatre San Diego, Calif.	252
KDYQ	Oregon Institute of Technology Portland, Oreg.	360
KDYS	The Tribune Great Falls, Mont.	360
KDYW	Smith Hughes & Co. Phoenix, Ariz.	360
KDYX	Star Bulletin Honolulu, Hawaii	360
KDZB	Frank E. Siefert Bakersfield, Calif.	240
KDZE	The Rhodes Co. Seattle, Wash.	456
KDZF	Automobile Club of Southern California Los Angeles, Calif.	278
KDZI	Electric Supply Co. Wenatchee, Wash.	360
KDZK	Nevada Machinery & Electric Co. Reno, Nev.	360
KDZQ	Nichols Academy of Dancing Denver, Colo.	360
KDZR	Bellingham Publishing Co. Bellingham, Wash.	261
KDZT	Seattle Radio Assn. Seattle, Wash.	360
KFAD	McArthur Bros. Mercantile Co. Phoenix, Ariz.	360
KFAE	State College of Washington Pullman, Wash.	360
KFAF	Western Radio Corp. Denver, Colo.	360
KFAJ	University of Colorado Boulder, Colo.	360
KFAN	The Electric Shop Moscow, Idaho	360
KFAP	Standard Publishing Co. Butte, Mont.	360
KFAR	Studio Lighting Service Co. (O. K. Olsen) Hollywood, Calif.	280
KFAU	Independent School District of Boise City. Boise High School, Boise, Idaho	270
KFAV	Abbot Kinney Co. Venice, Calif.	224
KFAW	The Radio Den (W. B. Ashford) Santa Ana, Calif.	280
KFAY	W. J. Virgin Medford, Oreg	283
KFBB	F. A. Buttrey & Co. Havre, Mont.	360
KFBC	W. K. Azbill San Diego, Calif.	278
KFBE	Reuben H. Horn San Lula Obispo, Calif.	360
KFBG	First Presbyterian Church Tacoma, Wash.	360
KFBK	Kimball-Upson Co. Sacramento, Calif.	283
KFBL	Leese Bros. Everett, Wash.	224
KFBS	Trinidad Gas & Electric Supply Co. and the Chronicle News Trinidad, Colo.	360
KFBU	The Cathedral (Bishop N. S. Thomas) Laramie, Wyo.	283
KFCB	Nielsen Radio Supply Co. Phoenix, Ariz.	236
KFCD	Salem Electric Co. (F. S. Barton) Salem, Oreg.	360
KFCF	Frank A. Moore Walla Walla, Wash.	360
KFCH	Electric Service Station (Inc.) Billings, Mont.	360
KFCK	Colorado Springs Radio Co. Colorado Springs, Colo.	258
KFCM	Richmond Radio Shop (Frank T. Doeing) Richmond, Calif.	360
KFCP	Ralph W. Flygare Ogden, Utah	360
KFCV	Fred Mahaffey, Jr. Houston, Tex.	360
KFCY	Western Union College LeMars, Iowa	252
KFCZ	Omaha Central High School Omaha, Nebr.	258
KFDA	Adler's Music Store Baker, Oreg.	380
KFDD	St. Michaels Cathedral Boise, Idaho	252
KFDH	University of Arizona Tucson, Ariz.	360
KFDJ	Oregon Agricultural College Corvallis, Oreg.	360
KFDL	Knight-Campbell Music Co. Denver, Colo.	360
KFDO	H. Everett Cutting Bozeman, Mont.	248
KFDR	Bullock's Hardware & Sporting Goods (Robert G. Bullock). York, Nebr	360
KFDU	Nebraska Radio Electric Co. Lincoln, Nebr.	240
KFDV	Gilbrech & Stinson Fayetteville, Ark.	380
KFDX	First Baptist Church Shreveport, La.	360
KFDY	South Dakota State College of Agriculture and Mechanic Arts, Brookings, S. Dak.	360
KFDZ	Harry O. Iverson Minneapolis, Minn.	231
KFEC	Meier & Frank Co. Portland, Oreg.	360
KFEI	Guy Greason Tacoma, Wash.	360
KFEL	Winner Radio Corp. Denver, Colo.	360
KFEP	Radio Equipment Co. (Joseph L. Turre) Denver, Colo.	240
KFEQ	J. L. Scroggin Oak, Nebr.	360
KFER	Auto Electric Service Co. Fort Dodge, Iowa	231
KFEV	Radio Electric Shop Douglas, Wyo.	263
KFEX	Augsburg Seminary Minneapolis, Minn.	261
KFEY	Bunker Hill & Sullivan Mining & Concentrating Co. Kellogg, Idaho	360
KFEZ	American Society of Mechanical Engineers (F. H. Schubert,) St. Louis, Mo.	360
KFFB	Jenkins Furniture Co. Boise, Idaho	240
KFFE	Eastern Oregon Radio Co. Pendleton, Oreg.	360
KFFO	Dr. E. H. Smith Hillsboro, Oreg.	229
KFFQ	Marksheffel Motor Co. Colorado Springs, Colo.	360
KFFR	Nevada State Journal (Jim Kirk) Sparks, Nev.	226
KFFV	Graceland College Lamoni, Iowa	360
KFFX	McGraw Co. Omaha, Nebr.	278
KFFY	Pincus & Murphy Alexandria, La.	275
KFFZ	Al. G. Barnes Amusement Co. Dallas, Tex. (portable)	228
KFGC	Louisiana State University Baton Rouge, La.	254
KFGD	Chickasha Radio & Electric Co. Chickasha, Okla.	248
KFGH	Leland Stanford University Stanford University, Calif.	360
KFGJ	Missouri National Guard, 138th Infantry St. Louis, Mo.	268
KFGL	Arlington Garage Arlington, Oreg.	234
KFGQ	Crary Hardware Co. Boone, Iowa	228
KFGV	Heidbreder Radio Supply Co. Utica, Nebr.	224
KFGX	First Presbyterian Church Orange, Tex.	250
KFGZ	Emmanuel Missionary College Berrien Springs, Mich.	268
KFHA	Western State College of Colorado Gunnison, Colo.	252
KFHB	Rialto Theater (P. L. Beardwell) Hood River, Oreg.	280
KFHD	Utz Electric Shop Co. St. Joseph, Mo.	226
KFHF	Central Christian Church Shreveport, La.	268
KFHH	Ambrose A. McCue Neah Bay, Wash.	283
KFHJ	Fallon & Co. Santa Barbara, Calif.	360
KFHQ	Curtis Brothers Hardware Store (Alfred E. Fowler) Los Gatos, Calif.	242
KFHR	Star Electric & Radio Co. Seattle, Wash.	270
KFHS	Clifford J. Dow Lihue, Hawaii	275
KFHU	M. G. Sateren Msyville, N. Dak.	261
KFHX	Robert W. Nelson Hutchinson, Kans.	229
KFI	Earle C. Anthony (Inc.) Los Angeles, Calif.	469
KFIB	Franklin W. Jenkins St. Louis, Mo.	244
KFID	Ross Arbuckle's Garage Iola, Kans.	246
KFIF	Benson Polytechnic Institute Portland, Oreg.	360
KFIK	Gladbrook Electrical Co. Gladbrook, Iowa	234
KFIL	Windisch Electric Farm Equipment Co. Louisburg, Kans.	234
KFIO	North Central High School Spokane, Wash.	252
KFIQ	Yakima Valley Radio Broadcasting Association Yakima, Wash.	224
KFIU	Alaska Electric Light & Power Co. Juneau, Alaska	226
KFIV	V. H. Broyles Pittsburg, Kans.	240
KFIX	Reorganized Church of Jesus Christ of Latter Day Saints Independence, Mo.	240
KFIY	Brott Laboratories Seattle, Wash.	236
KFIZ	Daily Commonwealth and Oscar A. Huelsman Fond du Lac, Wis.	278
KFJA	Central Power Co. Grand Island, Nebr	244
KFJB	Marshall Electrical Co. Marshalltown, Iowa	248
KFJC	Seattle Post Intelligencer Seattle, Wash.	233
KFJD	Weld County Printing & Publishing Co. Greeley, Colo.	238
KFJF	National Radio Manufacturing Co. Oklahoma City, Okla.	252
KFJH	"The Sugar Bowl" (H. R. Shaw) Selma, Calif.	278
KFJI	Liberty Theatre (E. E. Marsh) Astoria, Oreg.	252
KFJJ	Carrollton Radio Shop Carrollton, Mo.	238
KFJK	Delano Radio and Electric Co. Bristow, Okla.	233
KFJL	Hardsaeg Manufacturing Co. Ottumwa, Iowa	242
KFJM	University of North Dakota Grand Forks, N. Dak.	229
KFJR	Ashley C. Dixon & Son Stevensville, Mont. (near)	250
KFJU	Central Power Co. Kearney, Nebr.	234
KFJV	Thomas H. Warren Dexter, Iowa	224
KFJW	Le Grand Radio Co. Towanda, Kans.	226
KFJX	Iowa State Teachers' College Cedar Falls, Iowa	229
KFJY	Tunwall Radio Co. Fort Dodge, Iowa	248
KFJZ	Texas National Guard, One hundred and twelfth Cavalry Fort Worth, Tex.	254
KFKA	Colorado State Teachers College Greeley, Colo.	248
KFKB	Brinkley-Jones Hospital Association Milford, Kans.	286
KFKH	Denver Park & Amusement Co. Lakeside, Colo.	228
KFKQ	Conway Radio Laboratories (Ben H. Woodruff) Conway, Ark.	224
KFKV	F. F. Gray Butte, Mont.	283
KFKX	Westinghouse Electric & Manufacturing Co. Hastings, Nebr.	280
KFKZ	Nassour Bros. Radio Co. Colorado Springs, Colo.	234
KFLA	Abner R. Willson Butte, Mont	283
KFLB	Signal Electric Manufacturing Co. Menominee, Mich.	248
KFLD	Paul E. Greenlaw Franklinton, La.	234
KFLE	National Educational Service Denver, Colo.	268
KFLH	Erickson Radio Co. Salt Lake City, Utah	281
KFLP	Everette M. Foster Cedar Rapids, Iowa	240
KFLQ	Bizzell Radio Shop Little Rock, Ark.	261
KFLR	University of New Mexico Albuquerque, N. Mex.	254
KFLU	Rio Grande Radio Supply House San Benito, Texas	230
KFLV	Rev. A. T. Frykman Rockford, Ill.	229
KFLW	Missoula Electric Supply Co. Missoula, Mont.	234
KFLZ	Atlantic Automobile Co. Atlantic, Ia.	273
KFMQ	University of Arkansas Fayetteville, Ark.	263
KFMR	Morningside College Sioux City, Iowa	261
KGB	Tacoma Daily Ledger Tacoma, Wash.	252
KGG	Hallock & Watson Radio Service Portland, Oreg.	380
KGN	Northwestern Radio Mfg. Co. Portland, Oreg.	380
KGU	Marion A. Mulroy Honolulu, Hawaii, Waikiki Beach.	360
KGW	Portland Morning Oregonian Portland, Oreg.	492
KGY	St. Martins College (Rev. Sebastian Ruth) Lacy Wash.	258
KHJ	Times-Mirror Co. Los Angeles, Calif.	395
KHQ	Louis Wasmer, Seattle, Wash.	380
KJQ	C. O. Gould Stockton, Calif.	360
KJR	Northwest Radio Service Co. Seattle, Wash.	270
KJS	Bible Institute of Los Angeles Los Angeles, Calif.	360
KLN	Monterey Electric Shop Monterey, Calif.	281
KLS	Warner Brothers Radio Supplies Co. Oakland, Calif.	380
KLX	Tribune Publishing Co. Oakland, Calif.	360
KLZ	Reynolds Radio Co. Denver, Colo.	380
KMJ	San Joaquin Light & Power Corp. Fresno, Calif.	278
KMO	Love Electric Co. Tacoma, Wash.	360
KNT	Grays Harbor Radio Co. (Walter Hemrich) Aberdeen, Wash.	283
KNV	Radio Supply Co. Los Angeles, Calif.	258
KNX	Electric Lighting Supply Co. Los Angeles, Calif.	380
KOB	New Mexico College of Agriculture & Mechanic Arts State College, N. Mex.	360
KOP	Detroit Police Department Detroit, Mich.	286
KPO	Hale Bros. San Francisco, Calif.	423
KQI	University of California Berkeley, Calif.	360
KQP	Apple City Radio Club Hood River, Oreg.	380
KQV	Doubleday-Hill Electric Co. Pittsburgh, Pa.	360
KQW	Charles D. Herrold San Jose, Calif.	360
KRE	Berkeley Daily Gazette Berkeley, Calif.	278
KSD	Post Dispatch (Pulitzer Pub. Co.) St. Louis, Mo.	540
KSS	Prest & Dean Radio Co. and Radio Research Society of Long Beach, Calif. Long Beach, Calif.	360
KTW	First Presbyterian Church Seattle, Wash.	380
KUO	Examiner Printing Co. San Francisco, Calif.	380
KUS	City Dye Works & Laundry Co. Los Angeles, Calif.	660
KUY	Coast Radio Co. El Monte, Calif.	258
KWG	Portable Wireless Telephone Co. Stockton, Calif.	360
KWH	Los Angeles Examiner Los Angeles, Calif.	360
KXD	Modesto Herald Publishing Co. Modesto, Calif.	252
KYQ	Electric Shop Honolulu, Hawaii	360
KYW	Westinghouse Electric & Mfg. Co. Chicago, Ill.	536
KZM	Preston D. Allen Oakland, Calif.	380
KZN	The Deseret News Salt Lake City, Utah	360
KZV	Wenatchee Battery & Motor Co. Wenatchee, Wash.	380
WAAB	Valdemar Jensen New Orleans, La.	286
WAAC	Tulane University New Orleans, La.	368
WAAD	Ohio Mechanics Institute Cincinnati, Ohio	360
WAAF	Chicago Daily Drovers Journal Chicago, Ill.	280
WAAK	Gimbel Brothers Milwaukee, Wis.	280
WAAM	I. R. Nelson Co. Newark, N. J.	283
WAAN	University of Missouri Columbia, Mo.	254
WAAW	Omaha Grain Exchange Omaha, Nebr.	360
WAAZ	Hollister-Miller Motor Co. Emporia, Kans.	660
WABA	Lake Forest College Lake Forest, Ill.	360
WABB	Dr. John R. Lawrence Harrisburg, Pa.	266
WABC	Fulwider-Grimes Battery Co. Anderson, Ind.	229
WABD	Parker High School Dayton, Ohio	283
WABE	Young Men's Christian Association Washington, D. C.	283
WABF	Mount Vernon Register-News Co. Mount Vernon, Ill.	234
WABG	Arnold Edwards Piano Co. Jacksonville, Fla.	246
WABH	Lake Shore Tire Co. Sandusky, Ohio	240
WABI	Bangor Railway & Electric Co. Bangor, Me.	240
WABJ	The Radio Laboratories South Bend, Ind.	240
WABK	First Baptist Church Worcester, Mass.	252
WARL	Connecticut Agricultural College Storrs, Conn.	283
WABM	F. E. Doherty Automotive and Radio Equipment Co. Saginaw, Mich.	254
WABO	Waldo C. Grover La Crosse, Wis.	244
WABO	Lake Avenue Baptist Church Rochester, N. Y.	252
WABP	Robert F. Weinig Dover, Ohio	288
WART	Holiday-Hall Radio Engineers Washington, Pa.	252
WARU	Victor Talking Machine Co. Camden, N. J.	226
WARV	John H. DeWitt, Jr. Nashville, Tenn.	263
WRAA	Purdue University West Lafayette, Ind.	360
WBAD	Sterling Electric Co. Minneapolis, Minn.	360

Pickups by Readers

(Continued from page 20.)

Gentlemen:

In this November RADIO AGE you have a letter sent in by Frank A. Fleckenstein, Memphis. According to his record he has heard twenty-two stations in nine days with his Cockaday. You ask if his record can be beaten in the same period of time. Here is my record, and let me state now that I keep two pairs of receivers hooked up to my set, and when I get a distant station I have my mother or a visitor to listen in on them long enough to prove that I am getting them. For practically all these stations I have such proof.

I have a single circuit set using the two-variometer hookup of the Aeriola portable set, and *I have only the detector.* From the twenty-seventh of October to the seventh of November I used my set nine nights (closed down on November 3, 4 and 5 on account of discharged A battery). Here is the list; a total of forty-seven stations:

KDKA, Pittsburgh, KFKB, Melford, Kan.; KSD, St. Louis; KOP, Detroit; KYW, Chicago; WAAP, Wichita, Kan.; WBAP, Fort Worth; WDAF, Kansas City; WDAP, Chicago; WFAA, Dallas, Texas; WGY, Schenectady; WHAS, Louisville, WHAZ, Troy, N. Y.; WLW, Cincinnati; WMC, Memphis; WOC, Davenport; WSB, Atlanta; WWJ, Detroit; WSY, Montgomery, Ala.; WJAR, Providence, R. I.; 2XI, (?); 9CD, Chicago, Ill. WJAZ, Chicago; WCAP, Washington, D. C.; WOAW, Omaha; WGR, Buffalo; (?), Erie, Pennsylvania; WBAH, Minneapolis; WOR, Newark; (?), Columbus, Ohio; WSAI, Cincinnati; (?), Illinois University; WJAN, Peoria, Ill.; WOAI, San Antonio, Texas; WHAM, Rochester; WHB, Kansas City; WJAX, Cleveland; WIAS, Burlington, La.; WMAQ, Chicago; KHJ, Los Anegles, (heard for nearly one-half hour on three successive nights); CHBC, Calgary, Canada; WHN, Brooklyn; WTAM, Cleveland; WLAG, Minneapolis; WOS, Jefferson City, Mo.; WDAR, Philadelphia; WJAK, Greentown, Ind.

These stations were received on a tuner wound on an oats box, a well-known and widely used article in rado construction with a UV200 detector tube and 2,000 ohm phones. Practically all my listening has been done between the hours of eight and midnight. Mr. Jeffers, in the letter following Mr. Fleckenstein's, says he finished at 3:20 a. m. I got KHJ all three times between ten-thirty and eleven, although I have heard that one must wait until everything else has closed for the night before trying for the western coast.

Very truly yours,
LLOYD E. FOLTZ.

It looks like you were getting the raspberry, Mr. Fleckenstein. Mr. Foltz certainly has a mean way of snatching the long distance stations out of the air.

And say, fellows—do you know that our little "first tube set" described by Mr. Anderson in the October issue has enabled beginners to get into the real DX game! That little set is doing some real work.

Read for yourself:

Beach Haven, N. J.

RADIO AGE,
Pickups Department.
Gentlemen:

I made a set according to your description in the October RADIO AGE. It's a one-tube set described in "How to make your first tube set," and I want to say that it works fine.

The first two nights I had it working I received the following stations:

WHAS, Louisville, Ky., WSB, Atlanta, Ga., WGY, Schenectady, N. Y., WJAX, Cleveland, O., KSD, St. Louis, Mo., KYW, Chicago, Ill., 6KW, Cuba, PWX, Havanna, Cuba, WIP, Philadelphia, Pa., WCAP, Washington, D. C., WHB, Kansas City, Mo., WNAC, Boston, Mass., WJAN, Peoria, Ill., WGR, Buffalo, N. Y., WJZ, New York, N. Y., WJAZ, Chicago, Ill., WDAP Chicago, Ill., 8XD, Ohio, WOO Philadelphia, Pa., WBZ, Springfield, Mass., KDKA, Pittsburgh, Pa., WLW, Cincinnati, Ohio, WDAF, Kansas City, Mo., WPAD, Chicago, Ill., WCAE, Pittsburgh, Pa., WEAF, New York City, N. Y. WDAR, Philadelphia, Pa., WOS, Jefferson City, Mo., WWJ, Detroit, Mich., WOC, Davenport, Iowa, WSAI, Cleveland, Ohio, WPAM, Kansas City, Mo., WTAM Cleveland, Ohio. WEAM, Providence, R. I., WNAP, Ohio, WCBD, Zion, Ill., Ill., WDAH, El Paso, Texas, WMAQ, Chicago, Ill., a total of forty stations in two nights.

Yours truly,
RONALD COX.

This looks like a real DX record, and it looks like the best list we have this month! Consider receiving forty stations in two nights with a set composed of about eight or ten pieces or wireless instruments! We'll bet Mr. Cox will be able to hear a fly crawl on the wall down in the Hawaiian Islands broadcasting station when he adds a two-stage amplifier. Considering the type of set this little "flivver" is, we acclaim Mr. Cox the record holder for this month, and dare the rest of you to try and come up to it. By gum! You'd think it was a list taken off the log of a ten-tube superheterodyne. Congratulations, Mr. Cox.

In regard to this little DX getter, George Bindler, of Council Bluffs, Iowa, writes:

"Mr. Anderson's set published in the October issue is certainly a dandy. I built one for my father."

A little set of this type certainly makes a welcome gift, as it is easy to operate, more easy to understand, and least expensive to keep up. Tell your father to let us have his list of stations heard with this little set of his, Mr. Bindler.

Now tune in on this one from the Virginia Hotel, Quincy, Ill.

RADIO AGE,
Pickups Department,
Gentlemen:

In last month's RADIO AGE there was a circuit showing the amateur how to make his first tube set. This circuit looked good to me and I tried it. After assembling everything in shipshape order I tried it out. Did it work? Well, I'll say it did! It brought in the following stations the first three days: WOC, Davenport; WDAP, Chicago; WJAZ, Chicago; KSD, St. Louis; WOAW, Omaha; WGY, Schenectady; KDKA, East Pittsburgh; WOS, Jefferson City; WFAA, Dallas; WABE, Washington, D. C.; WBAP, Fort Worth; WSAI, Cincinnati; WLW, Cincinnati and WSB, Atlanta.

How is that for getting 'em? I'll say it is the best little one-tube set I have ever had and I have had lots of them. It pretty nearly equals the results of my five-tube Reinartz. The Reinartz is a great set for distance and amplification. I don't believe I would trade my old Reinartz for any other set made; that is how I like them.

Yours very truly,
W. L. CARROLL.

F'eaven sake! That little one-tube set must be a whiz if it's good enough to compare its reception records with a five-tube Reinartz! Considering the amount of apparatus used, we'll bet Mr. Carrol is willing to concede that the little one-tube flivver beats his Reinartz! From what we know, the fellows get to love their Reinartz sets like a shipwrecked sailor loves a floating spar! Ask some of the radio widows whose husbands have Reinartz sets.

If the foregoing two letters don't convince you as to the effectiveness of the "first tube set," read this one from 4840 North Lincoln Street, Ravenswood, Chicago, Ill., and weep:

RADIO AGE,
Pickups Department.
Gentlemen:

Just a few words to tell you that I made the hookup given on page five of the October issue into a common little wooden box given me by a druggist, using for the panel nothing else than the wood of one side of the box and connecting all the units of the circuit with common bell wire. There is not a soldered joint in the set. On the road as a traveling man, I am getting all kinds of DX stuff with this set, in hotel rooms at night using sometimes a lighting socket plug, but more often the bed spring for an antenna and ground wire to a common water faucet.

In Wisconsin towns have heard Buffalo, East Pittsburgh, Detroit, Chicago, and many others. Last night had KFKX of Hastings, Nebr., very loud and clear off the bed spring in this hotel. (Jefferson House, Jefferson, Wis.)

No one need hesitate to build this set, for a flivver to carry around. There is not a night that I use it but what I get something satisfactory from some direction, and real DX, using either of the above antenna systems.

Yours very truly,
A. J. BAUMGARDNER.

At this point, the owners of eight and ten-tube reflexes, Reinartzes, Cockadays, Superheterodynes, etc., will plug in

(Continued on page 46.)

Complete Corrected List of U. S. and Canadian Broadcasting Stations

WBAH	The Dayton Co.	Minneapolis, Minn.	417
WBAN	Wireless Phone Corp.	Paterson, N. J.	244
WBAO	James Millikin University	Decatur, Ill.	360
WBAP	Wortham-Carter Publishing Co. (Star Telegram)	Fort Worth, Tex.	476
WBAV	Erner & Hopkins Co.	Columbus, Ohio	390
WBAW	Marietta College	Marietta, Ohio	246
WBAX	John H. Stenger, Jr.	Wilkes-Barre, Pa.	360
WBAY	Western Electric Co.	New York, N. Y.	492
WBBA	Newark Radio Laboratories	Newark, Ohio	240
WBBD	Barbey Battery Service	Reading, Pa.	234
WBL	T & H Radio Co.	Anthony, Kans.	261
WBR	Pennsylvania State Police	Butler, Pa.	286
WBS	D. W. May, Inc	Newark, N. J.	360
WBT	Southern Radio Corp.	Charlotte, N. C.	360
WBZ	Westinghouse Elec. & Mfg. Co.	Springfield, Mass.	337
WCAD	St. Lawrence University	Canton, N. Y.	280
WCAE	Kaufmann & Baer Co.	Pittsburgh, Pa.	462
WCAG	Clyde R. Randall	New Orleans, La.	268
WCAH	Entrekin Electric Co.	Columbus, Ohio	286
WCAJ	Nebraska Wesleyan University	University Place, Nebr.	360
WCAK	Alfred P. Daniel	Houston, Tex.	360
WCAL	St. Olaf College	Northfield, Minn.	360
WCAM	Villanova College	Villanova, Pa.	360
WCAO	Sanders & Stayman Co.	Baltimore, Md.	360
WCAP	Chesapeake & Potomac Telephone Co.	Washington, D. C.	469
WCAR	Alamo Radio Electric Co.	San Antonio, Tex.	360
WCAS	William Hood Dunwoody Industrial Institute	Minneapolis, Minn.	246
WCAT	South Dakota State School of Mines	Rapid City, S. Dak.	240
WCAU	Durham & Co.	Philadelphia, Pa.	286
WCAV	J. C. Dice Electric Co.	Little Rock, Ark.	360
WCAX	University of Vermont	Burlington, Vt.	360
WCAY	Kesselman O'Driscoll Co.	Milwaukee, Wis.	261
WCAZ	Carthage College	Carthage, Ill.	246
WCBA	Charles W. Heimbach	Allentown, Pa.	280
WCBD	Wilbur G. Voliva	Zion, Ill.	345
WCE	Findley Electric Co.	Minneapolis, Minn.	360
WCK	Stix, Baer & Fuller Dry Goods Co.	St. Louis, Mo.	360
WCM	University of Texas	Austin, Tex.	360
WCX	Detroit Free Press	Detroit, Mich.	517
WDAE	Tampa Daily Times	Tampa, Fla.	360
WDAF	Kansas City Star	Kansas City, Mo.	411
WDAG	J. Laurance Martin	Amarillo, Tex.	263
WDAH	Trinity Methodist Church (South)	El Paso, Tex.	268
WDAK	The Courant	Hartford, Conn.	261
WDAL	Florida Times-Union	Jacksonville, Fla.	360
WDAO	Automotive Electric Co.	Dallas, Tex.	360
WDAP	Board of Trade	Chicago, Ill.	360
WDAR	Lit Brothers	Philadelphia, Pa.	395
WDAS	Samuel A. Waite	Worcester, Mass.	360
WDAU	Slocum Kilburn	New Bedford, Mass.	360
WDAX	First National Bank (Appamoose County Farm Bureau)	Centerville, Iowa	360
WDAY	Radio Equipment Corp.	Fargo, N. Dak.	244
WDBC	Kirk, Johnson & Co.	Lancaster, Pa.	258
WDM	Church of the Covenant	Washington, D. C.	360
WDT	Ship Owners Radio Service	New York, N. Y.	405
WDZ	James L. Bush	Tuscola, Ill., Star Store Bldg.	278
WEAA	F. D. Fallain	Flint, Mich.	280
WEAF	American Telephone & Telegraph Co.	New York, N. Y.	492
WEAH	Wichita Board of Trade	Wichita, Kans.	244
WEAI	Cornell University	Ithaca, N. Y.	286
WEAJ	University of South Dakota	Vermillion, S. Dak.	283
WEAM	Borough of North Plainfield (W. Gibson Buttfield)	North Plainfield, N. J.	252
WEAN	Shepard Co.	Providence, R. I.	273
WEAO	Ohio State University	Columbus, Ohio	360
WEAP	Mobile Radio Co.	Mobile, Ala.	360
WEAR	Baltimore American & News Publishing Co.	Baltimore, Md.	360
WEAS	Hecht Co.	Washington, D. C.	360
WEAU	Davidson Bros. Co.	Sioux City, Iowa	360
WEAY	Iris Theatre (Will Horowitz, Jr.)	Houston, Tex.	360
WEB	Benwood Co.	St. Louis, Mo.	360
WEV	Hurlburt-Still Electrical Co.	Houston, Tex.	360
WEW	St. Louis University	St. Louis, Mo.	261
WFAA	Dallas News & Dallas Journal	Dallas, Tex.	476
WFAB	Carl F. Woese	Syracuse, N. Y.	234
WFAF	H. C. Spratley Radio Co.	Poughkeepsie, N. Y.	360
WFAH	Electric Supply Co.	Port Arthur, Tex.	236
WFAJ	Hi-Grade Wireless Instrument Co.	Asheville, N. C.	360
WFAM	Times Publishing Co.	St. Cloud, Minn.	360
WFAN	Hutchinson Electric Service Co.	Hutchinson, Minn.	380
WFAQ	Missouri Wesleyan College	Cameron, Mo.	360
WFAT	Daily Argus-Leader	Sioux Falls, S. Dak.	360
WFAV	University of Nebraska, Department of Electrical Engineering	Lincoln, Nebr.	275
WFI	Strawbridge & Clothier	Philadelphia, Pa.	395
WGAL	Lancaster Electric Supply & Construction Co.	Lancaster, Pa.	248
WGAN	Cecil E. Lloyd	Pensacola, Fla.	366
WGAQ	Glenwood Radio Corp. (W. G. Patterson)	Shreveport, La.	360
WGAW	Ernest C. Albright	Altoona, Pa.	261
WGAY	Northwestern Radio Co.	Madison, Wis.	360
WGAZ	South Bend Tribune	South Bend, Ind.	360
WGI	American Radio & Research Corp.	Medford Hillside, Mass.	360
WGL	Thomas F. J. Howlett	Philadelphia, Pa.	360
WGR	Federal Telephone & Telegraph Co.	Buffalo, N. Y.	319
WGV	Interstate Electric Co.	New Orleans, La.	360
WGY	General Electric Co.	Schenectady, N. Y.	380
WHA	University of Wisconsin	Madison, Wis.	360
WHAA	State University of Iowa	Iowa City, Iowa	283
WHAB	Clark W. Thompson	Galveston, Tex.	360
WHAC	Cole Bros. Electric Co.	Waterloo, Iowa	360
WHAO	Marquette University	Milwaukee, Wis.	280
WHAG	University of Cincinnati	Cincinnati, Ohio	222
WHAH	Hafer Supply Co.	Joplin, Mo.	283
WHAI	Radio Equipment & Mfg. Co.	Davenport, Iowa	360
WHAK	Roberts Hardware Co.	Clarksburg, W. Va.	258
WHAM	University of Rochester (Eastman School of Music)	Rochester, N. Y.	283
WHAP	Otta & Kuhns	Decatur, Ill.	360
WHAR	Paramount Radio & Electric Co. (W. H. A. Putus)	Atlantic City, N. J.	231
WHAS	Courier-Journal & Louisville Times	Louisville, Ky.	400
WHAV	Wilmington Electrical Specialty Co.	Wilmington, Del.	360
WHAZ	Rensselaer Polytechnic Institute	Troy, N. Y.	380
WHB	Sweeney School Co.	Kansas City, Mo.	411
WHK	Radiovox Co. (Warren R. Cox)	Cleveland, Ohio	360
WHN	George Schubel	New York, N. Y.	360
WIAB	Joslyn Automobile Co.	Rockford, Ill.	252
WIAC	Galveston Tribune	Galveston, Tex.	360
WIAO	Howard R. Miller	Ocean City, N. J.	254
WIAF	Gustav A. DeCortin	New Orleans, La.	234
WIAH	Continental Radio & Mfg. Co.	Newton, Iowa	258
WIAI	Heer Stores Co.	Springfield, Mo.	252
WIAJ	Fox River Valley Radio Supply Co. (Quinn Bros.)	Neenah, Wis.	224
WIAK	Journal-Stockman Co.	Omaha, Nebr.	278
WIAO	School of Engineering of Milwaukee	Milwaukee, Wis.	360
WIAQ	Chronicle Publishing Co.	Marion, Ind.	226
WIAR	Paducah Evening Sun	Paducah, Ky.	360
WIAS	Home Electric Co.	Burlington, Iowa	360
WIAT	Leon T. Noel	Tarkio, Mo.	360
WIAU	American Trust & Savings Bank	Le Mars, Iowa	360
WIK	K. & L. Electric Co. (Herbert F. Kelso and Hunter J. Lohman)	McKeesport, Pa.	234
WIL	Continental Electric Supply Co.	Washington, D. C.	360
WIP	Gimbel Brothers	Philadelphia, Pa.	509
WJAB	American Electric Co.	Lincoln, Nebr.	360
WJAO	Jackson's Radio Engineering Laboratories	Waco, Tex.	380
WJAF	Press Publishing Co.	Muncie, Ind.	360
WJAG	Norfolk Daily News (Huse Pub. Co.)	Norfolk, Nebr.	360
WJAK	Clifford L. White	Greentown, Ind.	254
WJAM	D. M. Perham	Cedar Rapids, Iowa	268
WJAN	Peoria Star	Peoria, Ill.	280
WJAQ	Capper Publications	Topeka, Kans.	360
WJAR	The Outlet Co. (J. Samuels & Bro.)	Providence, R. I.	360
WJAS	Pittsburgh Radio Supply House	Pittsburgh, Pa.	360
WJAT	Kelly-Vawter Jewelry Co.	Marshall, Mo.	360
WJAX	Union Trust Co.	Cleveland, Ohio	390
WJAZ	Chicago Radio Laboratory	Chicago, Ill.	448
WJO	Richard H. Howe	Granville, Ohio	229
WJH	W. P. Boyer	Washington, D. C.	273
WJX	Deforest Radio Telephone & Telegraph Co.	New York, N. Y.	360
WJY	R. C. A.	New York, N. Y.	405
WIZ	R. C. A.	New York, N. Y.	455
WKAA	H. F. Paar	Cedar Rapids, Iowa	268
WKAD	Chas. Looff (Crescent Park)	East Providence, R. I.	240
WKAF	W. S. Radio Supply Co.	Wichita Falls, Tex.	360
WKAN	United Battery Service Co.	Montgomery, Ala.	226
WKAP	Dutee W. Flint	Cranston, R. I.	360
WKAQ	Radio Corp. of Porto Rico	San Juan, P. R.	360
WKAR	Michigan Agriculture College	East Lansing, Mich.	280
WKAS	L. E. Lines Music Co.	Springfield, Mo.	388
WKAV	Laconia Radio Club	Laconia, N. H.	254
WKAW	Turner Cycle Co.	Beloit, Wis.	242
WKAY	Brenau College	Gainesville, Ga.	280
WKY	WKY Radio Shop	Oklahoma, Okla.	360
WLAG	Cutting & Washington Radio Corp.	Minneapolis, Minn.	417
WLAH	Samuel Woodworth	Syracuse, N. Y.	234
WLAJ	Waco Electrical Supply Co.	Waco, Tex.	360
WLAK	Vermont Farm Machine Corp.	Bellows Falls, Vt.	380
WLAL	Naylor Electrical Co.	Tusla, Okla.	360
WLAN	Putnam Hardware Co.	Houlton, Me.	283
WLAP	W. V. Jordon	Louisville, Ky.	380
WLAQ	Arthur E. Schilling	Kalamazoo, Mich	283
WLAT	Radio and Specialty Co.	Burlington, Iowa	360
WLAV	Electric Shop	Pensacola, Fla.	254
WLAW	Police Dept., City of New York	New York, N. Y.	380
WLAX	Putnam Electric Co. (Greencastle Community Broadcasting Station)	Greencastle, Ind.	231
WLB	University of Minnesota	Minneapolis, Minn.	360
WLW	Crosley Manufacturing Co.	Cincinnati, Ohio	309
WMAB	Radio Supply Co.	Oklahoma, Okla.	380
WMAC	J. Edw. Page (Olive B. Meredith)	Cazenovia, N. Y.	261
WMAF	Round Hills Radio Corp.	Dartmouth, Mass.	380
WMAH	General Supply Co.	Lincoln, Nebr.	254
WMAJ	Drovers Telegram Co.	Kansas City, Mo.	275
WMAK	Norton Laboratories	Lockport, N. Y.	360
WMAL	Trenton Hardware Co.	Trenton, N. J.	250
WMAN	First Baptist Church	Columbus, Ohio	266
WMAP	Utility Battery Service	Easton, Pa.	240
WMAQ	Chicago Daily News	Chicago, Ill.	448
WMAV	Alabama Polytechnic Institute	Auburn, Ala.	250
WMAY	Kingshighway Presbyterian Church	St. Louis, Mo.	280
WMAZ	Mercer University	Macon, Ga.	268
WMC	"Commercial Appeal" (Commercial Publishing Co.)	Memphis, Tenn.	500
WMH	Precision Equipment Co.	Cincinnati, Ohio	249
WMU	Doubleday-Hill Electric Co.	Washington, D. C.	281
WNAC	Shepard Stores	Boston, Mass.	278
WNAD	University of Oklahoma	Norman, Okla.	360
WNAL	R. J. Rockwell	Omaha, Nebr.	242
WNAM	Ideal Apparatus Co.	Evansville, Ind.	360
WNAN	Syracuse Radio Telephone Co.	Syracuse, N. Y.	286
WNAP	Wittenberg College	Springfield, Ohio	231
WNAQ	Charleston Radio Electric Co.	Charleston, S. C.	360
WNAR	C. C. Rhodes	Butler, Mo.	231
WNAS	Texas Radio Corp. & Austin Statesman	Austin, Tex.	380
WNAT	Lennig Brothers Co. (Frederick Lennig)	Philadelphia, Pa.	360
WNAV	Peoples Telephone & Telegraph Co.	Knoxville, Tenn.	236
WNAW	Peninsular Radio Club (Henry Kunzmann)	Fort Monroe, Va.	360
WNAX	Dakota Radio Apparatus Co.	Yankton, S. Dak.	244
WNJ	Shotton Radio Manufacturing Co.	Albany, N. Y.	360
WOAA	Dr. Walter Hardy	Ardmore, Okla.	380
WOAC	Maus Radio Co	Lima, Ohio	266
WOAD	Friday Battery & Electric Corp.	Sizourney, Iowa	380
WOAE	Midland College	Fremont, Nebr.	360
WOAF	Tyler Commercial College	Tyler, Tex.	380
WOAG	Apollo Theater (Belvidere Amusement Co.)	Belvidere, Ill.	224
WOAH	Palmetto Radio Corp.	Charleston, S. C.	360
WOAI	Southern Equipment Co.	San Antonio, Tex.	385
WOAJ	Ervins Electrical Co.	Parsons, Kans.	258
WOAL	William E. Woods	Webster Groves, Mo.	229
WOAN	Vaughn Conservatory of Music (James D. Vaughn)	Lawrenceburg, Tenn.	360
WOAO	Lyradion Mfg. Co.	Mishawaka, Ind.	350
WOAP	Kalamazoo College	Kalamazoo, Mich.	240
WOAQ	Portsmouth Kiwanis Club	Portsmouth, Va.	360
WOAR	Henry P. Lundskow	Kenosha, Wis.	229
WOAT	Boyd M. Hamp	Wilmington, Del.	360
WOAV	Pennsylvania National Guard, 2d Battalion, 112th Infantry	Erie, Pa.	242
WOAW	Woodmen of the World	Omaha, Nebr.	526
WOAX	Franklyn J. Wolff	Trenton, N. J.	240
WOC	Palmer School of Chiropractic	Davenport, Iowa	484
WOI	Iowa State College	Ames, Iowa	360
WOK	Pine Bluff Co.	Pine Bluff, Ark.	380
WOO	John Wanamaker	Philadelphia, Pa.	509
WOQ	Western Radio Co.	Kansas City, Mo.	360
WOR	L. Bamberger & Co.	Newark, N. J.	405
WOS	Missouri State Marketing Bureau	Jefferson City, Mo.	441
WPAB	Pennsylvania State College	State College, Pa.	283
WPAC	Donaldson Radio Co.	Okmulgee, Okla.	380
WPAO	W. A. Wicholdt & Co.	Chicago, Ill.	380
WPAH	Wisconsin Department of Markets	Waupaca, Wis.	360
WPAJ	Doolittle Radio Corp.	New Haven, Conn.	268
WPAK	North Dakota Agricultural College	Agricultural College, N. Dak.	360
WPAL	Superior Radio & Telep. Equipment Co.	Columbus, Ohio	288
WPAM	Auerbach & Guettel	Topeka, Kans.	380
WPAP	Theodore D. Phillips	Winchester, Ky.	380
WPAQ	General Sales & Engineering Co.	Frostburg, Md.	360
WPAR	Ward Battery & Radio Co.	Beloit, Kans.	360
WPAT	St. Patricks Cathedral	El Paso, Tex.	360
WPAU	Concordia College	Moorhead, Minn.	380
WPAZ	John R. Koch (Dr.)	Charleston, W. Va.	273
WPG	Nusawg Poultry Farm	New Lebanon, Ohio	234
WQAA	Horace A. Beale, jr.	Parkersburg, Pa.	360
WQAC	E. B. Gish	Amarillo, Tex.	380
WQAO	Whitall Electric Co.	Waterbury, Conn.	242
WQAE	Moore Radio News Station (Edmund B. Moore)	Springfield, Vt.	275

another stage of radio frequency. About the only way you fellows who own big sets is to put a bunch of dinner plates on top of your cabinets, and say you had China on your set. Haw! Great work, Mr. Baumgardner.

---

411 So. 18th Street, Mt. Vernon, Ill.
RADIO AGE,
Pickups Department.
Gentlemen:

I am using a single-tube WD11 hookup of the ultra audion type with which I have had such good results that I simply have to tell somebody. In ten days I got the following stations: KSD, WHB, KDKX, KDKA, WHAZ, WHAS, WPAD, WDAJ, WJAZ, WAAF, WMAQ, WDAP, WCBD, WOAW, WOC, WOQ, WOR, WCAP, WTAM, WPA, WEAF, WOS, WDAF, WCK, WCAH, WOAF, WCAE, WSB, WLAP, WLAG, WMC, WEAN, WOK, and WAAW.

St. Louis is eighty miles from here, and Schenectady is 875, but I hear WGY louder than KSD. I'd like to know who can do that with one WD11 tube.

I can get any of the above stations any time they are transmitting, and can tune up as high as 600 meters.

Guess that list ought to hold you for a while, so that will be all for this time.

Yours very truly,
DUANE ROSSELOT.

Duane is another runner-up in the list of high batting averages this month. We are sure that many of the other fans will start to look for the places where losses occur in their sets which prevent them from duplicating this performance.

In a recent letter, George Rallison enclosed the following list of stations heard with one tube: WTAM, WJAZ, WHAS, WLAP, WOC, WAAW, WFAA, WDAF, WHB, WBAP, CKCK, CFAC, CFCN, CHCD, KFAF, KFEL, KLZ, KDZE, KGW, KFEC, KGG, KFAE, KZN, KDYL.

Most of these stations are over 1,000 miles distant, with two of them over two thousand miles!

Mr. Rallison is located at 418 West Elm Street, Hanford, Calif. When one considers that it is necessary to work over the tall Rockies to get these stations, it makes Mr. Rallison's list a feat of unusual merit.

Norwood P. O., Cincinnati, Ohio.
RADIO AGE,
Pickups Department.
Gentlemen:

I am not a subscriber to RADIO AGE, but I buy it at the news-stands and read the Pickups column in every issue. This is my pickup for November 23, 1923, using one U V 200 tube, 22 1-2 volts B battery in a Flewelling hookup, with antenna only:

WOR, WDAR, WJAR, WOO, WIP, WGY, WWJ, WCAE, WEAF, WHAS, WSB, WOAI, WBAP, WFAA, WOS, WJAX, WJAX, WMAD, KYW, WLAG, WDAF, WHB, KHJ, and on the twenty-fifth of November I added to this list the following: KHJ, KFI, KLZ, KWH and CKCK.

Tell the rest of the RADIO AGE family of Pickup readers to compare their lists with this one. I modestly acclaim it as a pretty good accumulation of DX stations.

Very truly yours,
S. MOESCHL.

Listen fellows—! You don't have to be a subscriber to be a pickup fan. If you are a reader of RADIO AGE, and have a list that you think is worthy of consideration among the rest of the Pickup fans, let's have it.

If you'll allow us to comment on your work, Mr. Moeschl, we would add to your last sentence that that sure is some acceleration with a circuit difficult to manage.

Next we have a letter from one of our Monon, Indiana, brothers:

RADIO AGE,
Pickups Department.
Gentlemen:

After seeing several pickup records published in your magazine, I have decided to send in a list of stations tuned in on a loud speaker with detector and two stages of audio frequency amplification and plate voltage of 67 volts.

KSD, St. Louis; WHB, Kansas City; WDAF, Kansas City; WCBD, Zion; WSB, Atlanta; WMC, Memphis; WGR, Buffalo; KHJ, Los Angeles; WOAI, San Antonio; WOC, Davenport; KDKA, Pittsburgh; WCAP, Washington, D. C.; WOS, Jefferson City; WOR, Newark; WOQ, Kansas City; WHAS, Louisville; WPAD, Chicago; WBAK, Harrisburg, Pa.; WBAA, Lafayette, Ind.; KOP, Detroit; KYW, Chicago; WJAZ, Chicago; WMAQ, Chicago; WFAA, Dallas; WOAW, Omaha; WEAF, New York City; WGY, Schenectady; KPO, San Francisco; WLAG, Minneapolis; WWJ, Detroit; WCAE, Pittsburgh; WBAP, Fort Worth; WLW, Cincinnati; WTAM, Cleveland; WTAS, Elgin, Ill.; WDAP, Chicago; WAAP, Wichita, Kan.; WHAZ, Troy, N. Y.; WSAI, Cincinnati; PWX, Havana.

My outfit is home assembled using nothing but the best parts throughout. I also wish to add that these stations are not freak pickups but stations that I can tune in and hear regularly.

Yours very respectfully,
LESLIE E. THOMAS.

This is probably not a record breaking list of stations received, but is a typical example of what a fellow can do with a set that is intelligently constructed and wisely operated. FB, Mr. Thomas.

To conclude the Pickups section for this month, we publish this letter particularly characteristic concerning the Reinartz, The Mighty:

RADIO AGE,
Chicago, Ill.
Gentlemen:

In your columns some months ago you published a letter of mine under "Stations I have heard" and at that time I was very enthusiastic over the Reinartz circuit, and still am. I have seen some very misleading reports concerning this circuit, and I really believe that such glowing reports come from some action in the set that even the maker does not understand. There are a million little things that are hardly noticeable that will make one set from 50 to 100 per cent better than one just like it, to all appearances. I believe about the best way to make enemies for any circuit is to boost it sky high and have a few disappoint-

Complete Corrected List of U. S. and Canadian Broadcasting Stations

WQAF	Sandusky Register	Sandusky, Ohio	240
WQAH	Brock-Anderson Electrical Engineering Co.	Lexington, Ky.	254
WQAL	Coles County Telep. and Teleg. Co.	Mattoon, Ill.	258
WQAM	Electrical Equipment Co.	Miami, Fla.	360
WQAN	Scranton Times	Scranton, Pa.	280
WQAO	Calvary Baptist Church	New York, N. Y.	360
WQAQ	Abilene Daily Roporter (West Texas Radio Co.)	Abilene, Tex.	360
WQAS	Prince-Walter Co.	Lowell, Mass.	266
WQAV	Huntington & Guerry (Inc.)	Greenville, S. C.	258
WQAW	Catholic University	Washington, D. C.	236
WQAX	Radio Equipment Co.	Peoria, Ill.	360
WRAA	Rice Institute	Houston, Tex.	360
WRAD	Taylor Radio Shop (G. L. Taylor)	Marion, Kans.	248
WRAF	The Radio Club (Inc)	Laporte, Ind.	224
WRAH	Stanley N. Read	Providence, R. I.	231
WRAL	Northern States Power Co.	St. Croix Falls, Wis.	248
WRAM	Lombard College	Galesburg, Ill.	244
WRAN	Black Hawk Electrical Co.	Waterloo, Iowa	236
WRAO	Radio Service Co.	St. Louis, Mo.	360
WRAV	Antioch College	Yellow Springs, Ohio	360
WRAW	Avenue Radio Shop (Horace D. Good)	Reading, Pa.	238
WRAX	Flaxon's Garage	Gloucester City, N. J.	268
WRAY	Radio Sales Corp.	Scranton, Pa.	280
WRAZ	Radio Shop of Newark (Herman Lubinsky)	Newark, N. J.	233
WRC	Radio Corporation of America	Washington, D. C.	469
WRK	Doron Bros. Electric Co.	Hamilton, Ohio	380
WRL	Union College	Schenectady, N. Y.	380
WRM	University of Illinois	Urbana, Ill.	360
WRR	City of Dallas (police and fire signal department)	Dallas, Tex.	360
WRW	Tarrytown Radio Researcb Laboratory (Koenig Bros.)	Tarrytown, N. Y.	273
WSAB	Southeast Missouri State Teachers College	Cape Girardeau, Mo.	360
WSAC	Clemson Agricultural College	Clemson College, S. C.	360
WSAD	J. A. Foster Co.	Providence, R. I.	261
WSAG	City of St. Petersburg (Loren V. Davis)	St. Petersburg, Fla.	244
WSAH	A. J. Leonard, jr.	Chicago, Ill.	248
WSAI	United States Playing Cards Co.	Cincinnati, Ohio	309
WSAJ	Grove City College	Grove City, Pa.	360
WSAL	Franklin Electric Co.	Brookville, Ind.	246
WSAN	Allentown Radio Club	Allentown, Pa.	229
WSAP	Seventh Day Adventist Church	New York, N. Y.	360
WSAR	Doughty & Welch Electrical Co.	Fall River, Mass.	254
WSAT	Donohoo-Ware Hardware Co.	Plainview, Tex.	266
WSAW	John J. Long, jr.	Canandaigua, N. Y.	275
WSAX	Chicago Radio Laboratory	Chicago, Ill.	268
WSAY	Irving Austin (Port Chester Chamber of Commerce)	Port Chester, N. Y.	239
WSAZ	Chas Electric Shop	Pomeroy, Ohio	258
WSB	Atlanta Journal	Atlanta, Ga.	429
WSL	J. & M. Electrio Co.	Utica, N. Y.	272
WSY	Alabama Power Co.	Birmingham, Ala.	360
WTAB	Fall River Daily Herald Publishing Co.	Fall River, Mass.	248
WTAC	Penn Traffic Co.	Johnstown, Pa.	360
WTAD	Robert E. Compton and First Presbyterian Church	Carthage, Ill.	229
WTAF	Louis J. Galle	New Orleans, La.	242
WTAG	Kern Music Co.	Providence, R. I.	258
WTAH	Carmen Ferro	Belvidere, Ill.	236
WTAJ	The Radio Shop	Portland, Me.	236
WTAL	Toledo Radio & Electric Co.	Toledo, Ohio	252
WTAM	Willard Storage Battery Co.	Cleveland, Ohio	390
WTAN	Orndorff Radio Shop	Mattoon, Ill.	240
WTAP	Cambridge Radio & Electric Co.	Cambridge, Ill.	242
WTAQ	S. H. Van Gorden & Son	Osseo, Wis.	226
WTAR	Reliance Electric Co.	Norfolk, Va.	280
WTAS	Charles E. Erbstein	Elgin, Ill.	275
WTAT	Edison Electrio Illuminating Co.	Boston, Mass. (portable)	244
WTAU	Ruegg Battery & Electrio Co.	Tecumseh, Nebr.	360
WTAW	Agricultural & Mecbanical College of Texas	College Station, Tex.	280
WTAX	Williams Hardware Co.	Streator, Ill.	231
WTAY	Iodar-Oak Leaves Broadcasting Station	Oak Park, Ill.	226
WTAZ	Thomas J. McGuire	Lambertville, N. J.	283
WTG	Kansas State Agricultural College	Manhattan, Kans.	485
WWAB	Hoenig, Swern & Co. (John Rasmussen)	Trenton, N. J.	226
WWAC	Sanger Bros.	Waco, Tex.	864
WWAD	Wright & Wright (Inc.)	Philadelphia, Pa.	360
WWAE	Alamo Dance Hall, L. J. Crowley	Joliet, Ill.	227
WWAF	Galvin Radio Supply Co.	Camden, N. J.	230
WWAO	Michigan College of Mines	Houghton, Mich.	244
WWI	Ford Motor Co.	Dearborn, Mich.	273
WWJ	Detroit News (Evening News Assn.)	Detroit, Mich.	517
WWL	Loyola University	New Orleans, La.	389

Canadian Stations

CFAC	Western Radio Co., Ltd.,	Calgary, Alta.	430
CFCA	Toronto Star	Toronto, Ont.	400
CFCF	Marconi Co.	Montreal, P. Q.	440
CFCH	Abitibi Power & Paper Co. Ltd.	Iroquois Falls, Ont.	400
CFCI		Vancouver, B. C.	410
CFCJ		Quebec, P. Q.	410
CFCK		Edmonton, Alta	410
CFCL		Victoria, B. C.	400
CFCN	W. W. Grant Radio, Ltd.	Calgary, Alta	440
CFCO		Bellevue, P. Q.	450
CFCW		London, Ont.	420
CFQC		Saskatoon, Sask.	400
CFUC		Montreal, P. Q.	400
CHCB		Calgary Alta.	410
CHCD		Quebec, P. Q.	410
CHCE		Victoria, B. C.	400
CHCL		Vancouver, B. C.	440
CHYC	Canadian Northern Elec.	Montreal, P. Q.	410
CJCA	Edmonton Journal, Ltd.	Edmonton, Alta.	450
CJCD	T. Eaton Co.	Toronto, Ont.	410
CJCE	Vancouver Sun	Vancouver, B. C.	420
CJCI	McLean, Holt & Co., Ltd.	St. John, N. B.	400
CJCN	Simmons, Agnew & Co.	Toronto, Ont.	410
CJCX		Olds, Alta.	400
CJGC	London Free Press	London, Ont.	430
CJSC	Evening Telegram	Toronto, Ont.	430
CKAC	La Presse	Montreal, P. Q.	430
CKCD	Vancouver Daily Province	Vancouver, B. C.	410
CKCE	Can. Ind. Telephone Co.	Toronto, Ont.	450
CKCK	Leader Publishing Co.	Regina, Sask.	420
CKOC	Wentworth Radio Supply Co.	Hamilton, Ont.	410
CKY		Winnipeg, Manitoba	450

ments among those who attempt to build them.

I read one report, in fact, several pages were devoted to it in a very popular radio magazine telling how the set operated four or five speakers to their full capacity and that programs could be heard at least half a mile from their shop. Anything is possible in radio but such reports are not consistent, as this one set is an exception and it is quite doubtful if it could be duplicated. We have also heard of the long distance crystal sets, and of course there are, but there isn't one in 100,000 that will hear more than forty or fifty miles at the most.

I believe what I have accomplished with the Reinartz is something that anyone with any knowledge of radio can do, and I do not doubt but that many would have much better success than I. I have added four tubes to my set and now have two RF detector and two AF. The consistent distance for this set on a loud speaker is from 800 to 1,000 miles, so for anyone who is centrally located he can feel reasonably sure that he will be able to get anything from the class B stations on his loud speaker. Such stations as WGR, KDKA, WJAZ, WBY, WOAW, WLW, WPAH, WOS, WDAP, we heard night after night regardless of weather conditions and these stations come in with about half the capacity volume of the set, taking the volume with which the local station WLAG comes on.

The set contrary to many reports is quite selective, as I have received a majority of the above stations through our local stations WLAG, WBAH, KFEX and WCAS, without interference.

After adding the RF I found that the volume of the distance stations were increased approximately twice, and I also found that there was a great deal of howling, but am glad to state that this is not permanent as with a little practice one is able to tune in with very little if any noise, but it takes some very fine manipulation to tune in without any noise, such as howling and whistling. I have two of the Day-Fan RF transformers and after I have tuned in on one distant station can get several different ones merely by adjusting the transformers.

I had some little trouble in installing the RF but after making two or three minor changes the set worked wonderfully well. In the Reinartz circuit the positive A and negative B are grounded, but when adding radio frequency this ground connection is not used. A potentiometer is put across the positive of the A to negative of the A battery and the negative of the B battery is connected to the positive of the A battery as before. Then the potentiometer is grounded to the condenser in the grid circuit, this being an 11-plate in my set. The filament connections of the two RF transformers are connected and then this connection is extended to the center or ground connection of the potentiometer, and a .002 condenser is shunted across the negative A battery connection of the potentiometer to the wire making the connection of the transformers to the potentiometer.

Yours very truly,
G. F. McCULLOUGH.

We are very grateful to Mr. McCullough, 1826 Park Avenue, Minneapolis, Minn., for his interesting letter, and are glad to learn that he gets results. One can readily learn from his letter that consistent results come from patient and painstaking design, construction and operation. Remember, that if you make thirty little improvements on a set and each one does not have the property of being noticeable in the phones you feel that not much has been accomplished; on the other hand, if the whole thirty changes and improvements could be made at once, the increase in efficiency would immediately be noticed. Just keep Mr. McCullough's words in mind when working out any new change.

We regret very much the inability to publish all the letters from the many fans who sent in lists in response to our call. However, we wish to acknowledge letters from Messrs. H. Q. Ten Eyck, of 215 W. Goepp Street, Bethlehem, Pa., who says he has a circuit of unusual merit which can be had merely for the writing; James E. Chandler, of Belvidere, Ill.; A. Des Rosius, of Windsor, Ontario, Canada; and from W. O. Halter of 357 South La Salle Street, Aurora, Ill., and others.

Well, fellows, we'll sign off in code this time jes' like a regular amateur station:

"Gess nm nw so best 73's Hppy es Prosperus Nw Yr., SK"

RADIO AGE PICKUPS AND HOOKUPS DEPT.

Kable Band

Many listeners of that sterling station, WOC, Davenport, Iowa, were pleased on the night of November 30 to hear a radio concert given by the Kable Brothers Company band. Kable Brothers print magazines at Mount Morris, Ill., but they mix play with their work and they have organized a musical organization of exceptional merit. RADIO AGE listened in and can commend with authority the performance at Davenport. Furthermore, it is a pleasure to register approval since Kable Brothers Company is our printer.

Miss Anna Leeb, assistant business manager of RADIO AGE, charmed the audience of Station WJAZ a few nights later by singing several songs that proved her to be a vocalist of accomplishment. Miss Leeb has a soprano voice, well suited to such songs as "I Love You Truly" and "Mighty Lak a Rose," both of which she sang, with the result that there were numerous telephone requests for encores.

It was the privilege of the editor of RADIO AGE on one of the Wednesday nights when the Zenith-Edgewater Beach Station talks with Explorer MacMillan to talk to Dr. MacMillan up there near the North Pole, and tell him how interested all radio fans were in the success of his adventure.

Yes, the RADIO AGE family are bugs, like the rest of you.

Best Hook-up Book Ever Printed

NO BUILDER of home-made receivers, or home-made parts, should spend time and money on any circuit without first getting this standard, comprehensive and up-to-date guide. It should be on every home work bench. It shows you how to start right and leads you to successful completion of your work.

All the popular standard hook-ups are described. Throughout the book are numerous full page drawings showing all the parts and wires as they should be assembled. You cannot go wrong following these picture diagrams. Even the most complicated circuits are simplified. Wiring diagrams are added for those who need or want them.

Simple Crystal Set
Long Distance Crystal Set
Your First Tube Set
Kopprasch Circuit
Erla Reflex
Kaufman
Grimes Inverse Duplex
Two Stage Amplifier
Junior Heterodyne
One Tube with Loop Aerial
Wave Trap, Filter, Eliminator
Loading Coils
Transformers
Battery Charger
Reinartz
Hopwood
Haynes
Cockaday
Neutrodyne
Three-circuit Tuner
Super-Heterodyne
Simple Radio Frequency
Ultra Audion
Rosenbloom
Push-Pull Amplifier
Portable Reinartz
Wave-Meters
Two-Circuit Crystal

That is an imposing array of material but it is only a part. There are many pages of information on antennae, tuning, soldering, diagram symbols, etc. Complete instructions on how to learn the code. All written and illustrated by experts.

On The Press Now!
Big Sales Assured
Order Now For First Delivery

Send only $1 as payment in full to address below. Don't blame us if you are behind time. Send money order, check, currency. If by check add 5 cents for exchange.

Nothing else like it,
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THE RADIO AGE ANNUAL

For 1924

Make all remittances to RADIO AGE, Inc., 500 North Dearborn Street, Chicago, Ill.

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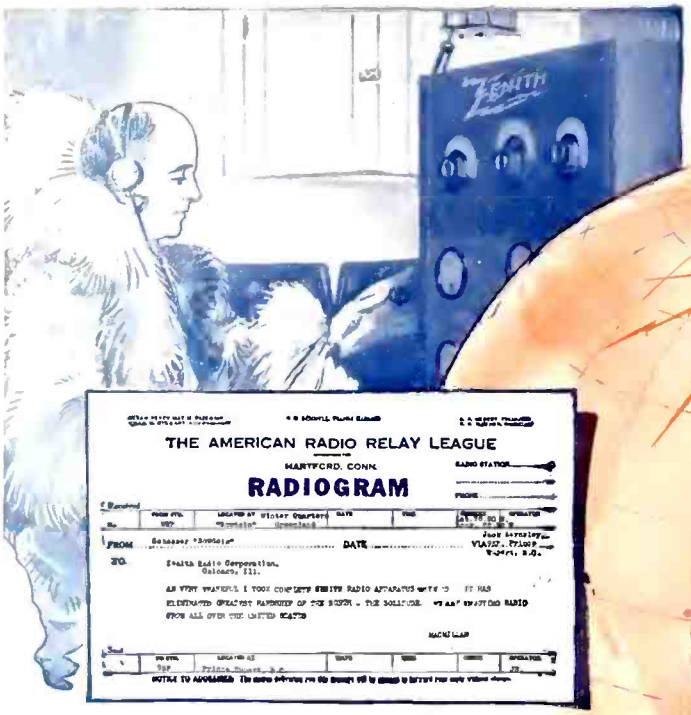
AT THE NORTH POLE



Inside the Arctic Circle, nine degrees from the North Pole, a little 89-foot schooner is frozen fast in the ice of Smith Sound. Aboard this schooner a group of brave men are enduring, as best they can, the desperate cold of the Arctic—cold that often drops to 60 degrees below zero. Human atoms in a boundless field of ice!

Cold is hard to endure, but far more terrible is the Arctic solitude—unbelievably oppressive. Radio, at length, has broken this spell forever!

Concerts from Honolulu!

Daily, by means of powerful sending and receiving apparatus, the crew of the "Bowdoin" are in communication with relatives and friends in the far-off States. Daily they listen to concerts as far away as Chicago, Dallas, and Honolulu!

When the sanity, the very lives of one's shipmates may depend upon contact with the outside world, none but the ***best*** is good enough.

Dr. MacMillan's Choice—the Zenith

Out of all the radio sets on the market, Dr. MacMillan selected the Zenith exclusively—because of its flawless construction, its unusual selectivity, its dependability and its tremendous ***reach.***

Already his operator, on board the "Bowdoin" ***in Northern Greenland,*** has tuned in several hundred stations. You along the Atlantic who brag a little when you tune in Catalina Island—what would you say if you tuned in Hawaii ***from the Arctic Circle?***

The set that Dr. MacMillan has is a standard Zenith receiving set. And you can do all that MacMillan does, and more, with either of the two new models shown at the right. Their moderate price brings them easily within your reach. Write today for full particulars.

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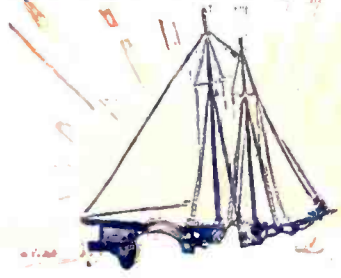

Model 4R—The new Zenith 4R "Long-Distance" Receiver-Amplifier comprises a complete three-circuit regenerative receiver of the feed-back type. It employs the Zenith regenerative circuit in combination with an ***audion detector*** and ***three-stage*** audio-frequency amplifier, all in one cabinet.

Because of the unique Zenith "selector," unusual selectivity is accomplished without complication of adjustment.

The Zenith 4R may be connected directly to any loud-speaker ***without*** the use of other amplification for full phonograph volume, and reception may be satisfactorily accomplished over distances of more than 2,000 miles **$85**

Model 3R—The new Zenith 3R "Long-Distance" Receiver-Amplifier combines a specially designed distortionless three-stage amplifier with the super-efficient Zenith three-circuit regenerative tuner.

Fine vernier adjustments—in connection with the unique Zenith aperiodic or non-resonant "selector" primary circuit—make possible extreme selectivity.

2,000 to 3,000 Miles with Any Loud-Speaker

The new Zenith 3R has broken all records, even those set by its famous predecessors of the Zenith line. Satisfactory reception over distances of 2,000 to 3,000 miles, and over, is readily accomplished in full volume, using ***any ordinary loud-speaker.*** No special skill is required.

The Zenith is the only set built which is capable of being used with all present-day tubes as well as with any tubes that may be brought out in the future. The Model 3R is compact, graceful in line, and built in a highly finished mahogany cabinet **$160**

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