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# RADIO WORLD

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The First and Only National Radio Weekly
*421st Consecutive Issue—NINTH YEAR*

A Simple Ohmmeter

An AC Circuit in a Smoking Stand

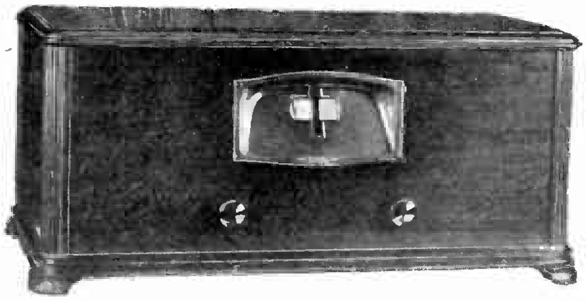
What Is Sound?

# A System for Getting DX

*By M. U. Wallach*

RADIO WORLD, published by Hennessy Radio Publications Corporation. Roland Burke Hennessy, editor; Herman Bernard, managing editor and business manager, all of 145 West 45th Steret, New York, N. Y.

# Long Distance Reception Guaranteed!



The Balkite A5 neutrodyne, in real walnut table model cabinet by Berkey & Gay. Volume control at left, AC switch at right, drum dial at center, with space to mark in call letters.

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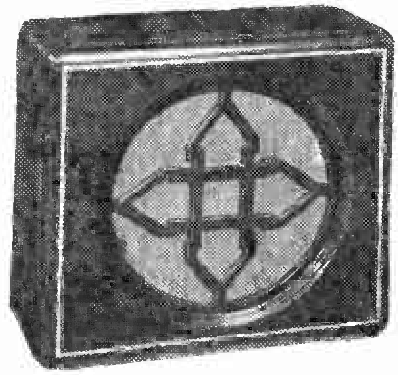

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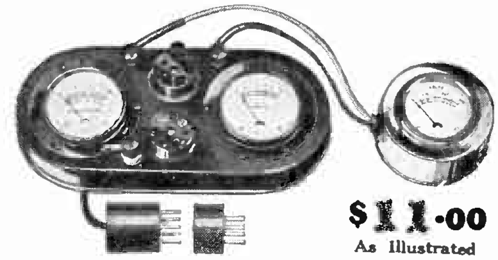

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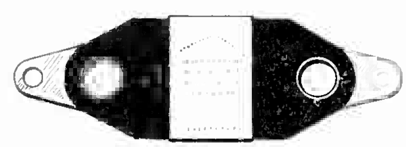

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# Distance For All

## A Devotee of DX Discloses His "System"

*By M. U. Wallach*

[*M. U. Wallach, an experienced radioist with a fine observation faculty, wrote an article published in the March 8th issue of* Radio World, *entitled "A DX Fan Speaks Up." He reported such excellent distant results—although he lives amid the steel structures of New York City—that readers wrote to the editor, wanting to know Mr. Wallach's "system." The following painstaking report is Mr. Wallach's reply.*—Editor.]

SINCE my last article appeared in Radio World, I have been requested, by a number of readers, to reveal in what manner I have been successful in hearing far-distant stations. There is no secret formula for this, but there are a number of factors, all more or less important, which are here given for what they are worth.

The reception of far distant stations has always held a fascination for me; so, for quite some time, I have kept records relating to the quality and volume of these broadcasters, weather reports, temperature changes, etc. These data are too voluminous to be published in detail. Therefore, they have been condensed so that the reader may be able to apply the information to a particular case.

Let it be distinctly understood that there is no such thing as consistent distant reception. By this I mean that night after night one cannot expect to receive the same far-off broadcasters. There are many reasons for this. We have so-called good and bad nights, yet as there seems little hope that anyone will ever be able to control atmospheric conditions, we must take what we have on hand and make the best of it.

### Antenna and Ground

Reception consists of two important factors, the transmitter and the receiver. Taking for granted that transmitters are operated on a high standard, we must improve receiving conditions to raise our sets to a similar standard.

The first in importance is the antenna system. Be it loop, indoor, outdoor, outlet plug or any other type, it forms the input to the receiver. I have seen dozens of aerial installations that were nothing more than a hindrance to any good set. No care had been taken in locating the antenna; it was badly insulated; little wonder that the man who owned it complained of poor reception.

Then again, I have seen what evidently started out to be a good installation only to be ruined by carelessness in so small a matter as a led-in. A good installation *must* be made in the following manner. First select a position for it, running preferably East to West, in the Eastern part of the United States with the view in mind of tapping the lead-in from the Western end. This will help to receive the Western station. Those in the West will reverse the situation. Fifty to 75 feet, *including led-in*, is sufficient in congested locations. Outside a city one may increase this to 150 feet without materially affecting apparent selectivity. Keep your aerial as far from others as possible. It is far better to cross another antenna, above or below, than to run yours in the same direction.

### Use of Insulation

Now we come to insulation. Use only the best insulators you can buy. Do not try to save pennies. The first good rainstorm will make you wish you hadn't. Buy large insulators. Remember that we get windstorms once in a while and that the aerial is subjected to a heavy strain. Do not use thread. Buy some man-sized wire—enameled or tinned copper to delay oxidation— and try to run it directly to your set. Avoid joints if possible. If you are unable to do so make an air-tight waterproof joint in this manner: scrape the wires to be joined and, after twisting them together with pliers, wrap tin foil tightly around the joint and bind it thoroughly with friction tape. Do the same with the lead-in connection at your window. See sketch for proper connections. Erect the antenna as high as possible. Use poles—trees—anything, but keep it *high*.

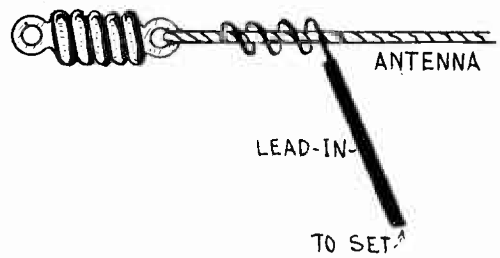



FIG. 1
WHERE THE SEPARATE LEAD-IN IS MERELY WRAPPED AROUND THE HORIZONTAL STRETCH, AND BROUGHT DOWN SLANTING, YOU HAVE A BAD JOINT, POOR RECEPTION, NOISE, EARLY CORROSION AND AN OUTFIT THAT'S AN EASY MARK FOR HIGH WINDS.

The antenna system being disposed of, let us proceed to the next important factor, the ground system. Only a freak receiver could work well without a ground of some kind. Even loop sets are greatly improved by using one. Proper grounding is very important. There are many kinds: water pipes, radiators, direct earth grounds, electrical, etc. We must select the best one at our disposal. Those fortunate enough to live in the suburbs as a rule can use a water pipe ground; there is no better. But many of us live in cities, the writer does, and it is not always possible conveniently to reach the water pipe. Therefore, we resort to a radiator, as a rule.

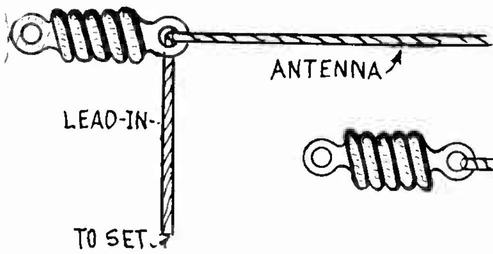
### Condenser to Ground

For the benefit of those living in houses wired with alternating current there remains a far more efficient ground than the radiator. This is an electrical ground and is connected in the following manner. Determine the ground side of the line. That is best accomplished by using an AC meter, and inserting a 2 mfd. (400 volt rating) by-pass condenser between it and the ground of your set. See sketch for proper connections. No damage will be done if you happen to use the live side of the line, as the condenser will effectively prevent a short circuit, but this type of ground may increase your power bill. There is no advantage in using this type ground with direct current lines, as your set is already grounded when connected to this current. However, it may be tried; but be very careful which side of the line you use on DC, otherwise you may be buying many new fuses.

The electrical ground goes a long way toward clearing up line noises and some objectionable electrical interference. It certainly will iron out peculiar buzzes and strange noises often caused by using AC screen grid tubes. You can also use a radiator or water pipe ground in conjunction with it; the more, the merrier. So far we have taken good care of the aerial and ground. Now let us take a peep into the receiver itself.

### Tubes

It does not matter what circuit we employ, be it single detector, tuned RF, heterodyne system, band selector or any other pre-tuned method, but tubes are absolutely necessary in the operation of any receiver, and yet so little attention is paid to them. We become



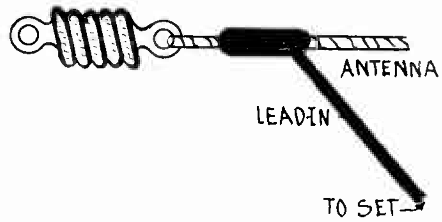




FIG. 2 (left)
THE PREFERRED METHOD, A CONTINUOUS WIRE FOR THE HORIZONTAL STRETCH AND LEADIN, WITH LEADIN SECTION VERTICAL. BY HAVING BOTH AS ONE PIECE, JOINTS ARE AVERTED AND CORROSION RETARDED.

FIG. 3 (right)
IF A JOINT MUST BE USED, MAKE A TIGHT ONE. TWIST THE WIRES WITH PLIERS. SCRAPE THE WIRE, WRAP THE JOINT WITH TINFOIL, BAND WITH FRICTION TAPE, AND ALSO TAPE THE WIRE AT ITS ENTRY THROUGH THE WINDOW.

slaves of habit. The worst habit to get into is to rely too much upon vacuum tubes. They are manufactured by the million to bring the manufacturing cost down; yet while their performance rates high it is difficult to find any two tubes having the same characteristics upon first inspection.

*Anyone really interested in distant reception should be equipped with a tube tester.* The importance of using matched tubes cannot be stressed too strongly. Good tube testers will more than pay for themselves in results obtained. They are reasonable in price and highly efficient. *One* weak tube in any of the RF stages, or in the detector circuit, will effectively destroy all possibilities of distant reception. We shall proceed to match them. This is done with the tube tester and, if it is used according to the instruction furnished with it, this will be a very simple operation. If the reader feels that he cannot afford a tester, or the meters used to construct one, he can use the following method.

Set the volume control at the lowest point where you hear a distant station. While the set is in operation remove one of the RF tubes and insert another in the same socket. By having the volume control set at its lowest audible point you will be able better to hear any increased volume when a better tube has been selected. Continue to change tubes until there is a decided increase in volume. Proceed to the next stage and continue right up to the detector and power tubes. This is a matter of only a few minutes with a tester. Naturally, it will take longer changing them in the receiver.

Always have a number of extra tubes on hand. The pet detector or RF tube may decide upon a vacation and you will want one to take its place. Mark your extra tubes. It will save you going through the whole operation again.

### 140 Spare Tubes!

The writer was in a broadcasting station when one of the RF tubes went west. The operator removed the tube and, opening a chest, substituted another, marked for its position. The set continued to operate as before. Dear reader, there were exactly 140 tubes to take the place of the burned out valve!!! We cannot afford such luxuries, but we can have a few spares on hand. Be patient in matching tubes. The writer spent a great deal of time in doing this and tested *eighteen* AC screen grid tubes before *six* were selected. About a dozen detector tubes, first stage audio and power tubes went through the same process of elimination.

Before passing on from the tube question let me add this bit of advice. Do not buy cheap tubes. You will get out what you put into them. If there ever was false economy it is the purchase of "tube bargains." Results, over a long period of time, are what we are after. There are no bargains in the quest of quality. The quicker one arrives at this conclusion, the better off he will be.

### Operating the Receiver

Mention of the operation of a receiver sounds like an extremely simple subject, but it isn't. It would be impossible to estimate the great number of really distant stations that are "passed" on the dials of countless receivers every night. A little care in the operation of a set will enable the operator to listen to stations he never heard before. No one would press down the accelerator on an automobile all at once; it is done gradually until the desired speed is attained. Yet thousands of radio set owners literally speed from one station to another without giving much thought to what lies between their positions on the dial, or dials.

Gone are the days when radio sets were equipped with micrometer tuning controls. Accuracy in tuning has become an individual accomplishment and much is to be said about the carelessness with which it is done. I have watched a number of persons tune receivers in about the same manner as one would use an axe in chopping down a tree. Then there is the other extreme. There is the owner who is afraid to tune the set for fear he will damage something. Our hands now replace the micrometer controls. Do not attempt to tune in distant stations by free hand tuning unless you have had some previous experience.

It is best to rest the hand upon something, a book or the receiver cabinet itself. This will give you the necessary balance. Here is the way to go after the elusive distant station:

First of all, *memorize the position of every local station on the dial.* This will permit you to "skip them" with the volume control turned up full. Let us start with a powerful local. WOR crashes though with plenty of volume in New York City. The carrier wave of this station—710 kilocycles—merges into the carrier wave of WJZ—760 kilocycles although there is sufficient separation betwee them. Now, if you will refer to a good station list—RADIO WORLD for instance—a number of broadcasters will be found between or near these locals. Among those powerful enough to be heard, while the stations nearby are going full blast, are the following:

WGN—720 kilocycles.
CHYC—730 kilocycles.
WSB—740 kilocycles.
KFAB—770 kilocycles.

### Stay Up Late One Night

These stations are all below 710 kilocycles with the exception of KFAB which is directly below WJZ. To hear all of them a receiver would necessarily be almost too selective and side bands would be cut, destroying quality. However, it is quite possible to hear WGN, WSB and KFAB. This is done by tuning *very slowly* from one setting to another. It may sound almost impossible, yet with patience it can be accomplished. Stations are there; once you tune them "on the dot" they will swell in with surprising volume. When you learn the knack of tuning slowly and carefully, the distant station will be heard although you may have previously passed it.

I have tuned receivers owned by friends of mine and have succeeded in adding a number of stations to their logs without making any change in their equipment. Of course, it is taken for granted that your receiver is sensitive and has a fair degree of selectivity. It would be ridiculous to expect results from a receiver that gives the owner difficulty in separating locals. Fast tuning will not produce results. Study your set, especially the dial settings of local stations.

The following bit of advice is very helpful, although I am not insisting upon it. Stay up late *one* night and tune in everything you can. Log all stations carefully. Then try to tune them in again earlier some evening while the locals are on. A surprise awaits you —and a thrill also. Many of the stations you thought were lost forever will come through. WOR and WJZ were listed merely for comparison. You should be able to separate locals from distant stations "all over the dial."

### Static and Interference

The most annoying thing that can happen while we are listening to a program is the crackle of static discharges or interference from electrical sources. Until scientific research discovers some method of reducing static we shall have to grin and bear it. If engineering staffs of the best broadcasters have difficulty with this form of interference, especially when attempting transatlantic rebroadcasts, we cannot expect to eliminate it ourselves. Many set owners take the precaution to turn off their sets during a severe thunderstorm. Though this is commendable, it is not necessary. Of the millions of aerials in use not one has actually been struck by lightning or, if it has, no report of it has been made. It might be a better procedure to disconnect the antenna, during a very heavy storm, and use the ground alone. A number of set owners have an inside aerial, in reserve, for just such an emergency. They do not deprive themselves of good local reception. In many cases the indoor installation will give suprisingly good results in pulling in distant stations. I cite my own case as an example. Using indoor aerials I can get Pacific Coast stations. Often the outdoor aerial will intensify interfering noises. Sometimes the indoor installation will have a tendency to decrease this.

There is another form of interference that should be abolished by law. Call it man-made static. Technically, it is called electrical disturbance. This article would be lengthened by several thousand words if the various forms of this insidious interference were itemized. Their causes are many and unfortunately they seem to emanate directly from the electrical outlet we use for power. Elimination of electrical interference is such a costly operation that very few individuals can indulge in this luxury. However, there are a number of excellent devices to be had for the sole purpose of eliminating some objectionable noise in the line current. Caution should be used in buying them. Some types present other difficulties. They reduce the noise if it is in the line but they also reduce voltage slightly, yet in many cases sufficient to cause a receiver to operate below par.

### Use of Loop Set for Tracing Source

A good little instrument to own is a small battery-operated loop receiver. It can be purchased for little, as it is considered obsolete for practical use in this day of modern receivers. With one of these it becomes an easy matter directly to trace the source of interference. Once located, it does not require much persuasion to make the owner of the interfering device realize exactly what damage is being caused. If you know of an actual case of interference from some appliance, get in touch with your local lighting company. You will be amazed how quickly it will investigate. It sees some forms of interference in a different light from the set owner. It often represents a leakage; hence the interest on their part. Your local company employs experienced engineers equipped with delicate apparatus for locating these disturbances. Make use of their service.

Sometimes hums and other objectionable noises can be located in outlets and outlet plugs. Very often changing from one to another will remove interference from this source. Reverse all plugs also.

Electrical interference in the house you live in, from oil burners, elevators, electric pumps and other devices, is an entirely different matter. Appeal to your landlord to eliminate the disturbance. He may be a real radio fan. Invite him to listen to your set while this is going on. Even if he isn't interested in radio his better nature might assert itself. If no results are obtained in this gentle manner become acquainted with radio set owners living in your house. They may be suffering the same inferno. Strength in numbers should convince the owner of the house that something can be done about it. Go so far as to offer to share the expense of changing noisy equipment, or the cost of having it properly by-passed with condensers.

Just think of all the distance one could get without any electrical interference. The day may not be far off when laws will be enacted making it a misdemeanor to operate any device that will interfere with radio reception. Get ready for it and, if you can, cast your vote in favor of it.

### Atmospheric Conditions

On many occasions we listen to our radio sets and remark about fine distant reception. We usually attribute such results to "good radio weather" and let it go at that. It is not the intention of the writer to explain what causes good and bad radio weather; volumes could be written on this subject. Not having the facilities such as would be found in a weather bureau, I can only give you the benefit of my experience.

Every radio fan should become interested in weather conditions. Reception is entirely dependent upon these changes. Barometric pressures, temperature variations, winds etc., also play an important part. This may all sound unnecessary, but as you read further it may not seem so. Great scientists, such as Sir Oliver Lodge, have definitely concluded, from years of scientific research, that winds do not have any effect upon radio transmission. The fact that radio waves travel at the same speed as light, 186,000 miles per second, apparently strengthens this opinion. Let it be said right here that I am in no position to agree or disagree with these eminent opinions; lack of laboratory equipment, inexperience from a scientific viewpoint, also yet other factors make it impossible for me to come to a definite conclusion. However, I do believe that by the contribution of experimental data upon this subject, they might enable experts in this form of research to conduct experiments along lines bound to produce definite means for pre-determining distant radio reception.

### Barometer and Temperature Readings

We are going in for a little scientific research that is going to prove useful as well as fascinating.

Tune your receiver, carefully logging all distant stations and making a note of their geographical location. Record the time the station was received, at the same time take a reading of the temperature, also a reading of the barometer. If you are not able to own or borrow these important instruments, it will be necessary to postpone your research until the following morning, when you will find a complete table of weather conditions printed on one of the inside pages of your morning newspaper.

It will be necessary to record your data. Make a chart in this manner. On a sheet of paper (office stationery size) rule off four vertical lines each one and one-half inches apart. Then rule off seven horizontal lines, also one and one-half inches apart; we are then ready to mark the columns. The last space, larger than the rest, will be used for remarks on reception.

Over the columns mark these headings in the following order:

| Date | Weather | Temp. H L | Bar. | Reception |
|---|---|---|---|---|

The chart has been ruled off for a week's records, so we will proceed to fill in the top line. See sketch. Here is what we notice. The weather was clear and cool. The temperature was 40.5 at 8 p.m., at 11 p.m. it had dropped ten degrees to 30.5. This drop is going to do something to reception, as we shall learn.

Now we take a good look at the barometer. Its reading, at 8 p.m., is 30.40, an indication of fair weather—locally, perhaps. At 11 p.m. the reading is 29.80, which indicates that we are in for a weather change. Here is where our last column gives us the information we want. It would probably read something like this. At 8 p.m. reception was good locally, distance was weak and mushy. Very rapid fading on a number of frequencies. This indicates changing weather conditions. Western stations clear but weak. Some static. Now, let us see what we are going to mark down at 11 p.m. There is less static. Western stations are still weak. Southern and Canadian stations are strong with slight fading.

### Indications Capitalized

Perhaps you might ask what good are these records, what can we get out of them? Well, if my chart read something like the above, here is what it would indicate to me. That while the weather (local) was clear and cool, with apparently favorable conditions for distant reception, Western stations were weak. Early in the evening we had static which diminished as the evening wore on, and a drop in temperature took place. Southern and Canadian stations came in with volume. An indication that weather conditions were better in Southern and Northwestern sections of the country. On the

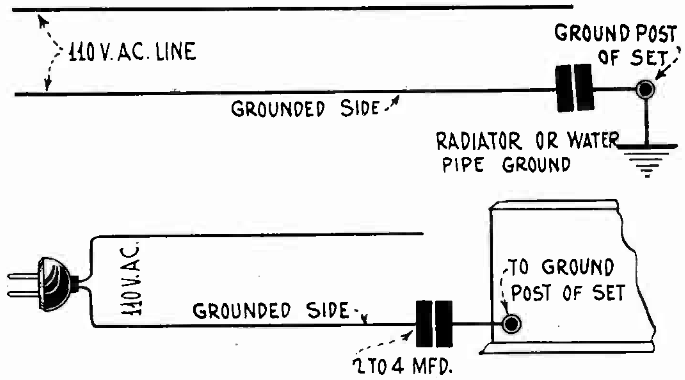



FIG. 4
TWO WAYS OF USING THE LIGHTING SYSTEM AS GROUND.

following morning our newspaper is going to give us some surprising information. It will show us, rather definitely, that atmospheric conditions were not the same throughout the country. It will also show us that from wherever we received signal strength conditions were similar to our own.

The following record will show how valuable this information becomes. New York City weather, 10 p.m., March 19, 1930. Clear and cool. Temperature, high—46, low—22, barometer 29.82. These stations, only a partial list, came in clearly through locals:

| *Station* | *Location* | *Kilocycles* | *Weather* | *Temp.* | *Barometer* |
|---|---|---|---|---|---|
| CKAC | Montreal | 730 | Clear | H26-L18 | 29.76 |
| WBAP | Ft. Worth | 800 | Clear | H60-L48 | 29.90 |
| WSUN | Clearwater, Fla. | 620 | Clear | H80-L72 | 29.96 |
| Several Chicago Stations | | — | Clear | H42-L36 | 29.70 |
| KFI | Los Angeles (signals weak, but clear) | 640 | Clear | H68-L52 | 30.00 |

These stations are merely indicated for comparisons. Make these observations. Clear weather prevailed in cities where the broadcasters were located. No great variations in temperature. Very slight difference in barometrical readings, all pointing to a continuation of fair weather. From locations where unsettled conditions prevailed reception was decidedly poor. I predicted good reception for the following night—March 20th. If the reader listened in that night he will bear out this prediction. The stations I have listed fairly boomed in.

I refuse to go on record as saying that good or bad reception can be definitely predetermined by using the information given here. It might start a controversy that would place me in a defensive position against those who might disagree with my theory. One thing, however, seems certain. When weather conditions, in other cities, compare favorably with your local conditions, good distant reception can be expected. When conditions are the reverse, reception will naturally not be good. Collect data for a week and use the chart.

At the end of that period you will be able to determine for yourself just how valuable this record will be. Even though you may be correct only 75 per cent. of the time, predetermining reception will prove to be a fascinating and educational recreation.

### Weather Reports

These valuable aids to reception should be studied by every radio set owner. You will need them when you make comparisons between locations. In conjunction with your chart the use of weather reports will enable you to make fairly accurate predictions for at least twenty-four hours following the report.

I know that a number of readers are eager to ask me why reception seems so much better on a rainy night. I believe it is for this reason. Rain, especially on cool nights, causes a great drop in humidity (degree of moisture in the air) and clears the atmosphere of heavy air pressure. This does not hold good on a Summer night when the relative degree of humidity is so much higher than in the Spring, Fall and Winter. When it is raining in your local area, it is ten to one that the weather conditions will be about the same from locations in which you receive the distant broadcaster. The barometer will tell you more about reception than any other instrument.

Have you ever noticed, on evenings when reception was below par, that your receiver seemed to lack sensitivity and selectivity? It happens to be a fact; even supersensitive sets behave in this manner. It is not difficult to understand why.

To reach out for any distance on a relatively poor night it is necessary to advance the volume control to its limit. While this apparently has little or no effect upon raising the volume on distant stations it does materially increase the volume on locals, resulting in a chaos of cross talk. Therefore, it *seems* that your receiver has lost its sensitivity and, of course, its selectivity too. When atmospheric conditions are favorable there is great signal strength from the distant station. It is not necessary, under these conditions, to advance your volume control very far. Locals come in with volume aplenty, and you have an abundant reserve of power to tease the distant station out of its hiding place.

When a signal is too weak to amplify, no matter what type of receiver you use, the results cannot be improved upon.

Background noise level also has a great effect on clear distant reception. It is absolutely impossible to determine exactly what

| DATE | WEATHER | TEMPERATURE | BAROMETER | RECEPTION |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

FIG. 5
HOW TO ARRANGE A CHART TO HELP YOU IN DISTANT RECEPTION, ESPECIALLY IN FORECASTING DX CONDITIONS. EACH CHART IS ON A WEEKLY BASIS.

causes background noise. It certainly is a form of interference, perhaps electrical, perhaps from static or a combination of all forms. On clear nights this *seems* to be less and undoubtedly is, but it is my belief that it remains where it is and, due to increased signal strength, appears to be subdued. Naturally, where atmospheric conditions are poor the noise level increases; there isn't anything to interfere with it.

Thousands of radio set owners have complained about poor reception and are invariably informed that it is due to their "poor location." This phrase is a closing argument for many dealers who insist that receivers work well when installed in "good reception areas." This holds true in many cases, but it is not universally so. I have no intention of trying to impress the reader with the opinion that reception is good everywhere. Various forms of interference make this impossible. But I do contend that everyone, with a little thought and care, can do much to improve his own condition.

The writer, living in New York City, must consider the residents of this Metropolis as far as their respective locations are con- concerned. Others, residing in suburban communities, have little or no difficulty with conditions such as are found here. Hundreds of tremendous steel buildings deflect radio waves; millions of kilowatts are in electrical consumption daily; there is a barrage from about ten dozen local broadcasters—these and many other things do much to blot out the distant station. Study your location. Investigate receiving conditions. Others may have sets right in your neighborhood "pulling in" many stations you thought impossible to get. Powerful receivers are the cure for bad locations. You must break through the barrier and if you will read on we may be able to overcome some of these difficulties.

### Direct and Alternating Current Districts

New York City is distinctive in one way as far as radioists are concerned—it has more direct current consumption than any other city in the world, perhaps all of them put together. In a way this inflicts a hardship upon radio fans. We all know the value of alternating current; what we are able, so far, to do with it; the excellent receivers, commercial and home-built, made to operate on this current; the elimination of all outside power units; storage and B batteries—and other things too numerable to mention.

It is natural, with all this information on hand, for the radio fan, living in a DC district to feel discouraged and out of the running. The radioist living in such a district wants to keep in step with his AC brethren; wants to operate a sensitive set; get distance and tone quality; in fact, wants to obtain everything that AC operated receivers deliver. He can do it, too; but he must not be too particular as to how he will go about it. Remember one thing—direct current rated from 100-120 volts cannot be increased in the same manner as AC. Therefore, you have a limited line voltage to start with.

It is my fervent prayer that a reader of RADIO WORLD will be the first to discover a means for increasing the line voltage of DC. Over a million dollars in cold cash will be his reward. When you take into consideration that the best paid, most intelligent engineers have been working on this problem for many years, and so far have not achieved any worth-while results, you may forego your determination in this respect. Some day, and not far distant, you will discover that your DC lines have been converted into AC. Power companies will come to it. They can sell AC at less cost, to themselves, than DC. It may take a long time, but it will be well worth waiting for.

If you want the same results in DC that you would get in AC districts, build a sensitive receiver and *add* voltage to the DC line by the use of additional B batteries. I know of many DC installations where an excellent A and B eliminator is used in conjunction with a few B batteries, and results are most satisfactory. I have built many Diamonds of the Air—in fact so many that I've lost count—for friends living in DC districts. By using an A and B eliminator and two B batteries, to bring the voltage up to 190, results are equal to those from most AC receivers, and better than from many. You can even use 245 tubes—one, if you like, as a single stage, or two in push-pull without necessarily ruining your batteries. At 190 volts the drain of two 245s is only 52 mils., slightly more than a pair of 171s. I have found a much fuller bass response with these tubes at this voltage. Most DC set manufacturers are using them right now with the limit of the line voltage (90 to 120 volts) on the plates, with fine quality, too.

### Summer and Winter Reception

Every one is of the belief that reception is best in Winter and poorest in Summer. This holds good to a great extent. There are seasons for radio reception, but Winter is not necessarily the best. There are too many violent atmospheric changes at this time of the year. Due to their varying intensities, locally and far off, distant stations put on a see-saw act.

How many readers have noticed how peculiarly far away broadcasters swing in and out during the so-called fine reception season? Quite a number, I venture to say. The common interpretation of this would be termed fading, and fading it is, due, in many instances, to very rapid changes in weather conditions. It may be quite cold and clear in, let us say, New York. It may also be cold, but not so clear, in Chicago; perhaps a snowstorm is raging there. An atmospheric disturbance is set up immediately between the two points, with an abundance of static in the Western city.

We wonder why the Chicago stations come in with weak volumes while Southern broadcasters fairly boom in. Barometric conditions, reported in the following morning's paper will give you the answer. When my barometer reads 40 degrees I know that reception is going to be good. Don't ask me why. I can't answer; but on nearly every occasion when California stations were heard, a temperature of from 38 to 42 degrees was recorded. Fine, clear weather, throughout the entire country, may have been responsible for this reception.

From my past experience with reception periods, I venture to say that the best time of the year for most consistent reception, is either in the early Spring or the Fall. The particular months are: March, April, May, October and November. Winter weather is far from settled and, though we experience fine conditions in the colder months, reception does not seem to be so consistent as during the time I have mentioned. Summer reception is far from bad. At times it equals the best conditions. I wonder if the reader can recall a really hot Summer three years ago. We had stinging weather for several weeks. A phenomenom of nature took place. The continued heat, without any apparent let-up, practically burned every particle of static electricity out of the atmosphere. Reception of far distant stations was excellent; it continued to be so for almost a week.

In the Spring and Fall months weather conditions are consistently good; for that reason one can expect consistently good reception. Do not get the idea that your radio set is ready for the storage room when this season makes its appearance. If you suffer from a case of Spring fever, perhaps your receiver is likewise afflicted. Give it a chance. It might welcome your confidence in it and reciprocate to a surprising degree.

Nothing has been said about the speaker as an important aid in reception. There are many readers who prefer a cone to a dynamic speaker. Then again, many prefer the dynamic to the cone. This is a matter of personal opinion and should be left for the individual to decide. I do believe that the dynamic is preferable as it is able to handle more volume than the cone, without any apparent distortion. At times my set delivers 3000 milliwatts of undistorted input to my speaker. That really is quite a lot, and I doubt if any cone could handle it. If your dynamic hums, see if it is in the line or in the rectifiers. If it emanates from this point, by-pass it heavily with suitable condensers. Do not be afraid to use enough capacity. Some speakers require all of 12,000 mfds. to suppress completely the annoying hum.

Be painfully accurate in regard to the little things that make or mar reception. You are bound to find some trivial thing that, upon being corrected, will enable you to explore new worlds of radio reception and will provide you with the thrill experienced by most people when they listen to some far-off broadcaster clearly and with perfect tone quality.

## *Summary of Pointers on Getting More DX*

As this article has been written with the object of assisting readers to obtain better distant reception, it might be helpful if we summarized the advice given.

### (1)—Factor Governing Reception of Distant Stations

The transmitter (broadcasting stations).
The receiver (your own radio set).
Antenna—install the best.
Ground—install the best.
Tubes—Use a good tube tester and select the best for your receiver. Mark your spares in case of burn-outs. Buy the best. Operate them at rated voltages. Discard all microphonic tubes.

*(Concluded on next page)*

# A Smoking Stand Set

## Compact Assembly of a First-Class Circuit

*By Herbert E. Hayden*

HERE is an idea for a receiver out of the ordinary. Instead of using the conventional box or console for housing the receiver an attractive walnut-finish birch wood smoking stand is used. The inside dimensions of this stand are ample to house a good-sized receiver, including everything but the speaker. The circuit diagram of the receiver that was put into the stand is shown in Fig. 2. It will be observed that it is a full-grown receiver and not a plaything.

Room for the loudspeaker can be found either on top of the stand or on the cross piece below the receiver compartment, depending on the size of the speaker used.

The receiver contains three features worthy of special attention. First, there is the double tuner between the antenna and the first screen grid tube. This increases the selectivity without decreasing the sensitivity. Second, the coupling between the first audio tube and the push-pull stage is effected by two standard audio frequency transformers, secondaries connected in the usual way, but primaries connected reversely. The voltages induced in the secondaries are in opposite phase, as required in push-pull.

At first thought it would seem that the primaries are connected the same way as the secondaries, but a little consideration will show that they are really in reverse and that the voltages in the secondaries will be opposite.

The third feature is the special connection of the filter chokes in parallel in place of the usual series connection. The parallel connection is used to prevent core saturation and thus to improve the filtering and lowering the direct current resistance of the chokes.

While the inductance of two equal chokes connected in parallel is only one-fourth as great as that when they are connected in series, the inductance of each individually is increased considerably by the lowering of the magnetic flux density in the cores.

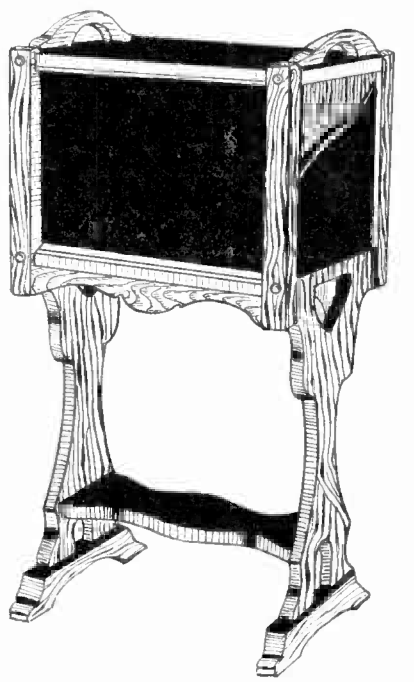


FIG. 1

A HANDSOME SMOKING STAND ADMIRABLY ADAPTED FOR A RADIO CABINET. THE CIRCUIT DIAGRAM AT THE RIGHT IS THAT OF THE RECEIVER ESPECIALLY DESIGNED TO FIT INTO THE CABINET.

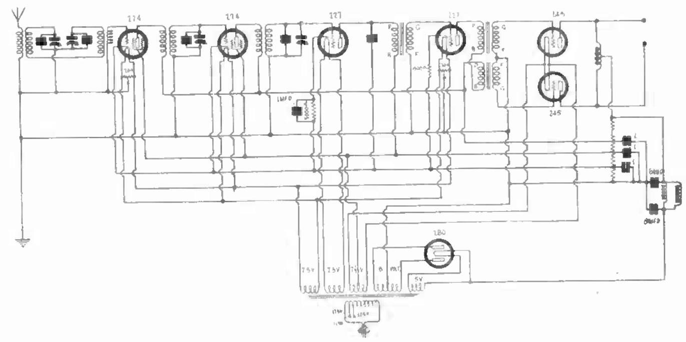


FIG. 2

THE DIAGRAM OF A TRANSFORMER-COUPLED, SIX-TUBE RECEIVER THAT FITS NICELY INTO THE SMOKING STAND DEPICTED AT THE LEFT. THE CIRCUIT EMPLOYS PUSH-PULL IN THE LAST STAGE BUT USES TWO ORDINARY TRANSFORMERS IN PLACE OF A PUSH-PULL INPUT TRANSFORMER

[*A full report on the construction of this receiver will be published next week in the April 26th issue.—Editor.*]

# Summary of Wallach's System of Getting Distance

### (2)—Operating the Receiver

Memorize all local dial settings.

Tune slowly and carefully.

Use a good station index for reference.

Learn to record your stations in kilocycles rather than "wavelengths." Stations are usually ten kilocycles apart.

Do not become discouraged if your first attempts produce meagre results. You cannot learn to drive an automobile in one hour.

Be sure that your receiver measures up to some standard of sensitivity. You cannot go eighty miles an hour on a bicycle. Build another set if necessary.

### (3)—Static and Interference

First make certain that the set itself is not responsible. Removing the antenna and ground will quickly prove this. If you have severe line noises, call in an expert if you are unable to eliminate them. Avail yourself of the service offered by lighting companies. Test your outlet plugs; see that they all fit tightly. Become acquainted with other set owners, in your house or neighborhood. Make comparisons. Many heads are better than one. Have all electrical equipment in apartment houses or directly near you, tested for defects which cause interference.

Do not buy so-called static eliminators. There are none. These devices apparently reduce static by reducing everything else including your reception.

### (4)—Atmospheric Conditions

Become interested in weather conditions.

Obtain, by borrowing if necessary, a good barometer and a good thermometer. Hang the thermometer outside your window and the barometer as near to it, on the inside, as possible.

### (5)—Weather Reports

Keep a chart of weather changes. Compare these with published reports in morning newspapers.

When reports show clear weather in many areas, and there has not been any severe temperature changes, it is safe to assume that you will receive stations from the locations comparing favorably with your own. This, however, requires some study. Do not attempt to predetermine reception conditions until you are able to understand the use of barometer and thermometer.

### (6)—Selectivity

Selectivity is dependent upon weather conditions. When you have to use all of your volume control you know that conditions are not good (unless, of course, there is something wrong with the receiver). The better the receiving conditions are, the less volume you will have to use. This is also a good method for determining receiving conditions.

### (7)—Location

A little care on your part will unquestionably improve the reception of distant broadcasters. Location has something, but not all, to do with it. Check over everything that pertains to the operation of your set. One little thing overlooked will retard it considerably.

### AC and DC Districts

You cannot raise voltage rating of a DC line. Add B batteries to obtain necessary voltage for operating power tubes. DC line voltage sufficiently high for all tubes up to the amplifier. Appearance in a receiver need not sacrifice results. Use eliminators and batteries if their use means distance and tone quality.

### (9)—Summer and Winter Reception

Spring and Fall months are much more dependable for consistent distant reception than all the Winter months. The cold season is subject to intense atmospheric variations. Do not put up the receiver too early. Give it a chance. Records prove that fine reception can be obtained during seasons that most people believe to be retarding it.

# What Makes a Dynamic

## Baffle, Cone Stiffness and Dampers

*By John C.*

*(This article is the sixth of a series on dynamic speakers. The series began in the March 15th issue with the article, "Design of Dynamic Speakers." The pot magnet, voice coil and baffle were discussed. The second article, "A Comparative Test of Dynamic Results," appeared in the March 22nd issue, in which comparisons were made between magnetic and dynamic speakers. In the March 29th issue, "Hum Reduction in Dynamic Speakers," was discussed. Reverse wound coils and condenser-choke systems were included. In the April 5th issue, "Wave Forms of Hum Reducers" was the topic. The use of the bucking coil and some remedies for hum were discussed. In the April 12th issue, last week, the subject was "Why Coils Have Lag and Condensers Lead." The effect of potential difference on atomic stability was shown.*—EDITOR.)

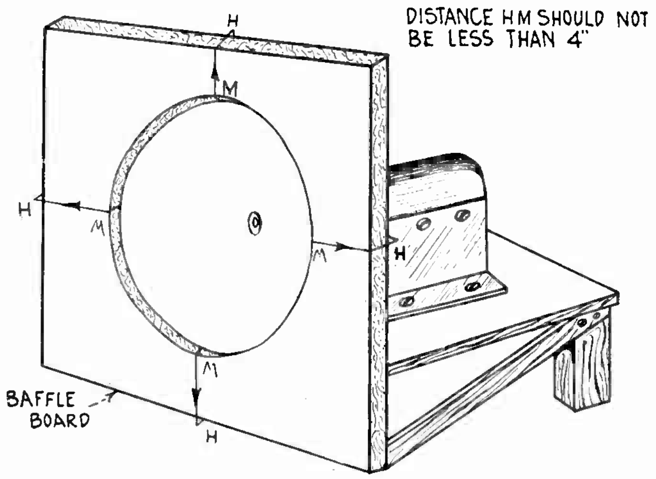



FIG. 1
A DYNAMIC SPEAKER MOUNTED ON A BAFFLE.

MANY may be tempted to ask, "What is Dynamic Speaker Quality?" and, incidentally, want to know something about what underlies dynamic speaker reproductive quality. That there *is* a difference between the reproductive quality of various speakers will be admitted readily, as will the fact that some magnetic speakers *sound* about as good as the dynamic ones. This is due to the effect of similarity or near similarity of overtones, whether by the use of a baffle or merely because constructional features combine to create the effect. But no matter what artifices may be employed to make a magnetic speaker *sound* like a dynamic, the magnetic never will be really the same, for a variety of reasons. More clearly to understand what it is all about, the facts that underly the operation of simple sound-producing devices should be reviewed, and in some cases some simple and easily understood analysis will be of help.

### Introduction of a Baffle

Fig. 1 shows a speaker mounted on a baffle. Fig. 2 shows a cone only, in motion, the semi-circular lines showing *one* long wave front A moving outward in the direction of the arrow A, and on the reverse side we show *two* separate and distinct wave fronts moving oppositely to the single wave front A, and at an angle to each other.

The sound energy in *front* of the cone is very much greater than the sound energy available at the *rear* of the cone because the rear wave fronts move as shown, along the axis B and arrow, so the farther these waves advance along the axis, the farther apart they will be, and, as a consequence, they will act as two independent sources of sound.

The single long wave front that advances from the front of the cone, however, in moving as a whole along the cone axis and as a consequence of having received a uniform "start," continues forward as a single pulse and gives an ear, placed on or near the cone axis, the impression that there is but a single source.

But in the case of the other wave fronts, this is not true. An ear when moved around, in or near the region of propagation of the cone rear-surface waves, would record the existence of two sound sources, and investigation would show that this is in fact the exact state of things.

Therefore, is it not clear that when a speaker cone is operating without a baffle that there are three distinct wave-form axes, with their directions of propagation at an angle to one another, which angle depends primarily on the cone angle. These angles will be equal, of course, when the cone sides make an angle of 45 degrees with the cone axis. Otherwise these directions of sound wave propagation will be different and the result, incidentally, affects the acoustical response of the speaker, or acoustical output. This cone angle effect, of course, is somewhat modified by the refractions and reflections that occur between the cone rear surface and the cone housing.

Designers utilize these principal effects in combination with various kinds of absorbing material placed within the cone housing and elsewhere on the speaker to correct acoustical deficiencies, including suppression of undesired sound components.

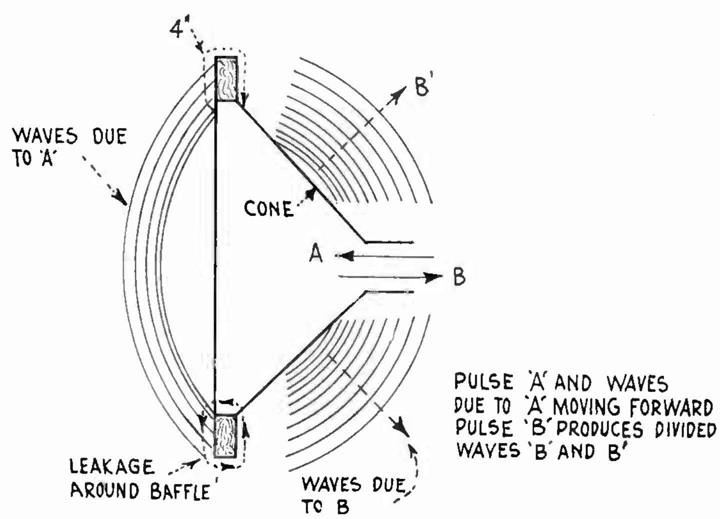



FIG. 2
CONE MOTION, SHOWING DIRECTION OF PROPAGATION OF THREE WAVE FORMS.

### Compensation Is Utilized

The first subject of interest is the baffle because its effect upon the acoustic output is of prime importance in speaker installations.

The word baffle is one of the most ambiguous terms in speaker discussions, because it can describe anything from a small board or a cigar box to the side of building or a huge horn. Accordingly it becomes necessary to be very open-minded in one's conception of a baffle, and only limit oneself to the baffle when actual dimensions are given.

Now when a single pulse leaves a speaker cone and travels to the observer the ear records this pulse a short time after it leaves the cone (Fig. 2), but if the cone now be made to replace the speaker in Fig. 1, and the same experiment is tried, the pulse will sound much louder, although the same energy is expended in producing the pulse in each case.

### Diversity of Radiation

The explanation is as follows: When a speaker cone is vibrating, sound waves are given off in opposite angular directions, and because of this the two wave fronts that are emitted from the rear surface of the cone are likewise opposite to the single wave front emitted from the front surface of the cone, in respect to their energy maxima and minima at a given instant. Now, in addition to some facts previously set forth regarding the direction of propagation of the wave fronts, there is another fact, the tendency of sound energy given off by the rear surface of the cone, partly to nullify the acoustic energy of the front surface. This is largely due to the inertia or "stay-as-it-is-ness" of the cone, i.e., when the cone has produced the front pulse it begins moving backward to produce the rear surface pulse and in so doing robs the front surface pulse of some of its support. In consequence the front surface pulses are not as strong as they would be if the air column behind the speaker

# Speaker Sound So Well?

## Among the Mechanical Means Used

*Williams*

cone were acting so as to prevent the rapid backward motion of the cone, hence the addition of a suitable baffle artificially increases the air column resistance behind the cone, thus permitting the increase of radiated sound energy from the front surface of the cone.

At this point it is well to inquire, "What is sound, anyway?" Why do we hear a bell ring, a person talk, a speaker reproduce? This is a very ordinary question, and being easy to ask, it is difficult to answer.

Sound is a form of energy manifestation that depends primarily on the atmosphere for its existence, i.e., without air, sound would not be of any use, and for most of us actually would seem non-existent. But for those who have their audible sense, most of their emotions, impressions and intelligence are transmitted and received by the medium of sound, hence this manifestation is very important and its study and the application of its principles are far-reaching.

#### The Evacuated Jar

A very striking example of the dependence of sound transmission on air is contained in the following old experiment: An electric bell, arranged to be operated by a few dry cells, is placed under a bell-jar and connected to a vacuum pump. The bell is connected and ringing (which you can plainly hear). Then the pump is started, and as the air in the bell-jar is exhausted the sound of the bell grows fainter and fainter. When the air is completely exhausted, no sound is heard. But the bell is ringing vigorously all the while, as the sparking contacts on the armature attest.

Now, the pump is stopped, and air is allowed to re-enter the evacuated space, with the result that the bell is heard with increasing loudness until finally the jar is full of air and the bell sounds normal again.

Sound is, therefore, due to the vibration of air particles set in motion by the sounding (or moving) body, or a portion of the moving body's free surface (in contact with air), and the vibration of air particles is transmitted in the form of a wave to the ear, which integrates the wave form into a series of nervous impulses which the brain records as a sound image of the original source. Therefore, it is apparent that sound sources are vibrating bodies, and the intervening air acts as the transmitting medium much the same as the ether conveys radio broadcasting waves from the station to your receiver.

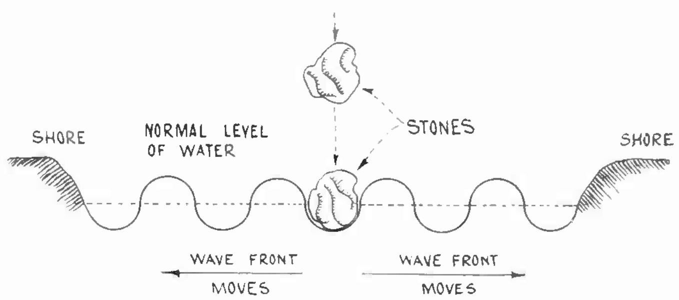



FIG. 3
WAVE FORM PRODUCED BY DROPPING STONES ON TO THE SURFACE OF A STILL LAKE.

Fig. 3 shows the familiar water analog. The dotted line is the smooth surface of a lake, and the shores are sloped so that there will be no disturbing reflections.

#### Depressions Are Radiated

The stones are dropped vertically and produce the full line impressions on the water, as shown, and these waves travel radially outward, as depicted, but the water as a whole does not move, but the surface that is depressed by the stone and the resultant *depression* is merely transmitted radially outward from the axis of descent of the stones to the shores, where it is absorbed. If you want to see more waves, then you'll have to drop more stones.

The surface of the lake is analogous to the air, the stone represents the striker, and the wave form on the water surface represents the sound that is set up. This analog is sufficient for preliminary explanation, but is not intended to explain the more complicated phenomena which follow.

The sound waves that are set up in air by any vibrating body move away from that body at a definite rate, which is the same for all frequencies or all kinds of sound waves, provided that the intervening air be of uniform transmitting ability. This radiation of sound waves by air is varied if the temperature rises or falls, and also changes if the advancing sound wave meets an area of heavy fog-laden air. Sound waves travel in other substances beside air, and in most cases the velocity of propagation is much faster than in air. As in the cases of air areas of different temperatures and densities, different woods and metals have differing sound wave transmission characteristics.

#### Radiation by an Impacted Medium

Fig. 3 showed a water wave produced by dropping a stone on a smooth lake. In practical uses sound waves are made to travel through water to warn ships of the amount of water (depth in feet) under the keel, etc. There are many other pertinent applications.

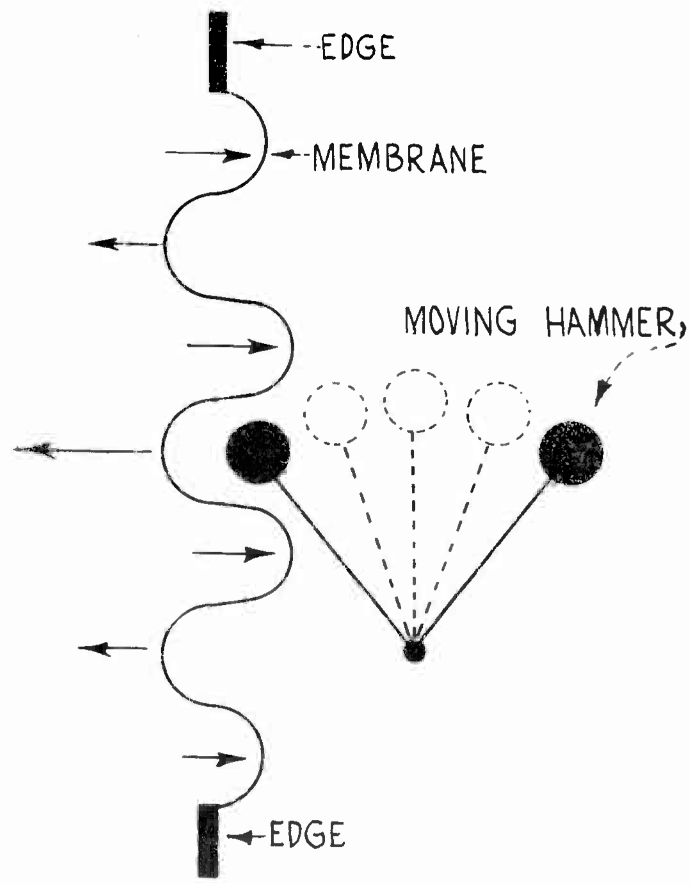



FIG. 4
WAVE FORM PRODUCED BY IMPACT ON A STRETCHED MEMBRANE.

Fig. 4 shows a wave of form almost similar to that produced by dropping the stone into the smooth lake, but the similarity ends here. The vibrating medium is a membrane that can be vibrated by the hammer (not unlike the padded stick used by the drummer when he sounds the bass drum). But the wave form on this drum is emitting sound. Now, whether I strike the membrane rapidly or slowly it produces the same sound and in a case like this we say that we are listening to a simple tone. If we move around the sounding membrane we will hear the same sound in front of either surface, although if we stand parallel to the axis of suspension the sound will seem weaker; nevertheless the tone of the sound will be the same. Now this shows that sound waves are emitted equally by a vibrating body that has the same air column on each side, a decided contrast to the case of the cone, but we can show that different portions of this plane membrane emit sound at different intensities, the intensity being greatest at the center where the membrane is being struck and gradually tapering off near the

(*Continued on next page*)

edges. This kind of motion is true of the cone also, but the cone usually responds to much higher harmonics than a large flat membrane, such as a drum.

The effect of change of tension on the velocity and pitch of the wave form of the membrane is next, and we can use the same device already described, but increase the tension by pulling the membrane radially outward. On striking the device now we hear a higher pitched sound and if we keep the body sounding constantly we can see that the humps and hollows of the wave form are more numerous than before. Why?

The density of the membrane has not changed, neither has the temperature gone down, but we have *increased* the number of humps and hollows by increasing the "stay-as-it-is-ness" of the membrane. The usual explanation is confined to the statement that the velocity of a sound wave in a medium is proportional to the elasticity of the material, but this is usually not very clear to everyone; therefore, if I say that if where the membrane was looser the sound waves were fewer because there was a greater damping effect due to air resistance, and there was less air damping resistance when the membrane was stiffer, because the membrane could not vibrate as far and consequently the waves could move faster, that statement is not exactly right, either, but I am recording it in order that I may disqualify it here.

Many questioners have asked whether this description is correct, but it is not.

### Natural Period is Different

The real cause of the above change in the number of waves set up when the membrane was tightened is the change in the natural period of vibration.

What is natural period? The period of vibration of any body that is emitting sound waves is due to the natural rate of sound wave propagation through the body not complicated by the application of any external forces whatsoever, and this statement is usually qualified by stating that the above conditions take place at zero degrees centigrade.

One of the best analogous demonstrations of natural period is pendulum motion. If a lead ball of convenient weight (say 20 grams) be attached to a light cord so that the distance between the center of the ball and the axis of suspension be 1 meter, the pendulum when started will require 1 second to swing from one side to the other of its arc of motion, no matter what the angle of arc may be, and so it is with sound-producing devices.

An excellent acoustic illustration of natural period is the following: A long tube (metal or fibre) is suspended or held vertically, and a lighted bunsen burner is placed at the bottom of the tube so that its flame will be central with the tube axis. A bunsen flame tends to roar a little, so under the condition described the long tube begins to emit a note, and very soon afterward is speaking its fundamental tone. This note is the natural period of vibration of the air column enclosed by the tube. This experiment is due to Professor Davis of Columbia University.

### Density an Important Factor

So it is seen that the propagation of sound waves through a medium depends upon the density, elasticity and size of the sounding body. Where air columns are involved the temperature of the air of the column is important.

Can natural period always be dealt with as such or is it a convenient fiction? This is a serious question and must be answered by those who are interested in speaker design. Perhaps I ought to qualify the question by adding "under operating conditions." When the designer is making comparative tests of two different dynamic speakers, which are proposed to be made to sound alike, it is obvious that the natural period idea is out of the picture, because the two speaker cones in the case the writer has in mind *are* very different, one being heavy stiff paper and a 7-inch diameter, and the other very flexible paper and a 10-inch diameter. Now these two different speakers can be made to sound alike, that is, when operated on a voice circuit, but when the individual sound outputs are measured the expected disparity occurs. So while the speakers reproduce complex tones with apparent similarity they don't compare so favorably in other respects.

Let us take two apparently similar speakers and subject them to sound analysis. They will be found to compare very favorably, but when placed on the voice circuit they do not sound similar, and in listening closely I find that the so-called background noise is different, whereas in the previous case it was the same.

### Effect of Change of Mass

This raises the question of the possibility of the preponderating effect of some common sound—frequency in the first case, and the existence of two very different large responses in the second, and analysis of the acoustic output in the second case usually reveals this as the cause.

Artificial measures in some cases can correct acoustic deficiency when the cone structure is easily subject to change, but in most measurements the voice coil current is a fairly reliable check on the comparative input energy to the voice coil, and from this point out the general speaker structure must be modified to meet the desired qualifications.

The effect of the stiffness of a membrane has been discussed previously but the effect of change of mass has not. In the case of the pendulum (which, by the way, is always a safe analagous guide) we remember that the period of vibration was stated to be 1 second. It would have been the same if a lead ball weighing 40 grams had been substituted for the original 20 gram ball.

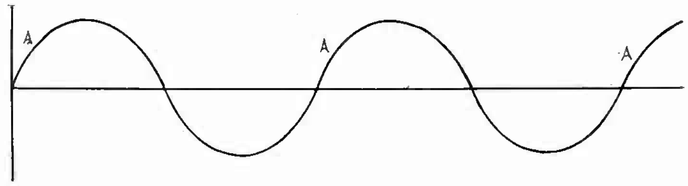



FIG. 5

A SIMPLE HARMONIC ORGAN TONE CURVE.

So it is with the speaker cone. A *change* of mass (or weight) is not effective in changing the tonal quality. Any change of tonal quality or sound analysis is due directly to a change in stiffness of the material of the one, as the velocity of sound waves in a membrane is only affected by *change* in stiffness.

### Diversity of Direction of Travel

This leads logically to the next item of interest. Sound waves travel in more directions than one. The direction of travel of sound waves is utilized in speaker designs intentionally and sometimes otherwise. Now there are *two* principally different sound wave directions of motion in a membrane, a fact that was not brought out before, and they are transverse and longitudinal.

In a previous paragraph I showed that certain acoustic differences existed between two different speakers, both of which were apparently similar, and the reverse case where two different speakers sounded or could be made to sound the same. Now these differences are really due to the complex composition of transverse and longitudinal sound waves in the membrane or cone, and it is rarely ever possible to produce two cones that will reproduce alike, because of the difficulty of getting two cones that have the same stiffness, hence, again, the simplest way out in most cases is to resort to changes in transformer design to cover up the unwanted sound characteristic and magnify another frequency out of proportion to the rest. And, too, the size of the baffle used has a very great deal to do with the final result. In consequence many speaker tests are conducted using a large flat Celotex board at least 7 feet by 9 feet with two openings located on either the major or minor axis of the panel.

### Simple and Complex Tones

Sound waves are either simple or complex, a fact forcibly impressed on me when in church. The deep organ tones, when analyzed, are shown to be of sine wave contour, while those tones of the upper register are plainly complex, and harmonic analysis would show this fact very readily.

Fig. 5 shows a curve of an organ tone similar to that which would be obtained on a harmonic analyzer, a machine for resolving the various components of a complex sound wave. This curve is for a low organ note, the kind that "rattles the church windows," and hits you in the pit of the stomach.

Fig. 6 shows two organ tones that are slightly out of phase. These two slightly different tones are producing beats and are likewise similar to curves that would be obtained by harmonic analysis. The organist makes very frequent use of the combination of two tones of slightly different frequency, producing the human voice or vox humana effect by this means. Also the sounds of bells and many other effects are produced by the process of acoustical mixture.

Before taking up a brief explanation of how sound waves move I want to digress on the discussion of some defects that are the results of acoustical studies.

A sound expert of world-wide renown, Dr. Dayton C. Miller, spent many years doing valuable acoustical research work, and in this connection made a critical study of the acoustic properties of various substances, of which he had some musical instruments made—it is told that he had a solid gold flute, a lead flute, and many other similar musical instruments made of many different material for the express purpose of researches into their acoustic behavior.

In Dr. Miller's book, "The Science of Musical Sounds," there are many topics of interest to sound students and lay readers—the book is most interestingly written and is understandable to the highest degree—and is in fact the recording of a series of popular lectures.

Dr. Miller is a member of the staff of the Case School of Applied Science at Cleveland, Ohio, and is responsible for the devising of an instrument called the "Phonodeik" (pronounced fonodike) which enables us to see the wave form of the acoustic output of any sounding device. It also makes possible the recording of the wave form of varous sounds.

The early models of the phonodeik had a limited frequency range and were responsive to pitch, a defect which was remedied in later designs, but nevertheless this pioneer method of sound-wave analysis by visual means was the stepping stone to the final perfection of our modern methods of analysis.

(*Concluded on page 13*)

# A Handy Ohmmeter

## With Proper Adjustment it is Practically Direct Reading

*By William A. Forbes*

A SIMPLE and convenient ohmmeter has been developed by Joseph Calcaterra and the facts published in the Aerovox Wireless Corporation's house organ, "Research Worker." The instrument is based on an application of Ohm's law, as are all devices for measuring resistance.

"Research Worker" gives two diagrams of the ohmmeter but only one of them is reproduced here, in Fig. 1. This is the more complex of the two but the circuit is more flexible and is preferable.

The resistance Rx to be measured is connected between the points (g) and (h) in series with a sensitive current meter A. Across the current meter and the unknown resistance is connected a voltmeter V. If a voltage source is connected between the terminals of this voltmeter, or between the points (e) and (f), we have the ordinary set-up for measuring a resistance. That is to say, we have means for connecting a known voltage in series with an unknown resistance and a means for measuring the current that will flow through the circuit. It is only necessary to divide the reading on the voltmeter V by the current reading on A, in amperes, and the quotient will be the resistance of the circuit in ohms.

The resulting value includes the resistance of the current meter A. To get the resistance of the unknown it is necessary to subtract the meter resistance. In most instances the resistance of the meter is so low that it may be neglected in comparison with the resistance of the unknown. However, the value of the meter resistance should be known so that it may be deducted in case it is necessary.

### Inconvenience of Division

It is not convenient to divide a voltage value by a current value every time a resistance measurement is made, especially when the current value is not a simple number. Therefore, it is desirable to arrange the circuit so that voltage may be adjusted every time so that the current is expressible in the simplest terms, that is, multiples or submultiples of 10. The resistance may then be obtained by simply reading the voltmeter as accurately as possible and then shifting the decimal point. It is this arrangement that Mr. Calcaterra has worked out.

At first we have a voltage source E, which may be any suitable battery, the voltage and current capacity depending on the sensitivity of the meters used on the ranges of resistances that are to be measured with the instrument. A switch S is connected in series with the battery for convenience in turning on and off the current.

Across the battery and the switch a potentiometer P is connected. By moving the slider (b) over the resistance of the potentiometer any portion of the voltage E may be obtained between the points (b) and (c). P1 might be called a course adjuster of the voltage.

Another potentiometer P2 is connected between the fixed point (c) and the moveable point (b), and the voltmeter V is connected between the fixed point (f) and the second moveable point (e). By sliding (e) any portion of the voltage drop in P2 may be impressed across the voltmeter V. The second potentiometer may be called a fine voltage adjuster.

### Selection of Meters

It is advisable to select a rather sensitive current meter so that only a small amount of current need be drawn from the battery and also so that high values of resistance may be measured. A suitable instrument is a milliammeter having a range of from 0 to 1. The one I used for the tests had an internal resistance of 88 ohms and is the one sold by Guaranty Radio Goods Company. I shall proceed on the assumption that a 0 to 1 milliammeter is used.

The kind of voltmeter to use is not very important, but it must be selected before the values of the potentiometers can be selected definitely. We proceed on the assumption that the voltmeter has a sensitivity of 200 ohms per volt so that the maximum current through it will be 5 milliamperes. This type of voltmeter is common and not expensive. It should have, preferably, several voltage ranges so that a greater range of resistance values may be measured.

With these limitations on the two meters we have limited the current to six milliamperes or less. This, however, does not mean that the current in P2 or in P1 is limited likewise. In order to obtain definite voltages a certain bleeder current must flow through P2 as a whole, and this current should be at least as large as the current shunted into the meters. Likewise there should be a bleeder current through P1 as a whole, which should be about equal to the current shunted into P2. There is much latitude, however, in the choice of resistances, because the essential thing is to get a voltage of the desired value across the meter V, and this can be obtained by many variations of the resistance values. The use of two potentiometers makes the circuit particularly flexible.

Ohm's law may be expressed $R = V/I$, in which V is the voltage reading on the voltmeter, I the current in amperes read on A, and R is the total resistance of Rx and the milliammeter. Suppose I always has the value .001 ampere, which is full-scale reading on the meter A. Then to get the resistance R it is only necessary to multiply the voltage reading V by 1,000 to get the value in ohms of the resistance. It is nearly always possible to adjust the voltage so that the current is exactly .001 ampere. In case it is not, it may be convenient to adjust it to .0001 ampere, in which case the voltmeter reading is multiplied by 10,000 to get the value of R. The reading will not be so accurate for the lower current as for the higher.

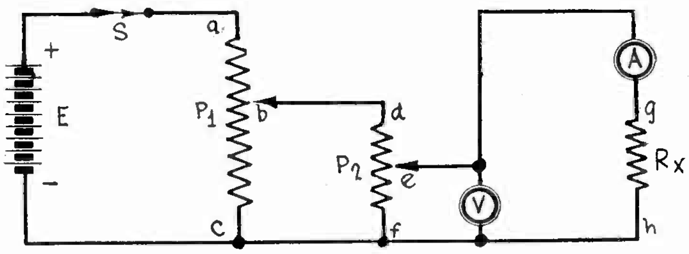



FIG. 1.
THE CIRCUIT ARRANGEMENT OF A SIMPLE AND CONVENIENT OHMMETER AS DEVELOPED BY JOSEPH CALCATERRA.

The range of the meter depends essentially on the range of the voltmeter V but it is clear that the range cannot be extended by merely increasing the range of the voltmeter. The voltage of the battery E must always be at least as great as the useable range of the voltmeter. For example, it will avail little to have a voltmeter that goes up to 150 volts if the voltage of E is limited to 6 volts.

### Method of Use

When using the instrument the first thing that should be attended to is placing the sliders of both potentiometers at zero, that is, at the points (c) and (f). This is to protect the delicate milliammeter. Then the unknown resistance Rx should be put into the circuit and after that the battery E should be connected. Then close the switch S, making the circuit ready.

Move the slider (b) a short distance from (c) and then move slider (e) very carefully, watching the deflection on the milliammeter A. Turn (e) until the reading on A is exactly full scale or until (e) comes to the top (d) of P2. If the current cannot be brought up to full scale with P2, return the slider of P2 to zero and move up that one on P1 a short distance. Then go back to P2 and try the adjustment again. Repeat if necessary.

When the current has been brought up to exactly full scale, that is, to .001 amperes, read the voltage on V as accurately as possible and multiply it with 1,000. The result is the total resistance in the milliammeter circuit. Subtract the resistance of the milliammeter to get the resistance of the unknown.

In case the resistance is so high that the current cannot be brought up to .001 ampere with the voltage that is available, it may be brought up to only .0001 ampere, in which case the voltage reading should be multiplied by 10,000 to get the total resistance.

### Limits of Measurements

Let us assume that the voltage of the source E is 6 volts, obtained with either a dry cell or a short battery. What range of resistance can be measured. The voltmeter should have a range of 0 to 6 or a higher range. Obviously, the potentiometers can be set so that the total voltage of the battery can be impressed across the voltmeter. Therefore, the highest reading may be 6 volts. Thus the highest resistance value that can be measured with the full-scale adjustment of the current is 6,000 ohms. With the one-tenth full scale adjustment the highest resistance would be 60,000 ohms.

The lowest value that can be measured is limited by the lowest voltage that may be read with accuracy. If the scale of the voltmeter is 0 to 10 volts it is certainly possible to measure to one-half volt. With the full-scale adjustment of the current this would make the lowest measurable resistance 500 ohms, and with the one-tenth scale adjustment it would be 5,000 ohms. The only way to measure lower resistance with the same current meter is to use a voltmeter which can be read more accurately than one-half volt. However, with a given voltmeter it is possible to measure lower resistance values by using a current meter less sensitive than a 0-1 milliammeter. If the milliammeter has a range of 0-100 milliamperes it is possible to measure resistance as low as 5 ohms, using the 0-10 voltmeter.

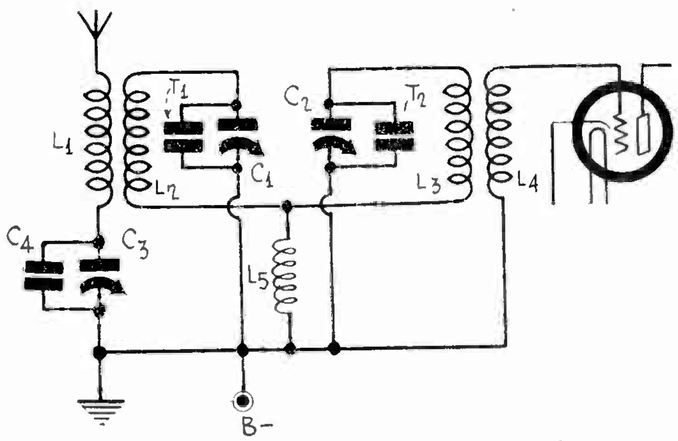
A suitable value for either of the potentiometer P1 and P2 is 5,000 ohms, which is a standard commercial unit. However, potentiometers of 1,000 or 10,000 ohms can be used also, as well as different intermediate values.

# Three Stages of Screen

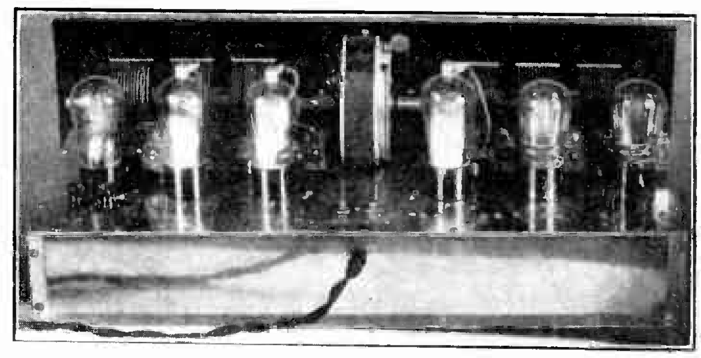
## Fourth Stage Developed Instability, Ove

*By Herm*

**Managi**




PROPOSED INPUT FOR THE CIRCUIT WHICH THE AUTHOR IS DEVELOPING. A SERIES CONDENSER, ONE OF THE TUNING GANG, IS PLACED IN THE GROUND LEAD, TO HAVE THE ANTENNA-GROUND COUPLING TO THE RECEIVER VARY INVERSELY AS THE FREQUENCY.



A NEW SET-UP FOR THE CHASSIS, SHOWING THE SIX TUNING CONDENSERS (A PAIR OF THREE-GANG .0005 MFD.) AND THE NATIONAL DRUM DIAL. THE SOCKETS ARE, LEFT TO RIGHT, DETECTOR, THIRD RF, SECOND RF, FIRST RF, FIRST AUDIO AND SECOND AUDIO.

MANY experiments were made with four stages of screen grid tuned radio frequency amplification, and while the amplification was tremendous, it became exceedingly difficult to make the receiver behave properly on the higher broadcast frequencies. The tendency toward squealing was hard to avoid.

It is always a good sign that a circuit should squeal at the higher frequencies, and this is the usual experience, but should it be quiet at the higher frequencies and obstreperous at the lower frequencies, there is considerable mistuning or othr loss-provoking condition, or a combination of many evils leading to the same general result—poor sensitivity and selectivity where these attributes are most needed.

So the number of tuned stages of amplification was reduced to three, and the stability that could be attained was far better, at high amplification, indeed was easily made altogether acceptable. It is true that the sensitivity was not as great, but, as has been pointed out, the prior height of the amplitude really rendered the receiver unworkable over the higher frequency part of the dial.

### Bias Effects

The bias on the radio frequency amplifying tubes can be altered to produce almost any result, even the attainment of stability in an otherwise ungovernable circuit, but the moment the bias is made more negative, for a given plate voltage, than a certain critical point, the amplification is as low as, or lower than, what would obtain with one fewer tube. So, while no definite course has been decided on, it begins to look as if we shall use three stages of screen grid tuned RF, instead of four, and as this offers us the opportunity to use a socket for some other purpose, it fits nicely into something we had in mind right along—the inclusion of a second stage of audio frequency amplification. Thus, simply by connecting up a 180-volt B eliminator, we will be able to work a speaker, although we still have the privilege of using the circuit ahead of a power amplifier.

With three stages of tuned RF, fed by a band pass pre-selector, and two stages of audio built into the chassis, I used the output to feed a power amplifier with a resistance-coupled stage and a transformer-coupled push-pull output. This worked very well, despite the poor load characteristic for the first 245. The tuner afforded 10 kc separation between stations of 50,000 microvolts per meter or less, and incidentally giving what we all desire, high gain on the low frequencies. The maximum volume, all told, was too much for the home, but one need not use all the volume possible. The volume control takes care of the reduction.

When you tune in a far-distant station you need as much amplication to get "local volume" as would be needed in an auditorium with a speech amplifier to serve 5,000 persons.

### WTAM Tuned Out, WBT Tuned in

The 10 kc separation was obtained experimentally between WTAM, Cleveland, then on 1070 kc, with a receiving antenna power of 125,000 microvolts per meter, and WBT, Charlotte, N. C., 1080 kc, 60,000 microvolts per meter. The trick was to tune out WTAM and tune in WBT without leaving WTAM, and this was done.

The rising characteristic of tuned RF was not compensated for in any way, but it is deemed a good idea to try to remedy this. In most receivers no attention is paid to the situation. The use of close shielding has a tendency to improve the condition, because the higher the frequency, the higher the losses, but still the self-regenerative vice of multi-tube circuits is stronger than the repression due to shielding.

Therefore it is proposed to use one of the sections of the gang tuning condenser at left to interrupt the ground lead on its way to the antenna winding. Then as the tuning condenser is actuated by the National dial, the section in series with the ground lead will increase input at the lower frequencies and reduce it at the higher frequencies. This change will be gradual, which is highly desirable. However, at lowest setting the coupling might be too loose, so it is proposed to put a fixed condenser in parallel with

# An Exposition of the

(*Concluded from page* 10)

The final subject of how sound waves move can be illustrated in many ways. It has been stated more or less indirectly throughout this series that sound is a wave motion. This is mainly true, but just as there are many kinds of waves, so it follows that sound waves are not similar in certain details to other forms of wave motion. To clarify opinion at this point, I want to state that I am still primarily concerned with the transmission of sound energy through air—and I am *not* confusing these statements with the known fact of the sine wave contour of sound impressions on phonograph records.

### Compression and Rarefaction

Sound energy is transmitted through air as an alternate series of compressions and rarefactions, the wave train from any continuously sounding source beginning with a compression first, then followed by a rarefaction, then another rarefaction, and so forth.

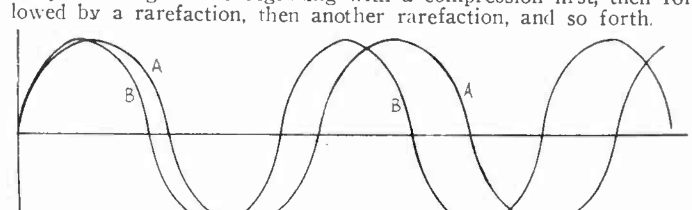



FIG. 6
TWO ORGAN TONE CURVES, SLIGHTLY OUT OF PHASE, PRODUCING BEATS.

# Grid RF Found Ample

## :come Only by Introducing Serious Losses

*ɪn Bernard*

**ɪg Editor**

the series condenser, say .00025 mfd. Then at maximum setting the series capacity will be .00075 mfd. While this is a simple arrangement indeed, I have never seen any mention of it.

The series condenser, C3 in Fig. 1, alters the degree of antenna-ground coupling, and the fixed condenser, C5, in parallel with it, performs the limiting function. This ought to work out in a most satisfactory manner. The intention is to try it in a few days, and report to readers in next week's issue, dated April 26th.

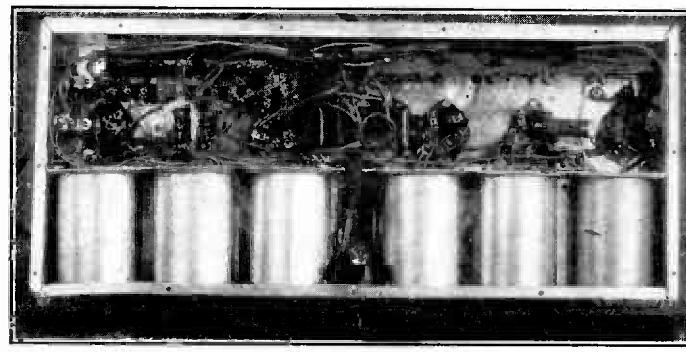
### Input Reduction

The band pass filter system has been retained, as shown in all previous diagrams, but the coupling to the first radio frequency amplifier is made inductive instead of conductive. The reason is that the receiver, with three stages of TRF, is so very sensitive that only a small degree of coupling is tolerable, therefore the reduction, it is expected, finally will be made in both places: at the antenna input by variation of a series condenser and at the first RF input by use of a step-down ratio between the second tuned circuit and the grid circuit.

The idea of using six tuned circuits has been under discussion since the March 29th issue, so this is the fourth time we have brought up the subject, and still we have not settled on a definite circuit. The final selection, however, will prove well worth duplication, and besides readers will become convinced that much time has been devoted to developmental and experimental work, and there is nothing like feeling that one is going into a tried and true proposition.

However, we may do a little prophesying. There will be three stages of tuned RF, using screen grid tubes, and tuned input to the detector, using a 227 tube, then a first stage of resistance coupled audio, with another 227 tube, and another such stage feeding a 245 tube as the output of the circuit. Yet this output need not be confined to the speaker. Two extra stages of audio may be used. It is highly inadvisable to use only one extra stage of audio. Either work the speaker from the six-tube design, or feed a two-stage amplifier. The reason is that three stages of audio amplification, where direct coupling is used, are unstable, and may produce a howl, whereas two stages are not subject to that particular vice, and four stages are not, either.

The idea of using four stages of AF may strike some as being somewhat forward, and indeed it is, but the DX hounds will appreciate hearing those far-off stations louder than they ever heard them before in their homes.



MORE SPACE HAS BEEN GAINED BETWEEN SHIELD CANS, UNDERNEATH. THE BYPASS CONDENSERS ARE ARRANGED IN FORMATION AGAINST THE REAR WALL OF THE CHASSIS, AT LEFT. THE CHASSIS USES THE REINFORCED METHOD OF CONSTRUCTION, A NEW FEATURE IN RADIO CHASSIS.

### Appearance is Improved

The two photographs reproduced herewith show that considerable improvement has been made in the appearance of the chassis. In fact, what you see depicted in an entirely new chassis, the third successive one. Two of the three were specially drilled by hand. The layout work and drilling of each takes about twelve hours. Then there's the wiring to do, and besides the constant shifting of connections and voltages as part of the electrical experimental work. If anybody wants a remedy for keeping out of mischief, I advise him to go ahead with some receiver design work, on the predetermined basis of having a finished product inside of six weeks that will be something to stir the keenest enthusiasm from radioists who know their science!

Some difficulty still is being experienced with killing off stray pickup. As has been stated in previous articles in this series, the objective is to make it impossible to bring in any stations unless an aerial is connected to the antenna post, even if it is only an 18-inch aerial. The chassis is metal, and it would seem that an adequate shielding effect would be produced, to protect the wire leads below from serving as tiny antennas, but after earnest efforts have failed to kill off all stray pickup, one is tempted to recall that the sockets require 1⅛" diameter holes, and there are six sockets, so there is your sieve, even if you block up the bottom with a metal undercover.

### What Will Be Tried

So a device will be worked. The sockets will be submerged, the tubes will be inserted through holes in the chassis top to reach the sockets, and individual shields for the tubes will be used. This is not mechanically difficult, or impractical except perhaps as to the output tube, if a 245, as commercial tube shields are not large enough to cope with that power tube. However, if we plug up five holes out of six we expect to improve still more a condition that already has been brought almost to the point of solution. As the chassis and circuit now stand, stray pickup is less than one-tenth of what it was when we started.

The object of avoiding stray pickup is to improve selectivity, as any pickup directly by a subsequent stage is without benefit of tuning by antecedent stages.

Much stray pick-up can be attributed to exposed leads on top of the receiver, leads that cannot very well be shielded completely without shielding the entire assembly. For example, the leads to control-grid caps from the coils and condensers. It is customary to run these leads through shielded and grounded conduit. Even when this is done the end of the lead and the cap on the tube itself are exposed. Therefore, with otherwise thorough shielding, there is ample room for signals to creep into the amplifier where they are not supposed to get in. Such stray pick-up is no detriment in an insensitive and non-selective receiver but in a very sensitive receiver it is most unwelcome as it leaves the set without a sufficient volume control and also with a low selectivity.

# Phenomena of Sound

In other words, the air particles next to the sounding body are compressed in a direction radially outward from the axis of the sounding body—but air is elastic and these air particles begin to push apart but meet the resistance offered by the surface of the sounding body and are reflected in the direction of their original start, this compression is then passed along to the next aggregation of air particles, where the above process is partially repeated and by this pass-it-along system the compression finally negotiates the distance intervening between the sound source and the ear—the rest is understood from what has been previously written in the early paragraphs.

The relation between the compression-rarefaction sound wave motion and its sine wave counterpart will be given in the next article—as it is a more advanced discussion and is treated separately—under acoustic measurements and comparisons of dynamic speakers.

Fig. 7 shows an organtone and its second harmonics. The nodes and loops can be easily counted.

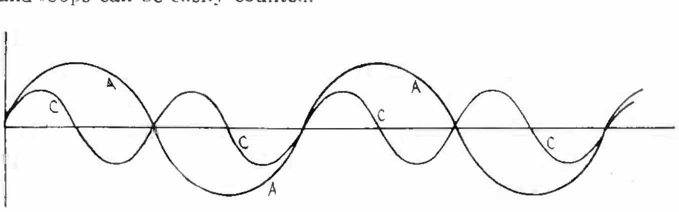



FIG. 7
AN ORGAN TONE AND ITS SECOND HARMONIC. COUNT THE NODES AND LOOPS.

# Resolved, That Transfor

## AFFIRMATIVE

*By Thomas J. Melville*

THE transformer coupled audio amplifier has always been the most popular in the radio industry. There is scarcely a single manufacturer who has put out a receiver with any other form of amplification. Does this popularity mean that transformer coupling is better than any other kind of coupling? Or do the manufacturers, as well as the majority of amateur and custom-set builders, select this form of amplification for any other reason than excellence?

We may compare the transformer coupled amplifier with other types on many different bases, and if it is to win out in the competition it must score a decided victory in at least a majority of the tests that are applied. We shall examine the merits of the transformer coupled amplifier on quality of performance, economy of operation, initial cost, reliability in service, and economy of space.

### Tone Quality

Tone quality is by far the most important consideration in rating the value of an amplifier. On this point does the transformer coupled circuit score highly when compared with other forms of amplification, such as impedance, resistance, and straight non-reactive coupling? Theoretically, the transformer coupled circuit is the lowest in the scale, and it rates far below the resistance and non-reactive amplifiers. This is not an admission that the transformer coupled circuit is inferior in point of quality of tone output; it is a statement of a theoretical fact. But just how closely do theory and practice in this case agree? In most instances they deviate so greatly that when it comes to a measurement of the quality the transformer coupled circuit easily comes out in the lead, not by just a little bit, but by a long way.

What are the factors entering into the problem that so militate against the theoretically superior amplifiers and put the transformer circuit in the front rank? Stray interstage coupling for one thing and lack of practical and suitable voltages supply for another. The resistance and non-reactive amplifiers, and the impedance coupled amplifier to a less extent, are supposed to give equal amplification over the entire audio frequency scale, thus insuring high quality. And they would if the voltage supply were perfect and if the grids could be kept at the proper negative potentials. These conditions are impossible of fulfillment and therefore these amplifiers do not give as good quality as they are supposed to do.

In this connection it may be argued that the transformer coupled circuit is subject to the same difficulties. That is true, but in a negligible degree. Due to the fact that the DC resistance of the secondary of the coupling transformer is comparatively small the grids can be maintained at exactly the desired potential and also because the signal voltage drop in the plate supply is not directly applied to the grid of the succeeding tube there is practically not adverse effect on the amplification. It is comparatively simple to treat the voltage supply so that any feed back will be negligible.

The transformer coupled amplifier may not give an absolutely equal response over the entire scale but then there is no excessive building up of the amplification on certain notes as there is in the case of other amplifiers. Moreover, the little feed back that does exist usually builds up the amplification just where the transformer is deficient, that is, on the low notes. Here is a case where two vices neutralize each other to produce a desirable effect.

### Good Transformers Available

In selecting audio frequency transformers it is not necessary to select those that give poor quality. There are many transformers, not especially expensive, that give practically as good quality in fact as theoretically better couplers do. Naturally, one would choose the best audio transformers that can be obtained for the money that one cannot afford to spend, stretching it a little if necessary.

With transformer coupling one has the advantage of using push-pull in two or more stages. Some may counter with the statement that there is no advantage in push-pull because it is easily demonstrated that just as much volume can be obtained with single-sided amplifiers. Take out one tube in a push-pull stage and the circuit works just as well and just as loud. When anybody feels that way about push-pull there is not reason at all for using it for a large amount of harmonic distortion may be present without making any difference. However, there are those who have keener ears. It should be remembered that the object of push-pull is not to increase the amplification but to improve the quality on high output volumes. Push-pull is very much worth while and it is only obtainable with transformer coupling. Push-pull insures against overloading on fortissimo and gives a sense of security against the unpleasant consequences.

Transformer coupled circuits, for equal output volumes, are less expensive to maintain. There are fewer tubes which take less filament and plate current. Hence a given number of amplifier tubes will last longer and the rectifier tube will also last a longer time. The reduced current consumption is a considerable item saved in the monthly electric bill.

### Cheaper to Operate

Not only does it cost less to maintain, but it also costs less to buy in the first instance. Money is saved because for a given amplification fewer tubes and couplers are needed. Since fewer parts are needed, less room need be provided for the receiver, and this saves in cost of material.

It may be argued that transformers cost more than resistance couplers, and in one sense they do. A resistance coupler includes two resistors with a mounting and one stopping condenser. Taking the cost of these into consideration and comparing it with the cost of a good transformer, there is some difference. But there are extra parts to a resistance coupler that must be considered. Frequently many and large by-pass condensers must be used to make the resistance coupled circuit operative at all, and sometimes choke coils are needed in each plate circuit. While these are also desirable in transformer coupled circuits, they are not absolutely necessary, and when they are used they need not be so expensive. The greatest saving is possibly in the B supply. A good transformer amplifier will work well on a mediocre supply, but a resistance coupled amplifier will not work at all on such a voltage supply. On a first-rate and expensive B supply the transformer coupled circuit will work excellently and a resistance coupled amplifier will only work tolerably well.

### Non-reactive Amplifiers

The non-reactive coupler is less expensive than any audio transformer, but in this case the cost is transferred from one part of the circuit to another. The voltage supply must be designed for higher voltage, requiring by-pass condenser of higher voltage rating. The cost of condensers goes up rapidly as the voltage rating goes up. So even when the transformer coupled circuit is compared with the least expensive of the other types, it does not suffer by the comparison.

And how does the quality of the output of a transformer circuit compare with that of the non-reactive? The difference is so small that only one specially trained can tell one from the other. And those that can are able to pick out the flaws in the quality from the non-reactive circuit. And this circuit has them notwithstanding its reputation.

### Reliability in Service

In respect to reliability in service the transformer coupled amplifier ranks first. This may be the principal reason why receiver manufacturers almost invariably have selected this form. It is rarely that a transformer breaks in service unless it is abused with excessive voltages, and almost all transformers are wound with insulation which will stand several times the voltage that will be used in the circuit.

Resistance coupled and similar circuits are notoriously unreliable in service. Resistors break down at frequent intervals. If it is the plate coupling resistor that breaks down the circuit goes dead. If the grid leak breaks down distortion sets in, or the circuit again goes dead. Stopping condensers also breaks down frequently, either completely or partly. If the break-down is complete the circuit stops working and if the break-down is partial distortion sets in. The grid of the tube following the coupler goes positive, the plate current goes up, the voltage down, and the signals become mushy, if they come through at all. This trouble is periodic and often the frequency is disconcertingly great.

Another difficulty to which resistance coupled circuits is subject is leakage between the plate and the grid of an amplifier tube. This increases in moist weather and with dust that settles on the socket and on the coupler mounting. This leakage results in distortion of the signals and may even stop the operation completely.

### Economy of Space

While a resistance coupler takes less space than any audio frequency transformer the space required by the coupler alone is not the determining factor. The resistance coupled circuit requires much larger by-pass condensers, and many more of them, than the audio circuit. Hence the space saved in the coupler is more than taken up by the extra equipment in the B supply.

The transformer coupled amplifier wins on every point taken up, except the trivial one of theoretical tone quality. Since it is only the actual tone quality that counts, we are justified in saying that it wins on all points. The engineers of the many receiver manufacturers throughout the world must have reached this conclusion, since they have selected this form of coupling in nearly all instances. And fans who have tried both types of circuit have settled down on transformer coupling, so they, too, must be convinced of its superiority.

# mer-Coupled Audio Is Best

**NEGATIVE**

*By Wilbur A. Wells*

THE relative merits of various types of audio amplifiers have been discussed so many times that they are well known. There is little to add which would alter set opinions, but there is no harm in repeating some of the arguments for those who have not yet formed unalterable opinions.

One of the arguments in favor of transformer coupled amplifiers is that the vast majority of receivers uses this form of coupling and that nearly all manufacturers avoid all other forms of coupling. As an argument this is entirely worthless. One might as well attempt to prove that sand is more valuable than diamonds by stating that there is more sand in the world than diamonds, or that Fords are better cars than Lincolns because they are many more of them.

Receiver manufacturers have the happy faculty of turning out receivers that can be sold in the largest number and that will give the least trouble after they have been sold. This statement admits that in respect to reliability in service in the hands of inexperienced persons the transformer coupled amplifier is superior. It admits that the transformer coupled amplifier is as nearly foolproof as an amplifier can be made at a cost that comes within the limits of most people.

### Question of Quality

The one characteristic on which an amplifier should be judged more than on any other is tone quality. How does a transformer coupled circuit rate on this point in comparison with circuits employing resistance and non-reactive coupling? It does not rate, it is not in the running at all. In the first place, it does not amplify the high audio notes well, for it has a rather sharp cut-off. In the second place, it does not amplify the low notes well, for it has also a sharp low-note cut-off. In the third place, it amplifies too well as some intermediate frequency, where the gain is sharply augmented by resonance.

Resistance coupled amplifiers, on the other hand, whether they be of the standard type or the strictly non-reactive, amplify all audio frequencies to the same degree. It is true that if they have not been designed properly there may be a fall in the gain on the high notes, and again on the low, but this defect cannot be attributed to the system. It is a fault of the designer. It costs no more to design and build one of them correctly than incorrectly. And when the design is right there is no appreciable variation in the response over the audio range. In the case of the non-reactive amplifiers the gain is exceptionally uniform from zero frequency to the upper limit of hearing. No transformer coupled circuit, however expensive transformers are used, will equal this performance.

Do these resistance and non-reactive amplifiers perform as well in actual reception as they will in theory or under laboratory conditions? Surely. There is a very close correspondence between theory and practice and the actual performance can be predicted with great accuracy.

### Wave Form Distortion

Frequently it is said in favor of transformer coupled amplifiers that there is less wave form distortion in them than in other types of amplifiers. How about it? Tubes, which do the amplifying have the same characteristics when used in one form as another. Each tube introduces a certain amount of distortion of this form in all types of amplifiers. But when the load on a tube is a high impedance the characteristic is nearly straight and the distortion negligible. Now, in resistance coupled and non-reactive amplifiers the load impedance is higher than it ever is in transformer coupled circuit. Hence the wave form will be better in these amplifiers than in transformer circuits.

In addition to the greater wave form distortion due to a lower load impedance there is the wave form distortion introduced by the saturation of the transformer core. Resistance coupled amplifiers are entirely free from this trouble.

Transformer coupled circuits may be arranged in push-pull for the purpose of balancing out some of the harmonic distortion that is introduced by curvature. Resistance and non-reactive amplifiers cannot readily be put into this form. However, if an even number of stages is used the effect in bucking output hum is similar, and this not only bucks out the even order harmonics but all harmonics, whereas the push-pull only balances out the even. Although the transformer coupled circuit seems to have an advantage in the degree of harmonic elimination the appearance is not based on fact. When the transformer coupled circuit has been designed as well as it may in practice, and made push-pull throughout, the harmonic content in the output of the resistance coupled circuit is still less than that in the transformer circuit.

One argument that has always been advanced in favor of transformer coupled circuits is that the same amplification can be obtained with fewer tubes. This used to be a fact when there was only one tube, and that designed for transformer circuits. Now several tubes are available by which a greater amplification may be obtained in resistance coupled circuits than in transformer circuits. For example, in DC circuits we can choose 240 or 222 type tubes and in AC circuits we have the 224 screen grid tube and the new pentode. In suitable, and practical, resistance coupled circuits these tubes amplify tremendously.

Space is an item that should not be forgotten in building circuits. The resistance coupled amplifiers take so little room that it is almost entirely determined by the tubes used. The couplers can be tucked away in nooks and corners. Transformers, on the other hand, take up space of major magnitude. It might be argued that whatever space is saved in the amplifier proper is more than taken up in the B supply, which admittedly should be better for the resistance coupled circuits.

This, however, is offset by the fact that the resistance coupled circuits take much less current so that both the choke coils and the by-pass condensers in the filter are much more effective. Practically there is no difference between a B supply of given filtering ability suitable for resistance coupled circuits and one suitable for first class transformer coupled circuits.

In point of cost the resistance and non-reactive amplifiers are so far in the lead that a comparison is hardly possible. A resistance coupler might cost one dollar while a transformer of really good quality might cost ten to fifteen times more.

### Reliability in Service

Break-downs of couplers frequently occur, but no more frequently in resistance coupled circuits than in transformer circuits. One thing that causes break-down in resistance couplers is excessive current through the resistors . If the resistance units are metalized or wound with wire they will last indefinitely, and only these kinds of resistors should be used. They don't cost much more than the cheap resistors that break down recurrently.

Transformers break down, too, and quite frequently. Who has not heard of burned-out transformers? Actually they seldom burn out, but the insulation in them is punctured by excessive voltage surges. This cannot happen to resistance units. Break-down of a transformer may happen when a tube is removed from a socket while the power is on, when the plate voltage is removed before the filament circuit is opened, or it may happen when the signal suddenly forces the grids negative. By signal is here meant any radio frequency voltage that is impressed on the grids, including static. Voltage as high as 2,000 volts may be induced in the secondary winding of a transformer by surges, and the insulation usually is not designed for more than 500 volts.

One of the things that causes failure of resistance coupled amplifiers is excessive leakage from the positively charged conductors to the grids, for example, from the plates. This, however, does not happen if the resistor mountings and the tube sockets are made of good insulating material and when the stopping condensers have high insulation resistances. Neither is a small amount of leakage detrimental if the grid leak resistance is not excessive. When a resistance coupled amplifier fails because of leakage where there should be none, or because of insufficient leakage where there should be some, the fault is not with the type of circuit but rather with the choice of parts.

Non-reactive amplifiers of the Loftin-White type are not subject to this trouble at all provided the leakage is constant. And it is in practically all insulators. If there is a constant leakage it is only necessary to make a slight readjustment in the voltages applied.

### Motorboating in Circuit

It is often argued that only resistance coupled amplifiers are subject to motorboating, or oscillation due to feed back through the B supply. This argument is fallacious because the effect of feed back through the B supply was first discovered in transformer coupled circuits. Sometimes the effect was a serious distortion or blasting on certain notes, and at other times it was a violent oscillation. Because the oscillation occurred at rather high audio frequencies it was simply called squealing. The first audio transformers used were not efficient enough on the low audio notes to make oscillation possible, but when transformers were improved so that they were effective at frequencies below 100 cycles per second the oscillation occurred at lower frequencies. Then the trouble was called howling. If an audio transformer is good enough the transformer coupled circuit will misbehave just as a resistance coupled amplifier may do.

Remedies for oscillation, whether it is called howling or motorboating, are the same for both circuits. The only reason greater precautions have to be taken with resistance coupling is that this form is more effective at the low notes.

It is necessary to conclude that resistance coupled circuits are superior to transformer coupled circuits because they give better quality, cost less, are just as reliable in service, if not more so, and they take less to operate.

# A 4-Tube AC DX Receiver

## A Compact Receiver of High Sensitivity and Selectivity

*By Jack Tully*

IN THE MARCH 29th issue of RADIO WORLD I described a four-tube receiver for battery operation, utilizing the DC screen grid tubes. Since the publication of that article many requests have been received for the AC counterpart of the same circuit, utilizing the 224 tubes in the first two stages.

One of the objects of the DC circuits was to provide a light receiver for camping and motoring, for which it was especially suitable. It is understood that the AC circuit cannot be applied to this service since it must always be used where alternating current is available.

The schematic diagram of the AC circuit is shown herewith. By comparing this diagram with that given in the previous article it will be observed that the two represent the same circuit and that the changes and additions to the present circuit are those made necessary by the AC adaptation. AC sets are nearly always a little more complex than the corresponding DC sets, and for that reason the present circuit contains more condensers and other parts.

The layout of the AC circuit is the same as that of the battery circuit although slightly more room should be provided on the subpanel for the extra condensers. In the battery set the volume is controlled in part with the 30-ohm rheostat in the negative leg of the filament circuit of the first tube. In the AC circuit it is controlled in part with the potentiometer P1. These parts require approximately the same space, and since they are used for the same purpose, they would occupy the same position in the set. In the DC circuit are four filament ballast resistors, but in the AC circuit are only two bias resistors. Since the bias resistors take about the same room as the ballast resistors the space occupied by two ballasts is saved and may be utilized for a couple of the extra condensers.

### Type of Tuner

There are two independently tuned circuits which give satisfactory selectivity especially in view of the fact that the second tuner may be sharpened with the regeneration control. It is a fact that, with careful tuning of two independent circuits, as good selectivity may be obtained as with several tuners in tandem controlled with the same knob.

The capacity of the variable tuning condensers is .00035 mfd. LoL1 is a standard antenna coil for .00035 mfd. condenser and L2L3 is a similar coil on which the tickler L3 winding has a few more turns than the primary of the antenna coupler. A regular three circuit tuner may be used in this position provided the usual primary winding be left unconnected.

The tuned impedance L2C2 couples the screen grid tube to the detector very effectively, the regeneration increasing both the value of the coupling impedance and the selectivity of the circuit. The tickler is fixed, or if variable, may be left in a given position, while the degree of regeneration is controlled by the 50 mfd. midget condenser C6. Note that one side of this condenser is grounded so that there will be no body capacity effects.

Resistor R1 should have a value of 300 ohms; the condenser C4 across it not less than .01 mfd. The bias for the two audio tubes is obtained from a drop in the potentiometer P2. The total resistance of this unit should be 1,500 ohms, and it should be provided with one slider for the return of the cathode lead of the 227 amplifier. The bias on the 227 is the drop in that portion of P2 which is between ground and the tap. This portion is by-passed with a condenser C9 of not less than 2 mfd. Then entire P2 is by-passed by C11, which should be not less than 2 mfd. C5 and C7 should have values of .01 and 2 mfd., respectively.

Potentiometer P1 should have a value of 25,000 ohms, and it should be connected across a voltage of from 50 to 75 volts.

### Space Charge Grid

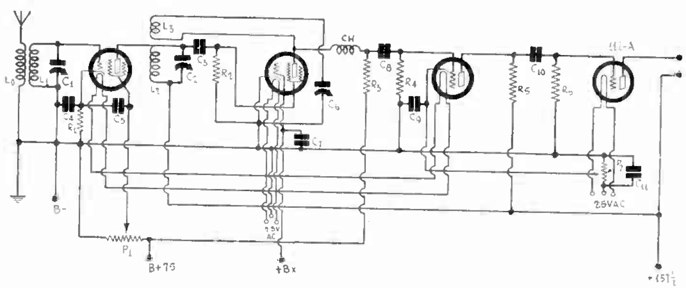
The inner grid (cap on tube) of the space charge detector should be connected to a positive voltage between 22 and 30 volts. The terminal is marked Bx to indicate that the voltage which gives best detection should be found by trial.

The remaining parts should have the following values: C3, .00025 mfd.; C8, C9, each .01 mfd.; R2, 2 megohms; R3, .5 megohm; R5, 100,000 ohms; R4, one megohm, and R6, one-half or one megohm.

The power tube is a 112A and for that reason it is not necessary to use any filtering device in its plate circuit. Any magnetic speaker may be connected directly to the output terminals, which include inductors, and since nearly all dynamic speakers have output transformers built-in, they, too, may be connected to the circuit without any other filtering device.

The choke coil Ch in the plate circuit of the detector is not critical but it should not be larger than 85 millihenries nor smaller than five. There are many commercial coils available which are suitable for this purpose.

The plate voltage on all tubes except the detector is 157½ volts.




FOR SIMPLICITY, COMPACTNESS, QUALITY, SENSITIVITY AND SELECTIVITY, THIS FOUR-TUBE GRID RECEIVER IS HARD TO BEAT.

This, of course, is nominal. It may be raised or lowered as desired provided that it is not increased beyond 180 volts, since the output tube will not stand much more than this. The voltage provided for the detector plate is the same as that applied across the potentiometer P1. A lower voltage should be tried since the detector sometimes works more efficiently on voltages as low as 50 volts.

### Filament Supply

The filament transformer should have two low-voltage windings, one of 2.5 volts, center-tapped, and capable of supplying 5.25 amperes, and another of 5 volts, also center-tapped, capable of supplying one-quarter ampere.

In view of the fact that the audio amplifier in this circuit is resistance coupled a well-filtered B supply should be used in order to prevent oscillation or distortion on the low audio notes. It is especially important that the condenser from the 157½ volt terminals to ground be very large. An electrolytic condenser is recommended, although a dry condenser of 8 microfarads should be sufficient. In the event that motorboating should set in at some low frequency it may usually be stopped by using lower values for the resistors R4 and R6, or for either of them.

In case a potentiometer of 1,500 ohms cannot be found for P2 one can be made with a 2,000 ohm wire wound resistor having metal bands for making connections. An extra band should be provided for the tap. Such resistors are standard equipment and can be obtained in all radio stores. To adjust the resistance it is only necessary to move one of the bands. The proper voltage for the bias on the 227 is also obtained by moving the band to which the cathode is connected. The right value can be found by trial, listening for quality of output, as well as for volume.

### LIST OF PARTS

**L0L1—One antenna coupler for .00035 mfd. condenser.**
**L2L3—One three circuit tuner (primary not tuned) for .00035 mfd.**
**C1, C2—Two .00035 mfd. tuning condensers.**
**C3—One .00025 mfd. grid condenser, without clips for grid leak.**
**C4, C5, C8, C10—Four .01 mfd. condensers.**
**C6—One 50 mmfd. midget variable condenser.**
**C7, C9, C11—Three 2 mfd. or larger condensers.**
**R1—One 300 ohm grid bias resistor.**
**R2—One 2 megohm grid leak with mounting.**
**R3—One .5 megohm resistor with mounting.**
**R4—One one megohm grid leak with mounting.**
**R5—One 100,000 ohm resistor with mounting.**
**R6—One one-half to one megohm resistor (use lower value of circuit motorboats) with mounting.**
**P1—One 25,000 ohm potentiometer.**
**P2—One 1,500 ohm potentiometer.**
**Ch—One 65 millihenry choke coil.**
**Three five-prong sockets.**
**One four-prong socket.**
**One filament transformer with one 2.5 volt, 5.25 ampere or more winding and one 5 volt, quarter ampere winding, both center-tapped.**
**Two 224 type screen grid tubes.**
**One 227 type amplifier tube.**
**One 112A power tube.**

# 26 STATIONS GO ON NEW WAVES; IN EFFECT MAY 1

Washington

Changes in the assignments of twenty-six broadcasting stations operating on cleared channels, seventeen of them licensed for evening operation with high power, were ordered by the Federal Radio Commission to become effective May 1st.

Representing the most sweeping revision of station assignments since the general reallocation in November, 1928, the changes were ordered with a view of eliminating interference between stations operating on the same channels. It was explained at the time changes were proposed in February that the stations were not to be affected in regard to power or hours, but only as to channel assignments.

The changes for clear channel stations:

| Station Location | Present kc | New kc |
|---|---|---|
| WAPI—Birmingham, Ala. | 1140 | 1130 |
| WBT—Charlotte, N. C. | 1080 | 1040 |
| WCAU—Philadelphia, Pa. | 1170 | 820 |
| WHAM—Rochester, N. Y. | 1150 | 1160 |
| WHAS—Louisville, K. | 820 | 1020 |
| WTAM—Cleveland, Ohio | 1070 | 1080 |
| WOWO—Fort Wayne, Ind. | 1160 | 1180 |
| WRVA—Richmond, Va. | 1110 | 1150 |
| WWVA—Wheeling, W. Va. | 1160 | 1180 |
| KEX—Portland, Oregon | 1180 | 1170 |
| KMOX—St. Louis, Mo. | 1090 | 1110 |
| KOB—New Mexico, N. M. | 1180 | 1170 |
| KRLD—Dallas, Texas | 1040 | 1070 |
| KSL—Salt Lake City, Utah | 1130 | 1190 |
| KTHS—Hot Springs, Ark. | 1040 | 1070 |
| KVOO—Tulsa, Okla. | 1140 | 1130 |
| KYW—Chicago, Ill. | 1020 | 1140 |

Changes in frequency of limited time stations:

| Station Location | Present kc | New kc |
|---|---|---|
| WCAZ—Carthage, Ill. | 1070 | no change |
| WCBD—Zion, Ill. | 1080 | 1040 |
| WDGY—Minneapolis | 1180 | 1170 |
| WDZ—Tuscola, Ill. | 1070 | no change |
| WHDI—Minneapolis | 1180 | 1170 |
| WJJD—Mooseheart, Ill. | 1130 | 1090 |
| WKAR—East Lansing, Mich. | 1040 | 830 |
| WKEN—Grand Island, N. Y. | 1040 | 1060 |
| WMBI—Addison, Ill. | 1080 | 1040 |
| KSOO—Sioux Falls, S. Dak. | 1110 | 1100 |
| KTNT—Muscatine, Ia. | 1170 | 1160 |

The inclusion of WCAZ and WDZ in the above list, despite absence of change, is due to previous consideration of changes of their frequencies having received publicity.

## Minnesota Seeks Radio Police Permit

St. Paul, Minn.

The State of Minnesota will apply to the Federal Radio Commission for a channel for a State-operated radio station to be used for criminal apprehension work, according to an announcement by Governor Theodore Christianson.

The object of filing the application at this time is to place Minnesota at the top of the list of States applying for channels for this kind of service. If the next Legislature sees fit to provide funds for such a station, the Governor said, with the Radio Commission's consent Minnesota would be able to proceed at once.

## The Recurring 65

### *Radio World's Good Friends Celebrate*

THROUGH the medium of a beautifully produced book entitled "Covering the Continent," Harry Gould, President of The American News Company, Inc., calls our attention to the fact that his big organization has reached its 65th year in the distribution of periodicals.

RADIO WORLD has been handled from its first issue by The American News Company and its 165 branches and sub-branches. This distribution service has been, as a whole, as nearly perfect as anything in the business world could be. This big news distributing concern has distributed many millions of copies of RADIO WORLD and there never has arisen a dispute of any kind, for the simple reason that The American News Company is always ready and anxious to serve publishers to the best of its ability—and that ability is of the highest order.

The publishers of RADIO WORLD have received many tempting offers to change its method of distribution. We have not bitten at this bait, often cleverly disguised as something worth while. RADIO WORLD is satisfied with The American News Company and The American News Company seems to be satisfied with RADIO WORLD. This leads to the best possible kind of a pleasant and intimate business relationship, and one that we should not think of changing in any direction or degree.

Therefore, those of you who purchase RADIO WORLD at a news-stand in Boston, in Portland, Me., New Orleans, La., Portland, Ore., or Vancouver, B. C.—yes, even in Australia, England and countries on the Continent—should know that our world-wide distribution is due to the efficiency, friendship and zeal of The American News Company, Inc., and its 165 branches and 65,000 dealers. This service includes the valuable asset of 2,200 railroad station stands controlled by The Union News Company and the foreign activities of The International News Company.

The writer has been connected with the newspaper and publishing business since he was a youngster and during the greater part of the intervening period he has been fully aware and appreciative of the warm friendship of The American News Company and the intelligent assistance rendered. Experience has shown that the same fine treatment has been accorded other publishers who have consistently stuck to The American News Company through its years of success and progress, in which the publishers themselves have shared in so large a degree.

Our best congratulations to President Harry Gould and his loyal associates in all branches of The American News Company, and may we all sit around the same table of good will when that concern celebrates its 75th anniversary which, after all, really is only just around the corner.

ROLAND BURKE HENNESSY.

## New Corporations

Radio Dealers Association of America, Inc., Brooklyn, N. Y., books relating to radio industry—Corporation Trust Company of America, Wilmington, Del.

Mel's Radio Sales and Service, Liberty, N. Y.—Atty. Lounsberry, Ellenville.

R.C.A. Victor Co. of China, New York, N. Y., record, reproduce, transmit sounds—U. S. Corp. Co., Dover, Del.

Vogue Radio Corp., Dover, Del., radio, wireless, television—United States Corporation Company.

Sight and Sound Corp., Wilmington, Del., moving pictures—Corporation Trust Co.

Radio Systems, Inc., Montclair, N. J., radios, wireless—Corporation Trust Company of America.

Adams Radio Stores, Brooklyn—Atty. L. D. Schwartz, 150 Nassau St., New York, N. Y.

Radio Wholesalers Corp.—Attys. Zalkin & Cohen, 49 Chambers St., New York, N. Y.

Author's Motion Picture and Radio Bureau—Attys. Reynolds & Goodwin, 36 West 44th St., New York, N. Y.

# BOARD ADOPTS NEW CODE FOR THE AMATEURS

Washington.

New regulation recommended to the Federal Radio Commission by a committee representing the legal and engineering divisions of the Commission, and delegates of the American Radio Relay League providing more stringent technical requirements for amateur stations, as well as safeguards to amateurs, were adopted by the Commission.

Due to the requirement of the use of modern transmitting equipment, it was pointed out that interference due to undamped waves, such as are produced by spark transmitter circuits would be eliminated. An additional provision is that if interference is complained of the amateur station involved must cease operation, for the time being, and in particular during certain evening hours, and at other times also, when requested to do so.

Also, in the event that an amateur station causes interference with regular broadcast stations it shall cease operation between the hours of 8 p. m. and 10:30 p. m. daily, and on Sundays between 10.30 a. m. and 1 p. m., local time.

The chief of the radio division of the Department of Commerce, William D. Terrell, presided at a conference, at which the new recommendations were made.

Frequencies are grouped and assigned in the following section:

Section IV. Assignment of bands of frequencies:

"(a) The following bands of frequencies are assigned exclusively to amateur stations: 1,715 to 2,000 kc.; 3,500 to 4,000 kc.; 7,000 to 7,300 kc.; 14,000 to 14,400 kc.; 28,000 to 30,000 kc.; 56,000 to 60,000 kc.; 400,000 to 401,000 kc.

"(b) All bands of frequencies so assigned may be used for continuous wave telegraphy.

"(c) The following bands of frequencies may also be used for radio telephony: 1,715 to 2,000 kc.; 3,500 to 3,550 kc.; 56,000 to 60,000 kc.

"(d) Upon application, amateurs who hold operators' licenses from the Secretary of Commerce of the extra first-class amateur grade, or higher, or who show special technical qualifications, satisfactory to the licensing authority, will also be licensed for radio telephony in the band of frequencies: 14,100 to 14,300 kc.

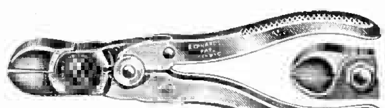
"(e) The following bands of frequencies may also be used for television; facsimile and picture transmission: 1,715 to 2,000 kc.; 56,000 to 60,000 kc.

"(f) Licenses to individual amateur stations shall permit the use of all frequencies within the service bands above assigned which the licensee may be entitled to use and shall not specify individual frequencies."

## Radio Kills Insects

A device for ridding orchards of obnoxious fruit insects and also for aiding plant growth by means of radio waves has been perfected by a Washington inventor. An operating license for the device was granted recently by the Federal Radio Commission. The operating frequency was not specified by the Commission. It is said that the device has proved successful in experimental test, using various radio frequencies.

## Spring Action Diagonal Nipper



A DIAGONAL cutting nipper is the second most useful tool for radio work, next to the soldering iron. Non friction spring action adds convenience of use, as the handles are sprung back just far enough for a comfortable grip, and the jaws are closed by easy pressure or the handles.

For cutting wire, a constant operation in your work, this tool is most serviceable, as it makes a clean cut, right through fuzzy insulation as well as through metal. The cut is far more incisive than with the common diagonal cutting pliers. With the diagonal nipper you can cut wire not only along its length, but wherever it may be attached, since accessibility is perfect. A cut can be made any place where the diagonal nipper can enter, since the cutting can be done at the tip. Pliers with diagonal cutters can only ply, not cut, at the extremity.

With the diagonal nipper insulation can be bared from wire ends for soldering. Also screws up to 8/32 machine screw used in radio can be nipped off at any point with one firm application of pressure with one hand.

The device is used extensively in radio set factories and by custom set builders and radio experimenters.

Size 5½" long; weight 1⅝ lbs.; material, drop forged steel; finish, nickel plated.

Send $3.00 for 6 months' subscription for Radio World and ask for No. 177 Nipper, free. RADIO WORLD, 145 West 45th Street, New York, N. Y.

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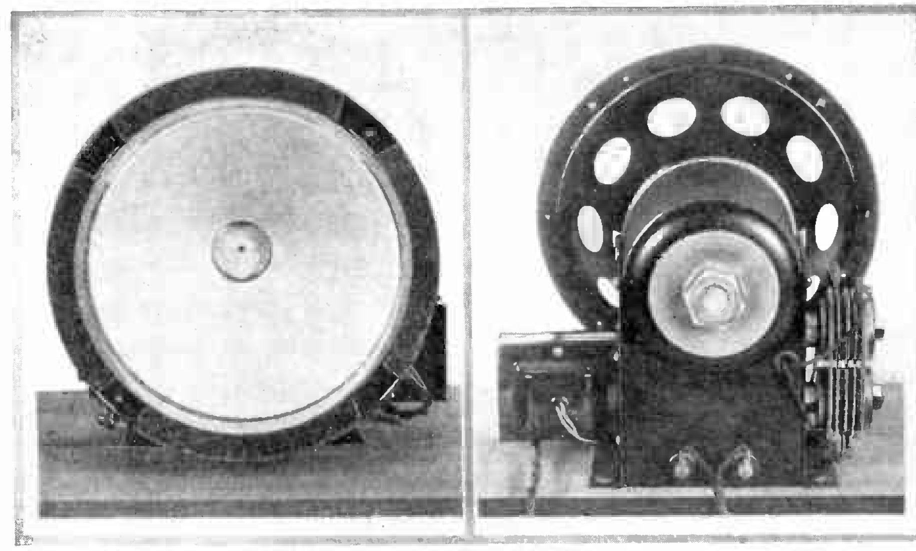

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*TO WORK this speaker, put plug into AC wall socket, lamp socket or convenience outlet of set, connect speaker tips to output posts of set, and tune in.*

Here are the technical data on the AC dynamic Erla:
10 feet long power leads with plug
10 feet long speaker leads with one-inch terminal tips
Outside diameter of cone, 9 inches
Depth of speaker, 8 inches
Overall width of speaker, 9.5 inches
Mounting board, detachable, 10¾x12¾x⅞ inches
Burtex cone
Diameter of central magnet pole, 1.5 inches
Flexible spring mounting of tip of cone, and moving coil
Moving coil accurately center-mounted
Depth of magnet structure, 4.5 inches
Outside diameter of magnet structure, 4.5 inches
Built-in full-wave Westinghouse Rectox dry rectifier
Husky output transformer built in; heavy core, shielded
Superior workmanship
Thick felt buffers on front of cone edges
Built-in power transformer for rectifier
Will stand output of 250 tubes in push-pull and work superbly in any tubes, single or push-pull
Tone quality is unsurpassed

**$12.50**

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We have had considerable experience with AC dynamic chasses, and it is our firm conviction this is the best one we have offered so far.

So convinced are we that you will be overjoyed from the reproduction afforded by this Erla chassis that we ask you to buy it at no risk to yourself whatsoever. Order one shipped C.O.D. Try it for five days If for any reason you desire to return it in that time, do so and we will refund your purchase price and expressage you laid out. This widest guaranty applies only to the Erla chassis.

Acoustical Engineering Associates
143 West 45th Street New York, N. Y.
Please ship at once, express C.O.D., one Erla dynamic chassis, 110 volt AC, 50-60 cycles, as advertised, at $12.50, on a five-day guaranty or money-back if not completely satisfied, including cartage money, which applies to the Erla offer only.

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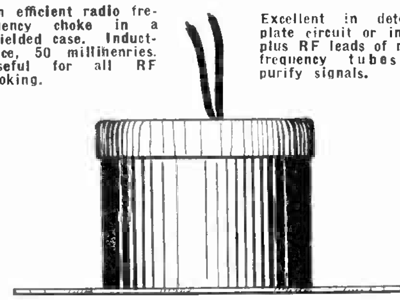

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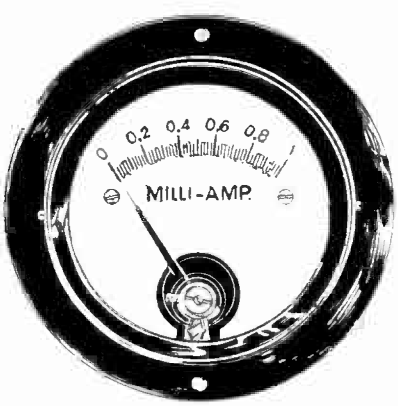


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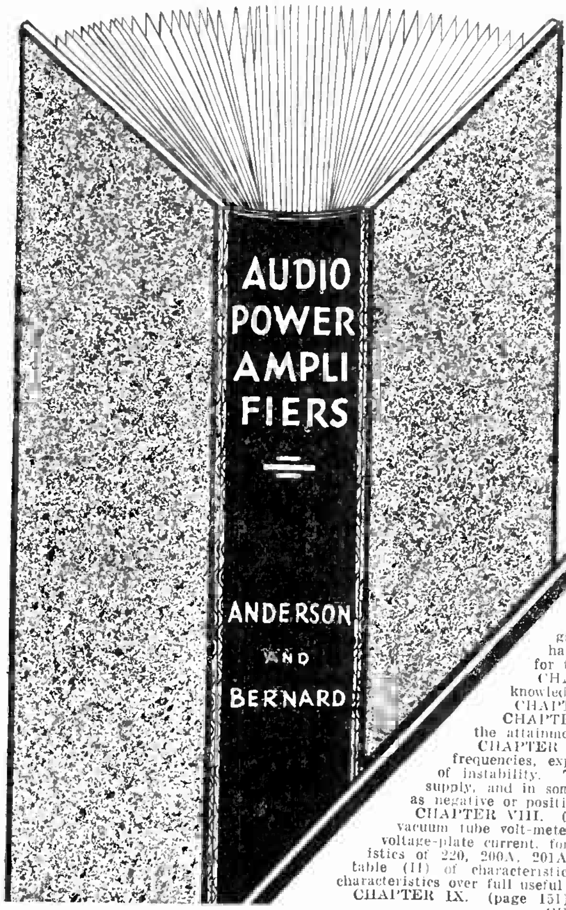


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## "AUDIO POWER AMPLIFIERS"

*By J. E. Anderson, M.A., and Herman Bernard, LL.B.*

**The First and Only Book On This Important Subject**

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J. E. Anderson, M.A., former instructor in physics, University of Wisconsin, former Western Electric engineer, and for the last three years technical editor of "Radio World."

Herman Bernard, LL.B., managing editor of "Radio World."

They have gathered together the far-flung branches of their chosen subject, treated them judiciously and authoritatively, and produced a volume that will clear up the mysteries that have perplexed many.

The book begins with an elementary exposition of the historical development and circuit constitution of audio amplifiers and sources of powering them. From this simple start it quickly proceeds to a well-considered exposition of circuit laws, including Ohm's laws and Kirchhoff's laws. The determination of resistance values to produce required voltages is carefully expounded. All types of power amplifiers are used as examples: AC, DC, battery operated and composite. But the book treats of AC power amplifiers most generously, due to the superior importance of such power amplifiers commercially.

"Audio Power Amplifiers" is for those who know something about radio. It is not for novices. But the engineers of manufacturers of radio receivers, power amplifiers, sound installations in theatres, public address systems and phonograph pickups will welcome this book. Engineers—even chief engineers—of the Bell Telephone Laboratories, Radio Corporation of America, Westinghouse Electric & Mfg. Co., Western Electric, Photophone, Vitaphone and the like needn't be afraid they won't learn something from this little book.

## Details of Chapter Contents

CHAPTER I. (page 1) General Principles, analyzes the four types of power amplifiers, AC, DC, battery-operated and composite, illustrates them in functional blocks and schematic diagrams, and treats each branch in clear textual exposition.

CHAPTER II. (page 20) Circuit Laws, expounds and applies Ohm's laws and their special form known as Kirchhoff's Laws.

CHAPTER III. (page 35) Principles of Rectification, expounds the vacuum tube, both filament and gaseous types, electrolytic and contact rectifiers, and explains why and how they work. Full-wave and half-wave rectification are treated, with current flow and voltage derivation analysis. Regulation curves for the 280 tube are given. Voltage division, filtration and stablilization are fully illustrated and dissected.

CHAPTER IV. (page 62) Practical Voltage Adjustments, gives the experimental use of the theoretical knowledge previously imparted. Determination of resistance values is carefully revealed.

CHAPTER V. (page 72) Methods of Obtaining Grid Bias, enumerates, shows, and compares them.

CHAPTER VI. (page 90) Principles of Push-Pull Amplifier, defines the push-pull relationship, with keys to the attainment of desired electrical symmetry.

CHAPTER VII. (page 98) Oscillation in Audio Amplifiers, deals with motorboating and oscillation at higher audio frequencies, explaining why it is present, stating remedies and giving expressions for pre-determination of regions of instability. The trouble is definitely assigned to the feedback through common impedance of load reactors and B supply, and in some special instances to the load's relationship to the C bias derivation as well. The feedback is shown as negative or positive and the results stated.

CHAPTER VIII. (page 118) Characteristics of Tubes, tells how to run curves on tubes, how to build and how to use a vacuum tube volt-meter, discusses hum in tubes with AC on the filament or heaters and presents families of curves, plate voltage-plate current, for 240, 220, 201A, 112A, 171A, 227 and 245, with load lines. Also, plate voltage-plate current characteristics of 220, 200A, 201A, 112A, 171A, 222, 240, 226, 227, 224, 245, 210, 250, full data on everything. There is a composite table (11) of characteristics of Rectifier and Voltage Regulator Tubes, and individual tables, giving grid voltage, plate current characteristics over full useful voltage ranges for the 220, 201A, 112A, 171A, 222, 240, 227, 245 and 224.

CHAPTER IX. (page 151) Reproduction of Recordings, states coupling methods and shows circuits for best connections.

CHAPTER X. (page 161) Power Detection, explains what it is, when it should be used, and how to use it. A rectifying detector, designed by one of the authors, is expounded also.

CHAPTER XI. (page 121) Practical Power Amplifier, gives AC circuits and shows the design of a sound reproduction system for theatres. A page is devoted to power amplifier symbols.

CHAPTER XII. (page 183) Measurements and Testing, discloses methods of qualitative and quantitative analysis of power amplifier performance. Order Cat. APAM.

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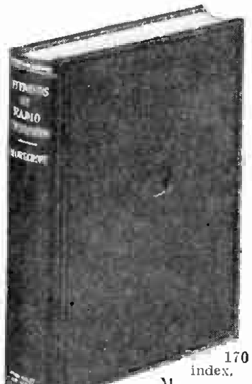

The latest book by Prof. John H. Morecroft, of the Engineering Department of Columbia University, and past president of the Institute of Radio Engineers, is his "Elements of Radio Communication." We regard this as the best elementary book to inform you authoritatively on the technical phases of radio in plain language, provided you have some foundation knowledge of radio. The book is a complete course on the elements of radio, containing much material never before published. It has 226 pages, 170 illustrations and a complete index. Cloth bound. Order Cat. M

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# Accurate Tuning Condensers and Accessories

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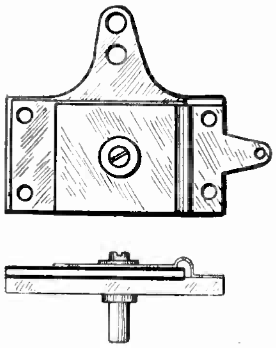

CAT. EQ-100 AT 35c

The most precise and rugged equalizing condenser made, with 20 mmfd. minimum and 100 mmfd. maximum, for equalizing the capacity where gang condensers are used that are not provided with built-in trimmers. Turning the screw alters the position of the moving plate, hence the capacity. Cross-section reveals special threaded brass bushing into which screw turns, hence you can not strip the thread. Useful in all circuits where trimming capacity of 100 mmfd. or less is specified.

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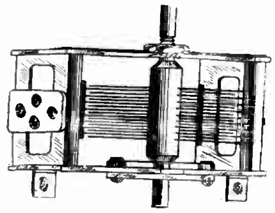

CAT. KH-3 AT 85c

A single .00035 mfd. condenser with nonremovable shaft, having shaft extension front and back, hence useful for ganging with drum dial or any other dial. Shaft is ¼ inch diameter, and its length may be extended ⅜ inch by use of Cat. XS-4. Brackets built in enable direct sub-panel mounting, or may be plied off easily. Front panel mounting is practical by removing two small screws and replacing with two 3/34 screws ¾ inch long. Condenser made by Scovill Mfg. Co.

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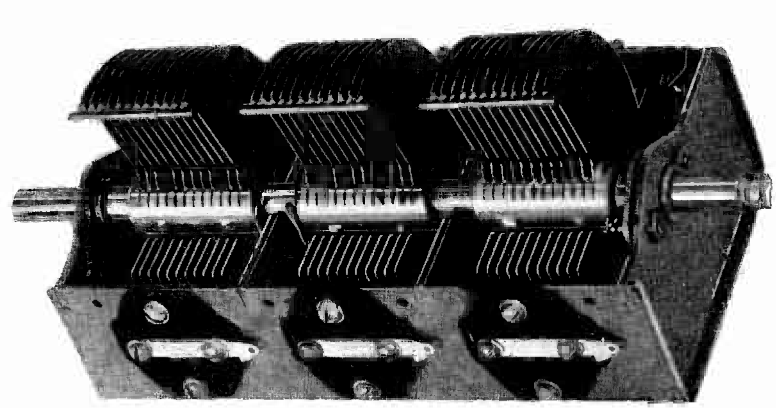

*One of the finest, strongest and best gang condensers ever made is this three-gang unit, each section of full .0005 mfd. capacity, with a modified straight frequency line characteristic. The net weight of this condenser is 3¼ lbs. Cat. SC-3G—5 at $4.80.*

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### SALIENT FEATURES OF THE CONDENSER

(1)—Three equal sections of .0005 mfd. capacity each.
(2)—Modified straight line frequency shape of plates, so-called midline.
(3)—Sturdy steel frame with rigid steel shields between adjacent sections. These shields minimize electric coupling between sections.
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(5)—Both the rotor and the stator plates are accurately spaced and the rotor plates are accurately centered between stator plates.
(6)—Two spring stoppers prevent jarring when the plates are brought into full mesh.
(7)—The rotor turns as desired, the tension being adjustable by set-screw at end.
(8)—The shaft is of steel and is ⅜ inch in diameter.
(9)—Each set of stator plates is mounted with two screws at each side of insulators, which in turn are mounted with two screws to the frame. Thus the stator plates cannot turn sidewise with respect to the rotor plates. This insures permanence of capacity and prevents any possible short circuit.
(10)—Each stator section is provided with two soldering lugs so that connection can be made to either side.
(11)—The thick brass plates and the generous proportions of the frame insure low resistance.
(12)—Provision made for independent attachment of a trimmer to each section.
(13)—The steel frame is sprayed to match the brass plates.
(14)—The condenser, made by America's largest condenser manufacturer, is one of the best and sturdiest ever made, assuredly a precise instrument.

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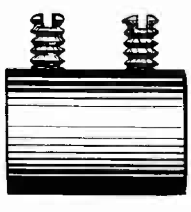
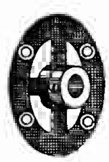


CAT. RL-3 AT 12c

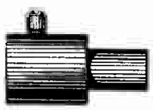
For coupling two ¼ inch diameter shafts, either coil shaft and condenser shaft, or two condenser shafts, a coupling link is used. This may be of the rigid type, all metal, where the linked units are not to be insulated. The rigid link, Cat. RL-3, has two set-screws, one to engage each shaft, and is particularly serviceable where a grounded metal chassis is used, as the returns then need no insulation.



CAT. FL-4 at 30c

Flexible insulated coupler for uniting coil or condenser shafts of ¼ inch diameter. Provides option of insulated circuits

## EXTENSION SHAFTS, TWO SIZES



CAT. XS-4 AT 10c

Here is a handy aid to salvaging condensers and coils that have ¼" diameter shafts not long enough for your purpose. Fits on ¼" shaft and provides ⅜" extension, still at ¼". Hence both the extension shaft and the bore or opening are ¼" diameter.

For condensers with ⅜" diameter shaft, to accommodate to dials that take ¼" shaft, order Cat. XS-8 at 15c.

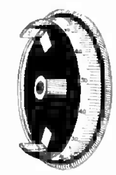
## .00035 TWO-GANG

A two-gang condenser, like the single type, KHS-3, but consisting of two sections on one frame, is Cat. KHD-3, also made by Scovill. The same mounting facilities are provided. There is a shield between the respective sections. The tuning characteristic is modified straight frequency line. Order Cat. KHD-3 at $1.70.

## DRUM DIAL

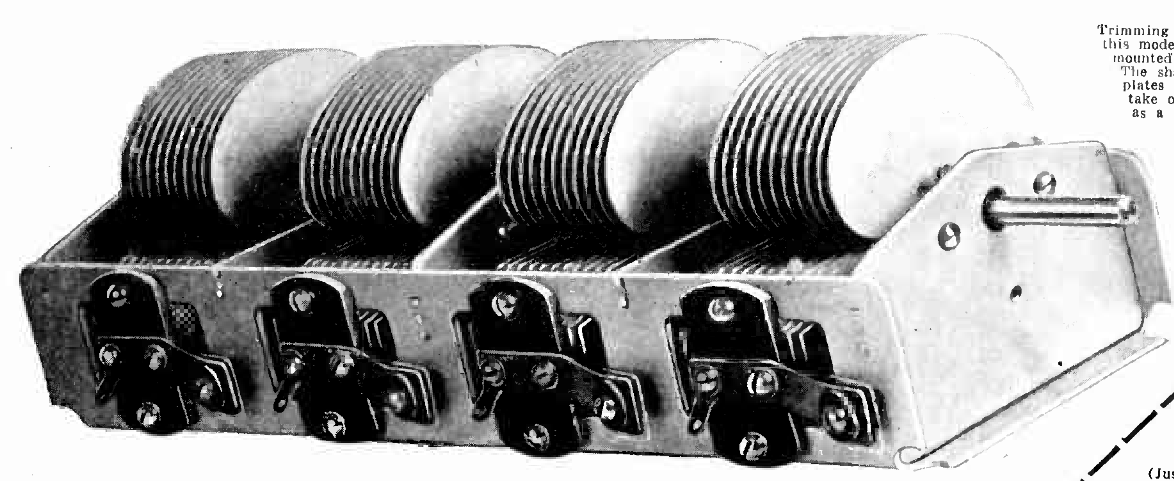
CAT DD-0-100 @ $1.50

A suitable drum dial of direct drive type is obtainable for ¼" shafts or ⅜" shafts, and with 0-100 scales. An escutcheon, is furnished with each dial.



## FOUR-GANG .00035 MFD. WITH TRIMMERS BUILT IN

Trimming condensers are built into this model. The condenser may be mounted on bottom or on side. The shaft is removable, also the plates are removable, so you can take out one section and operate as a three-gang.



Four-gang .00035 mfd. with trimmers built in. Shaft and rotor blades removable. Steel frame and shaft. aluminum plates. Adjustable tension at rear. Overall length, 11 inches. Weight, 3½ lbs. Cat. SPL-4G-3 @ $3.95.

## SHORT WAVES

Tuning condensers for short waves, especially suitable for mixer circuits and short-wave adapters. These condensers are .00015 mfd. (150 micromicrofarads) in capacity. They are suitable for use with any plug-in coils. Order Cat. SW-S-150 @ $1.50. To provide regeneration from plate to grid return, for circuits calling for this, use .00025 mfd. Order Cat. SW-S-250 @ $1.50.

A four-gang condenser of good, sturdy construction and reliable performance fits into the most popular tuning requirement of the day. It serves its purpose well with the most popular screen grid designs, which call for four tuned stages, including the detector input.

Ordinarily a good condenser of this type costs, at the best discount you can contrive to get, about twice as much as is charged for the one illustrated and even then the trimming condensers are not included. The question then arises, has quality been sacrificed to meet a price? As a reply, read the twenty-six points of advantage. The first consideration was to build quality into the condenser. The accuracy is 99¼%.

GUARANTY RADIO GOODS CO.,
143 West 45th St.,
N. Y. City
(Just East of Broadway.)

Enclosed find $..........for which ship designated parts:

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Street Address..............................

City.................... State....................

the following merchandise as advertised:

- ☐ Cat. XS-4 @ 10c
- ☐ Cat. KH-3 @ 85c
- ☐ Cat. XS-8 @ 15c
- ☐ Cat. KHD-3 @ $1.70
- ☐ Cat. RL-3 @ 12c
- ☐ Cat. DD-0-100 @ $1.50
- ☐ Cat. EQ-100 @ 35c
- ☐ Cat. SC-3 G-5 @ $4.80
- ☐ Cat. SPL-4 G-3 @ $3.95
- ☐ Cat. FL-4 @ 30c
- ☐ Cat. SW-S-150
- ☐ Cat. SW-S-250

ALL PRICES ARE NET

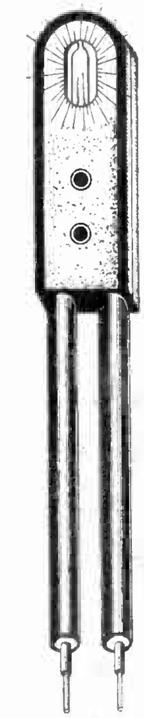
# NEW J-245-X TROUBLE-SHOOTING JIFFY TESTER

## *Illumination Continuity and Polarity Tester FREE with Each Outfit!*

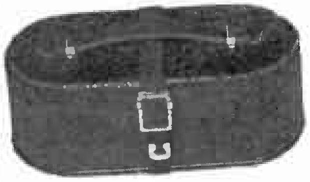

**Your Price**

**$15.82**

**Complete**



**Illumination Tester, Vest Pocket Size, Shows Shorts and Opens Visually, also polarity of DC line. A Neon lamp is built in.**



**The three-meter assembly, in the crackle-brown finish carrying case, with slip-on cover in place. The handle is genuine leather. The buckled strap holds the cover on.**

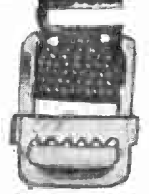
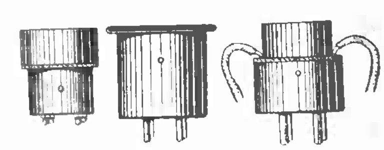


**Illustration above is 2/3 scale.**



**J-111 Multiplier, upper left, with tip; below it, J-106 Multiplier with tip; plugs, left to right, J-19, conforms UV socket to UX plug; J-20, conforms UX tester socket to UV199 tube; J-24, to test Kellogg and old style Arcturus tubes.**

## *Makes All Necessary Tests in a Jiffy and Simplifies Service Work!*

THE new Jiffy Tester, J-245-X, is a complete servicing outfit. It consists of a three-meter assembly in a metal case, with slip-on cover and a cable plug. There are ten adapters. It is vital to have the complete outfit so you can meet any emergency.

With this outfit you plug the cable into a vacated socket of a receiver, putting the removed tube in the tester, and using the receiver's power for making these tests: plate current, up to 100 milliamperes; plate voltage up to 300 volts; filament or heater voltage (AC or DC), up to 10 volts.

Each meter may be used independently. One of the adapters—a pair of test leads, one red, the other black, with tip jack terminals—serves this purpose. Multiplier J-106 extends the range of the DC voltmeter to 600 volts, but this reading must be obtained independently, as must readings on the 0-60 scale of the DC voltmeter. Independent reading of the AC voltmeter for line of voltage is necessary; also to use 0-140 scale while Multiplier J-111 extends the AC scale to 560 volts for reading power transformer secondaries.

The other adapters permit the testing of special receiver tubes, so that tests may be made, in all, of 22 different tubes: 201A, 200A, UX199, UV199, 120, 240, 171, 171A, 112, 112A, 245, 224, 222, 228, 280, 281, 227, 226, 210, 250, Kellogg tubes and old style Arcturus tubes.

**GUARANTY RADIO GOODS CO.**
**143 West 45th Street, Just East of Broadway,**
**N. Y. City.**

☐ Please send me on 5-day money-back guaranty your J-245-X Jiffy Tester, complete, with all 10 adapters, and with Illuminated Tester FREE with each order. Also send instruction sheet, tube data sheet and rectifier tube testing information.

☐ Please ship C. O. D. @ $15.82 plus cartage and P.O. fee

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**5-DAY MONEY-BACK GUARANTY**

WHEN servicing a radio set, power amplifier, speech amplifier or sound reproduction or recording equipment, the circuits and voltages are almost inaccessible, unless a plug-in tester is used.

The Jiffy 245-X plugs in and does everything you want done. It consists of:

(1)—The encased three-meter assembly, with 4-prong (UX) and 5-prong (UY) sockets built in; changeover switch built in, from 0-20 to 0-100 ma.; ten vari-colored jacks, five of them to receive the vari-colored tipped ends of the plug cable; grid push-button, that when pushed in connects grid direct to the cathode for 224 and 227 tubes, to note change in plate current, and thus shorts the signal input.

(2)—4-prong adapter for 5-prong plug of cable.
(3)—Screen grid cable for testing screen grid tubes.
(4)—Pair of Test Leads for individual use of meters.
(5)—J-106 Multiplier, to make 0-300 DC read 0-600.
(6)—J-111 Multiplier, to make 0-140 AC read 0-560.
(7)—Two jack tips to facilitate connection of multipliers to jacks in tester.
(8), (9), (10)—Three adapters so UV199 and Kellogg tubes may be tested.
(11)—Illumination Tester.

The illumination tester will disclose continuities and opens and also the polarity of DC house mains. It is as handy as a pencil and fits in your vest pocket. It works on voltages from 100 to 400. There are two electrodes in a Neon lamp in the top of the instrument. On AC both electrodes light. On DC only one lights, and that one is negative of the line, the light being on the same side as the lead. Hence the illuminator shows whether tested source is AC or DC, and if DC, which side is negative.

Even the output of the speaker cord will show a light.

Also, the device will test which fuses are blown in fused house lines, AC or DC. Besides it tests ignition of spark plugs of automobiles, boats and airplanes, also faulty or weak spark plugs.

Just flash on the illumination tester momentarily. It will last about 4,000 flashes.