List of U. S. and Canadian Stations by Wavelength

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RADIO WORLD

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The First and Only National Radio Weekly

427th Consecutive Issue—NINTH YEAR

Experiments for Novices

How to Build a Super

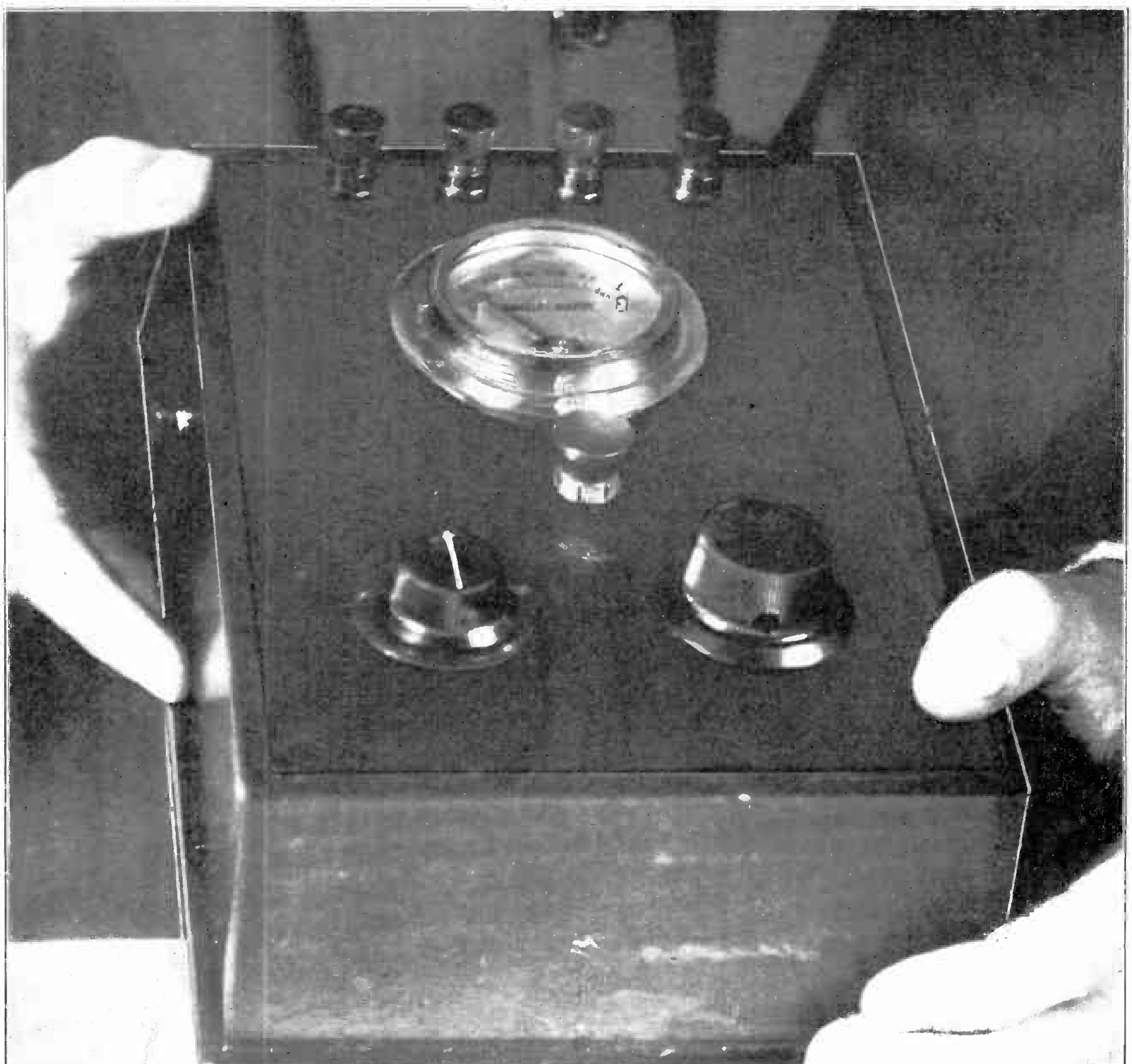
Infradyne Tuning

Capacity Measurement

Effect of Shields

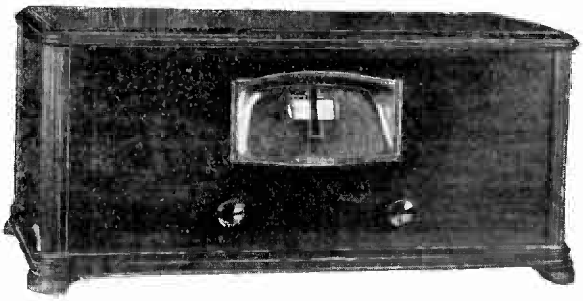
Dynamic Reproduction

PRECISION OHMMETER-VOLTMETER



This simple device measures 1,500 to 200,000 ohms, 0-10 volts, 0-200 volts and 0-1,000 volts at 1,000 ohms per volt.

Balkite Push-Pull Receiver



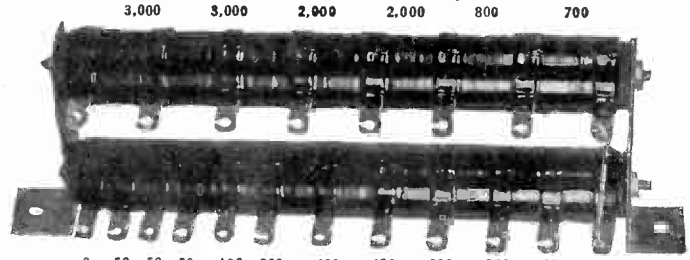
The Balkite A-5 Neutrodyne, one of the most sensitive commercial receivers ever developed; 8 tubes, including 280 rectifier. Wholly AC operated, 105-120 v. 50-60 cycles; in a table model cabinet, genuine walnut, made by Berkey & Gay.

Three stages of tuned RF, neutralized, so there's no squealing; easy tuning; operation on short piece of wire indoors perfectly satisfactory; no repeat tuning points; no hum; phonograph pickup jack built in; excellent tone quality; good selectivity. Two posts are accessible for connecting the field coil of a DC dynamic speaker.

The parts of which this receiver is made are all ace-high and the wiring is done with extreme expertness, by Gilfillan. The power supply is exceptionally fine, the set being worked at 50% less than the rated capacity of the power transformer and chokes, assuring long life. There is no hum, as filtration is remarkably good.

The illuminated drum dial, at center, reads 0-100 at left, and at right has a blank space in which to write call letters. The little knob at left is the volume control, and the one at right is the AC switch. Each RF stage is filtered and bypassed individually, and the RF coils, tuning condenser and power transformer are separately and totally shielded. The lead from antenna binding post to antenna winding of the first coil is of shielded wire that is grounded. Also, the receiver as a whole is totally shielded, with metal chassis and metal undercover, so there is no stray pickup. Cat. BAL-A5, list price $135; net price......... **$44.00**

New Multi-Tap Voltage Divider



The resistance values between the twenty taps of the new Multi-Tap Voltage Divider are given above. The total is 17,100 ohms and affords nineteen different voltages.

The Multi-Tap Voltage Divider is useful in all circuits, including push-pull and single-sided ones, in which the current rating of 100 milliamperes is not seriously exceeded and the maximum voltage is not more than 400 volts. Higher voltages may be used at lesser drain.

The expertness of design and construction will be appreciated by those whose knowledge teaches them to appreciate parts finely made.

When the Multi-Tap Voltage Divider is placed across the filtered output of a B supply which serves a receiver, the voltages are in proportion to the current flowing through the various resistances. By making connection of grid returns to ground, the lower voltages may be used for negative bias by connecting filament center, or, in 227 and 224 tubes, cathode to a higher voltage.

If push-pull is used, the current in the biasing section is almost doubled, so the midtap of the power tubes' filament winding would go to a lug about half way down on the lower bank.

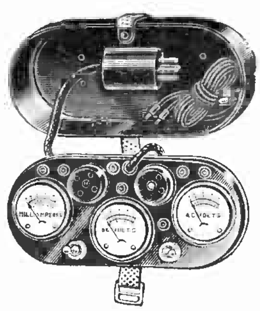
Order Cat., MTVD, list price $6.50, net price.................... **$3.90**

Silver-Plated Coils

Wound with non-insulated wire plated with genuine silver, on grooved forms, these coils afford high efficiency because of the low resistance that silver has to radio frequencies. The grooves in the moulded bakelite forms insure accurate space winding, thus reducing the distributed capacity, and keep the number of turns and separation constant. Hence the secondary reactances are identical and ideal for gang tuning.

The radio frequency transformer may be perpendicularly or horizontally mounted, and has braced holes for that purpose. It has a center-tapped primary, so that it may be used as antenna coil with half or all the primary in circuit, or as interstage coupler, with all the primary on a screen grid plate circuit, or half the primary for any other type tubes, including pentodes. The three-circuit tuner has a center-tapped primary, also. This tuner is of the single hole panel mount, but may be mounted on a chassis, if preferred, by using the braced holes. Pair consists of RF transformer and three-circuit tuner, both for .0005 mfd. only. Order Cat., G-RF-3CT, list price $5.00; net price.................. **$2.48**

R-245 Set and Tube Tester



With the R-245 Tube and Set Tester 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, on 0-20 or 0-100 ma. scale, changed by throwing a built-in switch; 0-60, 0-300 v. DC, changed by moving one of the tipped cables to another jack; filament or heater voltage (AC or DC), up to 10 volts, or any other AC voltage source, measured independently, up to 140 volts, including AC line voltage. Also screen grid voltage and screen grid current may be read by following connections specified in the new 8-page instruction sheet.

Each meter may be used independently. The two test leads, one red, the other black, with tip jack terminals, enable quick connection to meters for independent use.

With this outfit you can shoot trouble in receivers and test circuits using the following tubes: 201A, 200A, UX199, UX120, 210, 171, 171A, 112, 112A, 245, 224, 222, 226, 227, and pentodes.

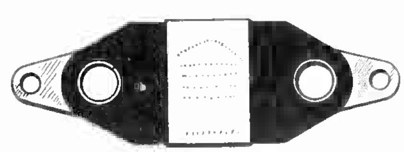
When the R-245 is plugged into the vacated socket of a set and the removed tube is placed in the proper socket of the Tester, the receiver's power supplies all the voltages and currents. You see the vital tests made right before your eyes, all three meters registering immediately, all three reading at the same time.

Here are some of the questions answered by the Tester when plugged into the receiver:

What is the filament or heater voltage (no matter if DC or AC)? What is the plate voltage at the plate itself? What is the plate current drawn by the tube? Is the tube in good condition or does it require replacement? What is the grid bias voltage? What is the cathode voltage? What is the screen grid voltage? Besides, when meters are used independently, you can answer these questions: What is the screen grid current? What is the line voltage (no mater if AC or DC)? Is the circuit continuous or is it open? What is the total plate current drawn in the receiver? What are the respective B voltages at the B batteries or voltage divider?

Order Cat. R-245. List price, $20; net price........... **$11.40**

Fixed Condensers



Dubilier Micon fixed condensers, type 642, are available at following capacities and prices:

.0001 mfd.	10c	.006	20c
.00025 mfd.	10c	.00025 with clips.	29c
.0003 mfd.	10c		
.00035 mfd.	15c		
.001	17c		
.0015	17c		
.002	18c		

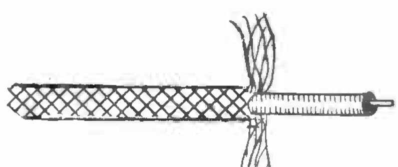
All are guaranteed electrically perfect and money back if not satisfied within five days.

Order Cat. MICON .0001 etc. at prices stated.

High-Voltage Meters

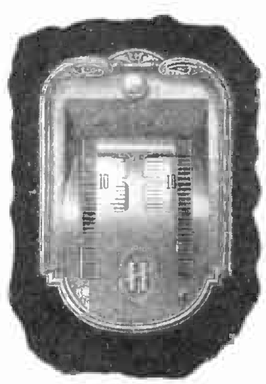
0-300 v., 200 ohms per volt. Cat. F-300 @ $2.59
0-500 v., 233 o.p.v. Cat. F-500 @...... 3.73
0-600 v., AC and DC (same meter reads both); 100 ohms p.v. Order Cat. M-600 @ 4.95

Shielded Lead-in Wire



No 18 solid wire, surrounded by a solid rubber insulation covering, and above that a covering of braided copper mesh wire, which braid is to be grounded, to prevent stray pick-up. This wire is exceptionally good for antenna lead-in, to avoid pick-up of man-made static, such as from electrical machines. Also used to advantage in the wiring of receivers, as from antenna post of set to antenna coil, or for plate leads, or any leads, if long. This method of wiring a set improves selectivity and reduces hum. This wire is now appearing on the general market for the first time although long used in the best grade of commercial receivers. Order Cat. SH-LW. List price 9c per ft.; net price per foot **5c**

Double Drum Dial

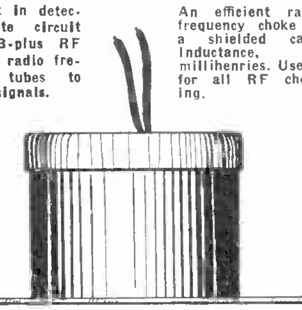


Hammarlund double drum dial, each section individually tunable. Order Cat. H-DDD. List price $6.00; net price **$3.00**

Shielded RF Choke

Excellent in detector plate circuit or in B-plus RF leads of radio frequency tubes to purify signals.

An efficient radio frequency choke in a shielded case. Inductance, 50 millihenries. Useful for all RF choking.



In some instances one outlead is connected to case, so use this lead for B-plus or for ground, otherwise ground the case additionally. Order Cat. SH-RFC. List price, $1.00; net price **50c**

Guaranty Radio Goods Co., 143 West 45th St., New York, N. Y.
(Just East of Broadway)

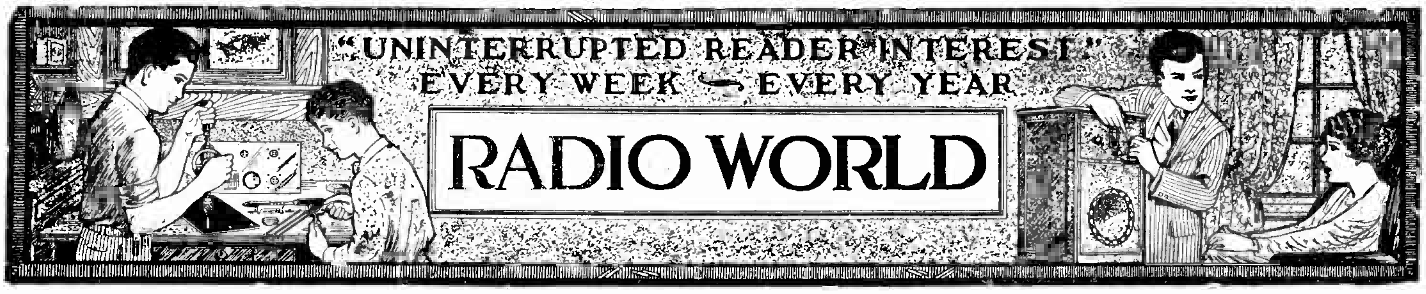
Enclosed please find $.................................. (Canadian must be express or post office money order, for which please ship:

☐ BAL-AS @. $44.00
☐ MTVD @ ... 3.90
☐ G-RF-3CT @ 2.48
☐ R-245 @..... 11.40
☐ Ft. of SH-LW @.......5c p. f.
☐ H-DDD @... $3.00
☐ SH-RFC @... 50c
☐ M-600 @.... $4.95
☐ F-300 @..... $2.59
☐ F-500 @..... 3.73
☐ MICON.... @ ....
☐ MICON.... @ ....
☐ If C.O.D. shipment is desired put cross here.

Your Name ....

Address ....

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



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Short Waves Galore

By J. E. Anderson

[The subject of short-wave converters has been discussed each week for four weeks. Herewith is a fifth article, dealing with a converter that uses two tubes. The filament supply is to be a transformer in the converter. B voltage is obtained from the receiver in conjunction with which the converter is worked. The converter receives short waves and changes them to a frequency that the receiver amplifies. In the present account only a single tuned circuit is used for bringing in the short waves.—Editor.]

IT IS no great exaggeration to say that this short-wave converter picked up 600 stations in one short evening. Not all these stations were identified, to be sure, for to wait for an identifying announcement would limit the number of stations one could tune in during an evening to about three. Announcers have a great habit of disregarding the Federal Radio Commission in this respect, or at least it seems so when one is trying to log a large number of stations in one evening.

Just to show that it was no great exaggeration to say that 600 stations were picked up in one evening let us give a few facts. There were three coils in the set. The dial used had 100 main divisions, and there were at least two stations for every division on the dial. That makes 600 stations in all. We got more stations than we cared to count.

Maybe even 600 is an exaggeration, for this converter is of the Superheterodyne type, and every Superheterodyne brings in every station at two points on the tuner, provided the intermediate frequency is not too high. It was not in this case, for it was only 1,700 kc at the most and sometimes it was as low as 550 kc. That cuts the number picked up to 300. To be honest, we even had to trim that figure down a little, for the three coils used overlapped. But even with that concession we had at least 200 stations left. We refuse to make any more concessions.

CW Received

In fact we shall begin to make further claims. This converter is not supposed to receive continuous wave signals, or interrupted continuous wave signals. There is no provision made for them. The air is just crowded with this type of signals, and although the receiver was not supposed to receive them, they actually crowded themselves in, and a large number of them at that. Little attention was paid to these signals, except to make a mental reservation to make provision for receiving them right at some other time. While these signals were received, and even could be read, they were not received right, for instead of clear tones there were only dull thuds.

Some doubtful soul might raise the objection that there are not so many stations on the air as modestly claimed above. Let us see how weak that objection is. The total range of the tuner was from about 20,000 kc to 550 kc. That is, it covered not only the entire short-wave range ordinarily used, but it covered the broadcast range as well. On the basis of one station for every 10 kc we would have 1,945 stations. But in the short wave range stations are crowded closer together than in the broadcast range. Hence we have ample margin for claiming a measly 200 stations.

Simple Receiver

And how were these stations received? With loudspeaker volume loud enough to be heard distinctly when the speaker was several feet away. If they were so weak that the observer had to lean over toward the speaker to hear them they were not considered to have been received. There were so many

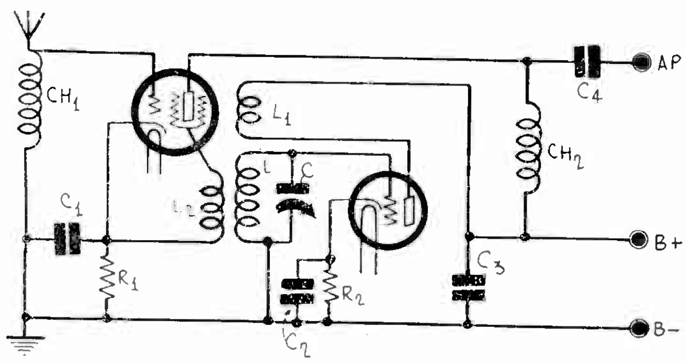


FIG. 1
DIAGRAM OF THE EXPERIMENTAL SHORT-WAVE CONVERTER USING ONE SCREEN GRID TUBE AND ONE 227 WITH WHICH A LARGE NUMBER OF SHORT-WAVE AND BROADCAST STATIONS WERE BROUGHT IN.

that a good catch could be obtained without retaining the little ones.

Now it might be suspected that converter was an elaborate affair to bag such a large number of stations in one evening. Well, the converter and receiver as a whole was not simple, but neither was it exceptionally elaborate. The converter part of it was about as simple as it could be made. The receiver part was an MB-29, followed by two stages of resistance coupled audio amplification. About the same results should be obtained with almost any modern radio receiver with this converter ahead of it. The sensitivity of the short-wave converter, of course, is directly proportional to the sensitivity of the broadcast receiver.

That the converter of the circuit was simple can be seen from Fig. 1, the circuit diagram, and Fig. 2, a photograph of it. Don't pay a great deal of attention to the unsymmetrical layout of the parts of the circuit, for it was experimental. There is no reason in the world why the tuning condenser should not be placed midway between the tubes. Indeed, there are many reasons besides looks for placing it in the middle. One is that by moving the condenser the two leads running to the plates of the condenser could be shortened by an inch or two, which would be an improvement. If this would make other leads longer in proportion it would not matter.

The main idea in hooking up this converter is to connect all the wires according to the pattern in Fig. 1. If that is done

LIST OF PARTS

Ch1, Ch2—Two shielded RF chokes, 50 mh. each.
C1, C2, C3, C4—Four .01 mfd. condensers.
C—One Hammarlund .0005 mfd. straight frequency line condenser.
L1L2—One set of Air-King precision air-wound short-wave coils with mounting.
Two five-prong sockets.
One dial.
7x10 inch front panel and a baseboard.

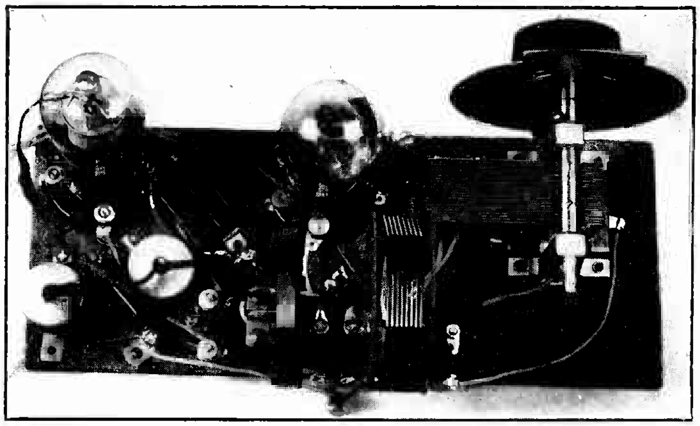


FIG. 2

THE TOP VIEW OF THE TWO-TUBE SHORT WAVE CONVERTER.

and the layout is at all reasonable the circuit will work as well as the experimental model. There is no doubt about that. If it does not work well it is because the circuit has not been connected as in Fig. 2, or because a tube is dead or fatigued.

One reason for the simplicity of the circuit is that the input is aperiodic. The antenna is connected directly to the grid of the modulator tube, that is, to the cap of the screen grid tube. A radio frequency choke coil Ch1 is then connected between the grid and ground. The inductance value of this choke is high enough to make the coupling efficient at the broadcast frequencies and its distributed capacity is so low that it remains efficient at the highest frequency to which the tuner responds, and this turned out to be slightly higher than 20,000 kc.

A bias is provided for the modulator tube by R1, the value of which is 300 ohms. To insure grounding of the cathode a .01 mfd. condenser C1 is connected across the bias resistor. The plate voltage applied to the screen grid modulator apparently had little effect on the detecting efficiency of the tube. Values from 135 volts down to 22.5 volts were used with almost equal results. Consequently most of the tests were made with a voltage of 67.5 volts.

The pick-up coil L2 is connected in the screen circuit which returns directly to the cathode. Thus the screen grid voltage is zero.

The oscillator tube is a 227 and the circuit is the well known tuned grid type. The values of the bias resistor R2 is the same as that of R1 and likewise condenser C2 is of the same size as C1. C3 is also a .01 mfd. condenser.

Condenser C4 is another .01 mfd. unit, although at this point values as low as .00025 were tried with about equal results. The output choke Ch2 was exactly the same as Ch1. The two chokes and the four condensers can be seen clearly in the photograph.

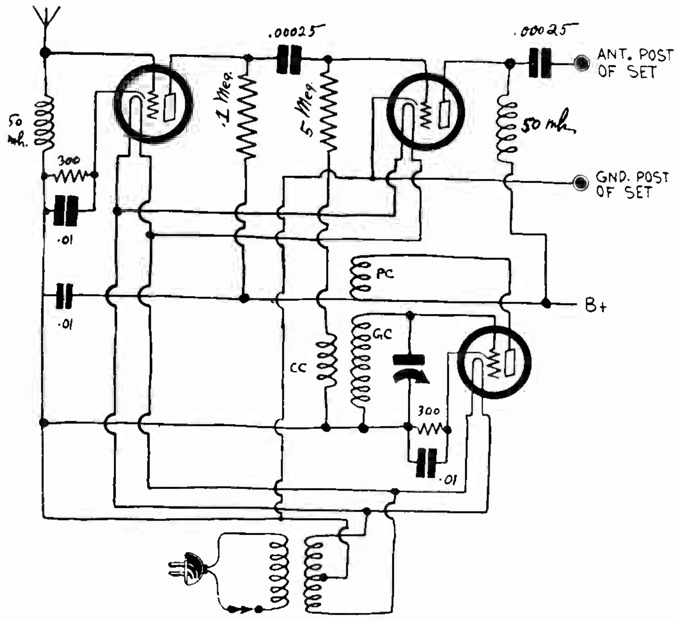
The aperiodic coupling between the first tube and the antenna is not selective, of course, and all stations, including broadcast stations, are picked up with equal relative strength. An attempt was made to exclude the broadcast stations by tuning the input, but the added selectivity thus gained did not warrant the addition of another set of plug-in coils and another tuning condenser. There was only a slight increase in the sensitivity. However, it should be possible to arrange the circuit so that the coupling between the antenna and the modulator tube is so loose that a high order of selectivity would result. A suitable input with this in view is now being worked out.

Just as the input is not selective so the output does not discriminate among frequencies. If the output terminals are connected to the primary of a radio frequency transformer the plate circuit is not arranged, theoretically, for highest detecting efficiency, because there is no by-pass condenser across the choke coil. But none can be put across in the usual manner without cutting down the efficiency since some of the signal frequencies tuned in are lower than the so-called intermediate frequency. One way out of this dilemma is to connect a parallel tuned circuit across the output terminals and tune this circuit to the intermediate frequency used, that is, to use impedance coupling between the converter and the broadcast receiver. This was tried, but the increased efficiency did not warrant the added complications. Indeed, the improvement was no greater than that effected by tuning the input.

In order to get good results with this converter it is essential that first class tubes be used, and in order to get any results at all it is necessary to have an excellent tube in the oscillator. The operation hinges entirely on the functioning of this tube and its associated circuit. But as soon as the oscillator starts functioning there is no dearth of signals.

The two heaters in Fig. 2 are not connected to anything, but both should be run to the same 2.5 volt winding on a filament transformer. It is well to use a winding that is center-tapped so that this center can be grounded.

The output terminal marked AP should be connected to the antenna binding post on the broadcast receiver, and the posts marked B plus and B minus should be connected to the appropriate terminals of a dry cell battery. While the converter will work very well from a B battery eliminator it will work better with a battery.



A SINGLE-TUNED-CIRCUIT SHORT-WAVE CONVERTER THAT USES NO PLUG-IN COILS. IT WAS DESCRIBED LAST WEEK.

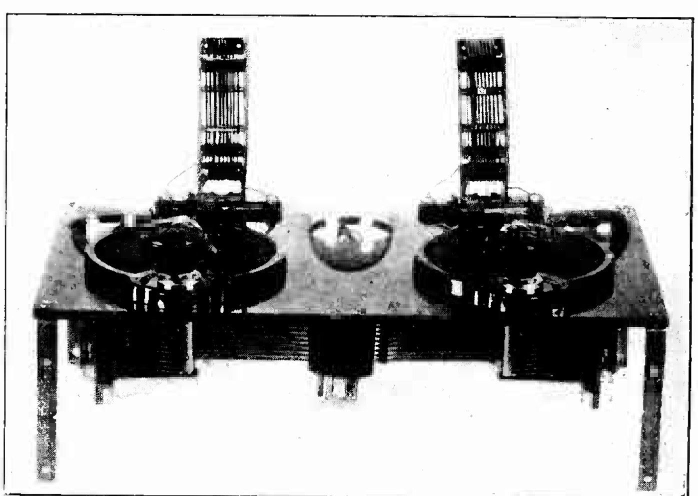
How to Sink Tubes on Converter Top Panel

In constructing a short-wave converter it is simplest to place the sockets at top, and mount the other parts, except the dials and binding posts, underneath the panel, since the whole outfit is to be accommodated in a small cabinet, with tuning accessibility on top. In that way everything can be wired on the panel and the finished product can be slipped into the cabinet.

However, by that method the tubes protrude far on top. If large holes are drilled in the panel to pass the tubes, then the tops of the tubes may be sunk to any desired depth, depending on how far down the sockets are placed, it being preferable to have the tubes protrude a little, so they may be gripped for insertion and removal. That method requires a top panel and a bottom panel, for there must be something on which the sockets will rest.

The illustration shows the arrangement of the top panel, with thre holes, each 1¾ inch diameter, to pass the tubes. Corner brackets support the top panel, and may be bent at bottom to a right angle to engage the subpanel. Then the entire outfit may be wired on the two-panel basis and inserted in the cabinet.

If AC design is desired, then room should be provided for the filament transformer, unless a receiver or power pack has a 2.5-volt winding that will stand the extra drain of three 227 tubes, 5.25 amperes, in which case two binding posts would be used for bringing in the 2.5 volt heater voltage. Otherwise the assembly as shown is for battery operation, that is, no room has been provided for a filament transformer.



TOP PANEL OF A SHORT-WAVE CONVERTER FOR SINKING THE TUBES

Why a Lamp Lights

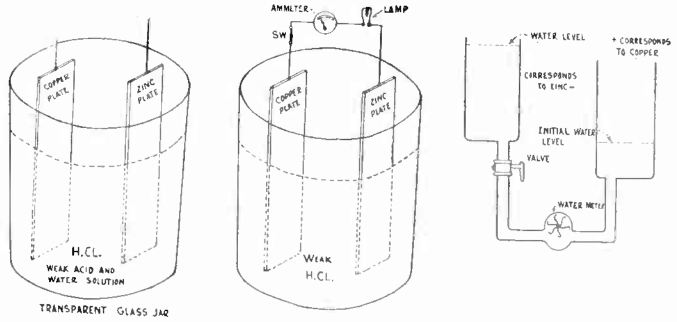
By Manning Trenholm

FOR the benefit of those who like to perform simple experiments with radio receiving circuits, batteries, both dry and wet, coils, magnets, motors, generators (both AC and DC) and lamps of all kinds, including tubes used in radio receiving circuits, in the preliminary study of electro-physical phenomena, the data on such experiments will be given.

There are many amateur radio enthusiasts, and also amateur electrical constructors whose interest in radio is not even academic, but who nevertheless would like to know something more about the "inside" details of the subject they are contemplating or some further information about the radio receiving circuit they are building or intend to build in the not too distant future.

There is always need for instruction in fundamental ideas and new offshoots thereof, because we always have the amateur and novice with us, and since the engineer of tomorrow is the novice of today is behooves us to try to do our bit to help this class of enthusiasts to help themselves.

What is electricity? This question puzzled scientists and lay workers ever since the days of the earliest experimenters, and many expirements were performed and much thinking was done, in the effort to solve the probable cause of the manifestation of a form of natural or "artificial" energy, electricity. We find that we cannot exactly define electricity. We can only define its manifestations and measure their causes and measure related effects by the use of certain natural laws which electrical effects seem to obey uniformly. So I suppose that since we have these limitations imposed upon us we must be sure to keep well within the circumscribed boundary—i. e., stick to facts as they are brought out and be careful not to tread upon new ground until that ground has been prepared.



1. 2. 3.

FIG. 1
ELEMENTS OF A SIMPLE CELL. WHEN DOTTED LINE CIRCUIT IS CLOSED A CURRENT WILL FLOW.
FIG. 2
A WATER-TANK ANALOG AS APPLIED TO FIGS. 1 AND 3.
FIG. 3
SHOWS FIG. 1 UNDER CONDITIONS OF A CLOSED CIRCUIT, WITH POTENTIAL DIFFERENCE BEGINNING TO FALL.

Bulb Lights

When you connect an ordinary (new) dry cell to a flashlight bulb, the bulb lights, indicating that something is happening now that did not happen before. Why is it necessary to connect the lamp to the dry cell in order to light it? The answer in part is that the lamp lights only because it is connected to a **suitable** source of potential difference, a source of electrical pressure difference.

Many years ago experimenters, both electrical and chemical, found that a current of electricity would flow along an external circuit that joined two dissimilar metals, when these metals were immersed in a solution of weak acid.

Fig. 1 shows such an arrangement and when the dotted line circuit that joins the full lines leading to the plates is completed, the arrangement constitutes an electric cell (a battery consists of more than one cell). Now when you have two tanks so situated relative to one another that one is at a **high** level and the other at a **low** one, if the upper one be now filled with water, a condition similar to that of Fig. 1 exists, namely, there is a difference in level between the two tanks and consequently the water contained therein, and there is also a difference in electrical level between the two immersed plates in Fig. 1.

Let us now look at Fig. 2. The tanks are connected by a long pipe and there are placed in the pipe a water meter and a valve. Directly the valve is opened the water meter's action indicates that water is passing through the pipe.

Similarly Fig. 3 shows that when the circuit is closed a current flows, but here I have taken the liberty of inserting a switch that corresponds to the shut-off valve in the water pipe of Fig. 2, and also inserting an ammeter in the circuit of Fig. 3 that corresponds to the water meter in the water pipe's circuit of Fig. 2. If a comparison of these sketches be made it will be apparent that they possess analogous features.

But in Fig. 3 I have included a lamp because we were talking about lamps previously and now it will be understood that before the valve was inserted in the pipe line of Fig. 2 the relation between the water in the upper tank to that in the lower tank was one of pressure only. since there was no water flow, but immediately upon opening the valve this pressure difference results in the water meter indicating a flow of water.

Dissimilar Plates

Now let's take a look at Fig. 3. Here we have the two dissimlar plates immersed in weak acid, a condition under which they are situated in much the same electrical condition as the two tanks of water were, namely, when the electrical circuit is completed by closing the switch, the lamp lights and the ammeter indicate a flow of electricity, just as the water meter indicated a flow.

Now, it is likewise apparent that as the lower tank's water level rises its opposition to further water flow from the upper tank increases, and as the level of the upper tank lowers, its pressure grows less, because the pressure is due to the height of the water, and in an analogous manner the electrical pressure difference between the zinc and copper plate of Fig. 3 grows less as long as I keep the circuit completed, and if I keep it closed long enough the **pressure difference** that caused the flow of electricity gradually dwindles down to the point where no current flows, because there is no longer any pressure difference to make it flow.

The analogy between electricity flowing along a wire and water flowing through a pipe ceases to bear a close relationship when each is scrutinized at short range because when a current of electricity started to flow, as in the case of Fig. 3, the cause of pressure difference was chemical, whereas in the case of Fig. 2 it is mechanical (or due to the fact that the tanks were at a different level).

Students of elementary chemistry soon become acquainted with the electro-chemical series of metallic substances. This series depends upon the activity or natural oxygen combining power of these substances.

Works Faster

Now, as zinc (Figs. 1 and 3) has a higher (or faster) oxygen combining power under a given temperature and environment, than copper, we say that the two metals are at dissimilar points in the chemical activity scale. Consequently it is possible to arrange all metallic substances in a progressive order of chemical activity so that any given substance will bear a certain electrical relationship to all substances that preceded it on the list and the opposite relation to all those that follow, in regular order, or otherwise, if so arranged. Hydrogen heads the list with a combining power of 1.

Now in Fig. 1 we started out with a fresh and clean transparent jar into which we poured some distilled water and subsequently placed the copper (positive) plate and the zinc (negative) plate into the water and if we had then connected a galvanometer to these plates we would have observed no deflection, showing that no difference of potential existed! This would be true if the plates were absolutely clean, that is, without a trace of acid, and the jar is super-clean, too, but immediately on allowing a drop of hydrochloric acid (H-CL) to mix well with the pure distilled water a deflection is obtained, showing the presence of a weak current.

If now the lamp had been substituted for the galvanometer the water in the jar could have been still further acidified until the lamp glowed brightly.

Cause of Condition

Now, what does this show? It shows that electrical pressure, or difference of potential, when such potential difference is due to a cell or a battery, is caused initially by the dissimilar chemical combining power of the two plates of the cell or battery, and the gradual loss of this potential difference is directly due to the fact that the combining power of the two plates grows progressively less and less as more and more of the zinc plate combines with acid solution of the jar.

In this particular case the zinc plate is eaten away rather rapidly because in addition to the normal action of the cell is the additional effect of "local action," a process that involves reaction between impurities contained within the structure of the zinc plate and the acid solution, with the result that the zinc plate is ruined before the regular cell action has progressed very far. This local action can be delayed by amalgamation with mercury.

(Continued next week)

Pointers on Building

By J. E.

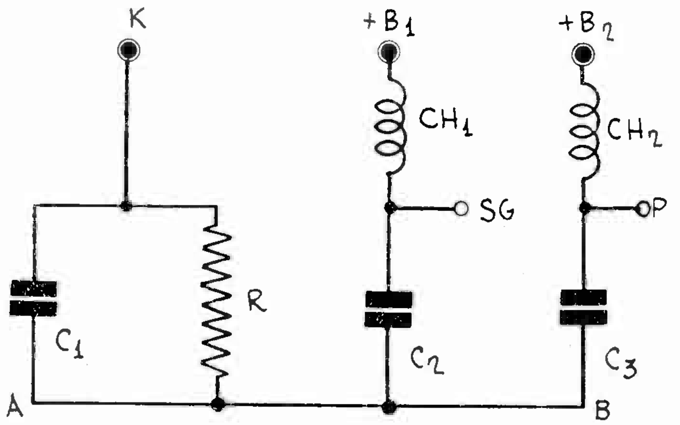


FIG. 1
THIS IS THE CIRCUIT DIAGRAM OF A FILTER TO BE USED IN SCREEN GRID AMPLIFIER STAGES TO PREVENT FEED-BACK AS WELL AS TO PROVIDE GRID BIAS.

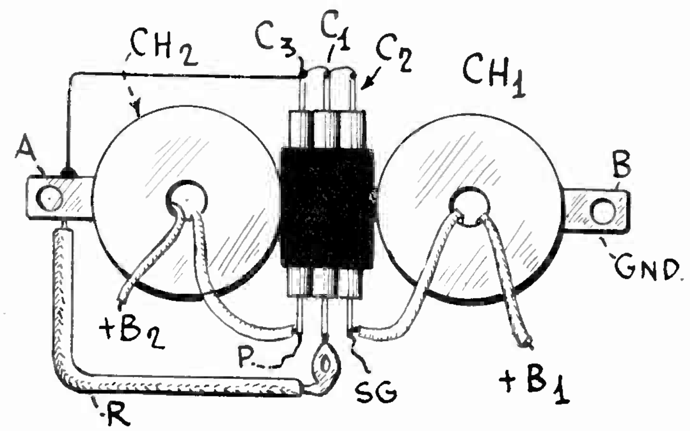


FIG. 2
THIS ILLUSTRATES THE LAYOUT OF THE FILTER ASSEMBLY SHOWN IN FIG. 1. THE TWO COILS ARE AT THE ENDS AND THE THREE CONDENSERS ARE GROUPED BETWEEN THE COIL. THE BIAS RESISTOR RUNS FROM THE MIDDLE CONDENSER TO GROUND.

IN BUILDING a receiver of any kind, and especially a complex receiver like a Superheterodyne, systematic and orderly wiring is the best insurance against failure, or against only mediocre success. A part of this orderly wiring is the testing of all parts that go into the circuit before they have been put in and then testing the connections immediately they have been made. Sometimes it is possible to assemble certain units, or groups of parts before they are connected into the main assembly.

One of these groups is the feedback filter, that is to say, the assembly of by-pass condensers, choke coils, and resistors, the object of which is to prevent feedback from one stage to preceding stages. In Fig. 1 we have such a group of parts. It occurs in many screen grid tube circuits and will be used in a Superheterodyne to be described.

The terminal marked K is to be connected to the cathode of the involved, SG to the screen grid of the same tube, and P to the B plus side of the primary of the transformer connected in the plate circuit of that tube. R is the grid bias resistor, which for a 224 screen grid tube should have a value of 300 ohms. The radio frequency choke coil Ch1 is in series with the screen voltage supply and choke coil Ch2 is in series with the plate voltage supply. Each of these chokes may have an iductance value of from 10 to 100 millihenries. Standard commercial values are 50, 65 and 85 millihenries, either of which may be used. B1 plus and B2 plus indicate the terminals which are to be connected to the screen and plate voltages, respectively.

The three condensers C1, C2, C3 by-pass, respectively, the bias resistor R, the screen voltage supply, and the plate voltage supply. Each of these condensers should have a value of .01 mfd. or more for the broadcast frequency range. All these condensers are connected to the grounded bus bar AB, as is one side of the bias resistor R.

A Compact Group

The compact group into which these parts may be assembled is illustrated in Fig. 2. The circles represent the two shielded choke coils Ch1 and Ch2. The three condensers are stacked up side by side, taped together with friction tape, and placed between the two coils. The shields of the coils and the metal mounting lugs form the ground bus bar. The resistor R is attached to the lugs on one side and to the K terminal on the other. The designations in Fig. 2 correspond to those in Fig. 1.

Before this group of parts is assembled, or at least before any connections are made among the members of the group, each part should be tested. Test each condenser for short-circuit. If a voltmeter and a battery are connected in series with a condenser there should be no permanent reading on the meter. Test the resistor R for an open, and also make sure that its resistance has the proper value. If the voltmeter and the battery are connected in series with this resistor there should be a permanent reading on the meter. Likewise test each of the choke coils, both for continuity and for short to the shield. The coils will be continuous if the voltmeter and battery test show a reading. To test whether or not the shield is connected to the coil connect the voltmeter and the battery to one coil terminal and to the shield. If a reading is obtained the coil should be rejected or else the short should be found and remedied. If there is a short it is likely that it will be found where the two coil leads emerge from the shield.

When all the units have been tested and found all right, complete by making the proper connections and soldering. Provide five flexible leads and mark them so that they can be identified later when the unit is to be connected in the circuit.

The Superheterodyne to be described will have three of these filter units, all the same in every respect. One of them will be put in the radio frequency amplifier ahead of the modulator and two will be placed in the two intermediate frequency amplifiers.

Wiring the Heater Circuit

After the parts have been laid out on the sub-panel and the sockets have been mounted, the first that should be wired is the heater circuit, in the case of an AC receiver, and the filament circuit in the case of a battery receiver. Fig. 3 shows the heater circuit of a six-tube Superheterodyne receiver utilizing 227 and 224 tubes throughout.

The heating transformer is supposed to have two 2.5-volt windings, one capable of supplying a heavy current and another a current for one or two tubes. The heavy winding is made to serve the first five tubes and the other the detector alone.

Note that the leads from the five heaters converge at two points, that is, that separate leads are run from each heater to the heavy leads on the transformer. Each pair of leads should be twisted separately up to the junction points, and from these points the common leads should be twisted. It is well to make the common leads as short as practicable. Since the heater transformer is heavy it may be well to decide where it will be most convenient to place the junction points before it is mounted and leave the final connection until most of the other wiring in the receiver has been completed. The junction points should either be soldered and taped separately or else they should be made to insulated screws in the sub-panel so that there will be no danger of a short-circuit.

The best test for the heater circuit is that all the tubes light when the power is turned on.

The center-taps of the two heater windings are joined together and connected to ground, and the core and case of the transformer are also grounded. If the transformer is not mounted when the heater circuit is wired, these connections cannot be made until after the transformer has been connected.

Transformers Used

Five radio frequency transformers will be required, all of practically the same design except for the number of turns on the secondaries. Coil data will be given in June.

The coils are mounted in specially turned wooden forms through the center of which the leads run below the sub-panel, except that the grid lead may run upward through a hole in the top of the shield.

The secondaries, for use with .0005 mfd. tuning condensers, will cover the broadcast band. Larger secondaries, when tuned with fixed condensers of the same value in addition to a midget condenser, will tune to a frequency slightly below 500 kc. which is the intermediate frequency. Just how much below depends on how much of the midget condensers is used in parallel with

a Superheterodyne

Anderson

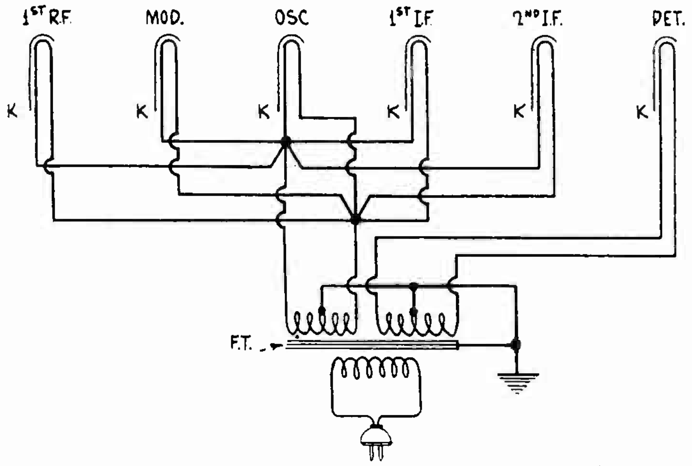


FIG. 3
THE WIRING DIAGRAM OF THE HEATER CIRCUIT IN A SIX-TUBE SUPERHETERODYNE. SEPARATE TWISTED LEADS ARE RUN FOR EACH TUBE TO THE COMMON SUPPLY.

the fixed condensers. Since it is desirable to use an intermediate frequency only a little less than 500 kc no more of the trimmer condensers should be used than is necessary to insure accurate tuning. This means that at least one of the trimmer condensers can be set at minimum.

The Oscillator Circuit

The oscillator coil is entirely different from the other coils. In the first place, it has three windings, the tuned winding, the tickler, and the pick-up. While the coil may be wound on the same kind of form as the others the turns must be different, and the number of turns depends largely on the intermediate frequency that is ultimately selected. If we assume that the intermediate frequency is 500 kc, the oscillator must cover a frequency range of 1,050 kc to 2,000 kc. If the oscillator condenser is to be one section of a three-condenser gang with a capacity of .0005 mfd. per section, the oscillator inductance must be much smaller than that of the RF secondaries. Moreover, since the rate of change of capacity required in the oscillator will be different from that required in the radio frequency circuits, it is necessary to make provision for compensating the difference. This is done with a midget condenser connected across the oscillator tuning condenser section. The exact adjustment of the oscillator will be given when the circuit diagram and the construction of the Superheterodyne are described.

Right or Wrong?

QUESTIONS

1—The Loftin-White amplifier cannot be built in push-pull because the coupling is direct.

2—There is no advantage in using an audio frequency amplifier having more than one stage of push-pull.

3—The pitch of a certain received note can be raised or lowered by changing the loudspeaker so that it becomes more or less effective at that frequency.

4—It is possible to start with one known frequency and an oscillator and measure other frequencies both higher and lower than the known frequency.

5—A short-wave coil can be made to cover a much wider range by using the Bernard dynamic tuner system.

(6)—It is not practical to build an A battery eliminator with dry rectifiers and electrolytic condensers.

(7)—A good way of improving the sensitivity of a multi-tube receiver in which the coils are shielded is to cut slots in the shields so that no appreciable induced currents can circulate in the shielding.

(8)—Induced currents in a short-circuited turn or in a shielding can have no effect on the inductance of the coil thus exposed to the short-circuit.

(9)—The distributed capacity effect of a shield is small compared with the effect of the shield on the inductance of the coil.

(10)—The more slots that are cut in a shield the better the shielding becomes.

(11)—Any broadcast receiver having good selectivity and sensitivity in the radio frequency amplifier may be made into a first rate superheterodyne receiver.

(12)—There is no distortion of a modulated signal in the transmitting medium, that is the ether.

(13)—A broadcast receiver of given sensitivity remains equally sensitive in all kinds of weather.

(14)—Moisture in the atmosphere has the effect of lowering the sensitivity of a receiver.

(15)—The effect of high relative humidity on the sensitivity of a receiver is not immediately noticeable and may not show up for four days.

ANSWERS

1—Wrong. Messrs. Loftin and White have worked out a push-pull amplifier in which the output tubes are in push-pull and both receive their input voltage in the proper phase. The phase inverter arrangement is used to effect the coupling.

2—Wrong. It is just as advantageous to use push-pull in the first audio stage as in the output stage following it. That is to say, harmonic distortion in the first stage is prevented if this stage is push-pull just as it is prevented in the output stage. The output stage does not eliminate any of the distortion generated in the stages ahead of that stage. If it did, it would not be a faithful amplifier.

3—Wrong. Nothing in the receiver, especially in the loudspeaker, can change the pitch of a note broadcast by a station. What is meant by the change of pitch in a speaker is change in the pitch to which that speaker responds most strongly.

4—Right. This is done in nearly every instance when oscillators ars calibrated against a standard frequency. Only one frequency is measured accurately by primary methods and when that frequency is known the frequencies of all its harmonics are also known with the same accuracy. Means are available by which harmonics as high as the 400th can be detected and utilized. However, it is customary to attune an auxiliary oscillator to one of the harmonics of the standard frequency and then utilize the harmonics of the auxiliary to get higher frequencies. For example, if the standard frequency is 5,000 cycles per second an auxiliary oscillator might be tuned to the 10th harmonic of the standard, that is, to 50,000 cycles. Then the harmonics of the auxiliary can be used. Its 10th harmonic would be 500,000 cycles, which is equivalent to the 100th harmonic of the standard.

5—Right. This is done in the short-wave converter described in Radio World for May 24.

(6)—Wrong. A highly satisfactory A supply can be made with this equipment, as was explained in the May 10th issue of Radio World.

(7)—Right. This is indeed a good way when the shielding is too close to the coil. The slots cut in the shielding break up the induced currents and thus minimize losses.

(8)—Wrong. Induced currents reduce the effective inductance of the coil so that to tune the coil to a given frequency more capacity is needed.

(9)—Right. While the distributed capacity of the coil is increased a little by the shielding this increase is very small compared with the decrease in the inductance.

(10)—Wrong. If enough slots are cut the condition of no shielding will be approached. The slotting does not increase the shielding, but reduces it, leaving enough to keep the circuit stable.

(11)—Right. A superheterodyne is nothing but a radio frequency amplifier of fixed frequency, preceded by a frequency changer. Hence by placing a frequency changer, consisting of at least one modulator and one oscillator, in front of a radio frequency receiver and coupling suitably we will have a superheterodyne.

(12)—Wrong. There is distortion because the signal travels to the destination by two or more routes, of different electrical lengths, and phase shifts among the received signals result in distortion.

(13)—Wrong. The sensitivity of a receiver varies with the relative humidity of the atmosphere. The higher the relative humidity the lower the sensitivity becomes.

(14)—Right. The more moisture there is in the atmosphere the higher the relative humidity, assuming fixed temperature, and the higher the relative humidity the more moisture does the insulation in the receiver absorb. The absorbed moisture lowers the efficiency of the circuit by increasing losses.

(15)—Right. There may be a lag of from one to four days between the effect and the cause. Thus when moist and dry weather periods follow each other in regular succession it may be that the receiver will appear to be more sensitive when the weather is wet than when it is dry.

Infradyne Tuning

MANY fans have fixed frequency amplifiers of the Infradyne type which they wish to use with modern Superheterodynes. The question that arises is how to construct the oscillator so that it will cover the broadcast band. There is no particular difficulty in determining the constants of the coil and the tuning condenser.

It must be clearly understood that the Infradyne is not a Superheterodyne. A Superheterodyne is characterized by the fact that the locally generated oscillation beats with the signal frequency to form a beat frequency which is tuned in by the intermediate frequency filter. The term "intermediate" is not used because the amplifier is located in the circuit between the radio frequency and the audio frequency parts of the circuit but because the frequency at which the amplifier operates is actually intermediate between the carrier and the audio frequencies.

The Infradyne does not utilize a beat at all but an addition or a summation frequency. Hence the circuit is not a Superheterodyne and the fixed-frequency amplifier is not an intermediate frequency amplifier. The fixed frequency is the highest frequency involved, or supermediate frequency.

When two frequencies interact in a distorting circuit like a detector or modulator there are two principal products of the interaction, the difference, or heterodyne, frequency and the summation frequency. We can tune the fixed-frequency amplifier to either. If we tune it to the difference frequency we have a Superheterodyne and the fixed-frequency amplifier is an intermediate frequency amplifier, but if we tune it to the summation frequency we have an Infradyne.

Fixing the Frequency

If we decide to use the summation frequency of the products of the interaction we may choose almost any value we desire, but for practical reasons we should choose a frequency which is higher than any of the signal frequencies we desire to receive. In the Infradyne the fixed frequency selected was 3,500 kc. This is satisfactory because it is much higher than 1,500 kc, the highest broadcast frequency. It is satisfactory also because it is not so high that an effective fixed-frequency amplifier cannot be designed.

When we have selected the fixed frequency we can proceed to determine the range of the oscillator that will cover the broadcast band. The broadcast range is from 550 to 1,500 kc and the fixed frequency is 3,500 kc. What should the frequency of the local oscillator be when the circuit is to tune in 550 kc? Let F be the frequency. We then have 550+F=3,500 kc. Solving for F we get F=2,950 kc. And what should the frequency of the oscillator be when the 1,500 kc broadcast frequency is to be tuned in? Let f be the frequency. Then we have 1,500+f=3,500 kc. Solving for the unknown we get f=2,000 kc Thus we get the range of the oscillator as 2,000 to 2,950 kc. It will be noted that the oscillator range is inverted with respect to the broadcast range, that is, the higher broadcast frequency requires the lower oscillator frequency. That this should be so is obvious from the fact that the sum of the two must always be equal to the constant frequency 3,500 kc.

Small Relative Range

Relatively the range 2,000-2,950 is very small, since it is only 1.475. The relative range of the broadcast tuner must be 2.73, since this is the ratio of 1,500 to 550 kc.

This small relative range has an important bearing on the design of the oscillator. If the inductance coil is reduced so that the lower frequency comes in at 100 on the dial the higher extreme frequency will come in well above the middle of the dial. This means that the whole broadcast band would be crowded into a small portion of the tuning dial. The circuit would seem to be very selective, although its selectivity might be considerably less than that of a Superheterodyne. Most of the oscillator tuning condenser would be useless. The situation would not be any better if the inductance were adjusted so that the higher frequency came in at zero on the dial. In this case the upper half or more of the condenser would be useless.

The thing to do is to use both a relatively small variable condenser and a large fixed condenser across the tuning inductance. If Co is the fixed capacity in the circuit when the variable condenser is set at minimum, the variable capacity should be .863 as large as the fixed capacity. These are so nearly the same that one fixed and one variable condenser of the same rating might be used. The broadcast band will then nearly cover the entire dial of the variable condenser. If the ratio of the fixed to the variable capacities were exactly as given above the broadcast stations would be spread out from zero to 100 on the dial.

Determination of Inductance

So far we have said nothing about the required inductance. The reason is that we have not yet specified the capacity. Since the frequencies involved are rather high we need a small capacity and a small inductance. Suppose we make the fixed portion of the condenser .0001 mfd. Then the variable portion should be .863×.0001, or .0000863. The nearest commercial condenser is a .0001 mfd. midget.

Then we have a total capacity in the circuit, when the condenser is set at maximum, of .0002 mfd. The inductance must be determined so that the circuit will tune to 2,000 kc when this capacity is used. We get 31.7 microhenries as the required inductance. This is, indeed, a very small coil. It can be obtained by winding 49 turns of No. 24 DCC wire on a one-inch diameter. The tickler winding may be put on the same form, using the same wire, and it need not have more than 20 turns.

It should not be supposed that a Superheterodyne cannot be built with an intermediate frequency as high as 3,500 kc., even for receiving broadcast frequencies. It is obvious that the locally generated frequency can be increased to such a value that when a broadcast frequency is subtracted from it the difference is equal to the fixed frequency. If we wish to receive the 550 kc broadcast frequency we can set the oscillator at 3,850 kc and if we want to receive the 1,500 kc broadcast frequency we can set the oscillator at 5,000 kc. Thus by making the range of the local oscillator from 3,850 to 5,000 kc we can cover the entire broadcast band.

In this case we note that the higher oscillator frequency will bring in the higher broadcast frequency, and vice versa. Thus a good way to distinguish whether we are using the difference or the summation frequency is to note whether or not the oscillator seems inverted. If the stations come in in the same order as the broadcast frequencies we have a Superheterodyne, but if they come in in the reverse order we have a summation, or Infradyne, receiver.

Smaller Coil for Super

If the circuit is made into a Superheterodyne with a 3,500 kc beat frequency the inductance in the oscillator must be less than when the circuit is used as an Infradyne, because the oscillator frequency is higher. Instead of being adjustable from 2,000 to 2,950 kc it should be adjustable from **3,850 to 5,000 kc.** If we use the same tuning capacity the inductance should be 8.52 microhenries. This is so small that it is probable that the circuit will not oscillate with the specified capacities. In that case it will be necessary to use smaller tuning capacity and a larger coil.

If there is a radio frequency tuner in the circuit for selecting broadcast frequencies, this is not changed in any way whether the fixed frequency amplifier is to be used as a heterodyne amplifier or an Infradyne. It is only the oscillator that need be changed, but that may have to be changed either by varying the inductance or the capacity, or by varying both.

Use Low Fixed Frequency

A fixed frequency of 3,500 kc is not recommended for a Superheterodyne for several reasons. First, the receiver will not be so selective as a receiver using an amplifier of much lower fixed frequency. The high selectivity of the Superheterodyne of low intermediate frequency is due to the fact that the ratio of interfering frequency of given value to the fixed frequency differs much from unity. As the fixed frequency increases, the ratio becomes closer and closer to unity, and the closer to unity the ratio is, the harder it is to separate the stations.

We give an example to emphasize this fact. Suppose the intermediate frequency is 50 kc. A station of 600 kc is desired and there is a station operating on 610 kc. The oscillator is set so that the beat with the 600 kc frequency is 50 kc, that is, it is set at 650 kc. When so set the oscillator also beats with the 610 carrier and generates a frequency of 40 kc. The ratio of the interfering frequency to the fixed frequency is 4/5, or 0.8. The original ratio of the two frequencies was 60/61, or .984. Hence, the frequency changing has made a decided improvement.

Now suppose the fixed frequency is 3,500 kc. The oscillator is set at 4,100 kc. The interfering frequency will beat at 3,490 kc. The ratio of the interference to the carrier is 349/350, or .9975. This is much closer to unity than .984. It would be better from the point of view of selectivity not to use the fixed frequency for the original ratio was only .984.

Advantages of High Frequency

Those who have 3,500 kc fixed-frequency amplifiers can use them by making the oscillator as previously described, that is, using a condenser of 100 mfd. fixed capacity, a variable condenser of the same capacity, and a coil having 49 turns of No. 24 DCC wire on a one-inch diameter. But they should realize that the selectivity will not be so good as if the fixed frequency were lower, or as it would be if a straight radio frequency amplifier were used.

The high fixed-frequency amplifiers have some advantages as well as disadvantages. First, the coils needed in the fixed-frequency amplifiers are very small and occupy little room. Second, the tuning condensers may be small, inexpensive trimmer condensers, which also take little room. Third, the oscillator coil and the oscillator condenser are also small and comparatively inexpensive.

Capacity Measurements

By Herbert E. Hayden

THERE are many different sizes of tuning and fixed condensers on the market. These are given certain ratings in terms of microfarads. But sometimes the actual capacity of a condenser is different from the rated capacity. The deviation in fixed condensers may be rated at 10 per cent. plus or minus, but the actual deviation may be much larger. Indeed, there is little certainty just what the capacity is. Tuning condensers are subject to even greater uncertainty, for these are not even marked. One is led to go by the number of plates in the condenser.

But the number of plates in a condenser does not tell anything about the capacity of that condenser. The capacity depends on many factors besides the number of plates. For example, it depends on the size of each plate and on the separation between the plates. If the condenser is not an air dielectric condenser one has to regard specially the kind of dielectric that is separating the plates.

There are transmitting condensers using huge plates and great separation between the plates, the capacity of which is less than that of a midget used for trimming tuning condensers in the broadcast receiver. Then there are small condensers used in compact sets that have as high capacity as the usual tuning condensers in broadcast receivers. Thus it is obvious that the number of plates does not tell anything about the capacity of a condenser.

The only way to be certain of the capacity of a condenser is to measure it. But that raises the question as to how the measurement should be made. In laboratories the question is simply answered by putting the unknown capacity in a Wheatstone bridge and comparing it directly with a standard calibrated condenser. Unfortunately, very few who wish to measure the capacities of condensers have access to Wheatstone bridges or to standard variable condensers. The equipment is both expensive and cumbersome.

So if the radio fan wants to measure the capacity of condensers he must have methods for doing it which he can apply with the parts he has or which he can get without great expense.

If the condenser in question is a tuning condenser of the same, or approximately the same, value as a tuning condenser the capacity of which he knows, the problem is easily solved. He can rig up a Wheatstone bridge out of parts he has and compare them directly. A simple bridge circuit is shown in Fig. 1. The resistance R1R2 is a straight resistance wire which may be taken out of a high resistance rheostat. It should be stretched straight and mounted on a board of suitable length, directly over a scale, which may be a strip of cross section paper, or simply a yardstick. Make the wire exactly the same length as the scale.

Cx is the condenser to be measured and C the condenser the capacity of which is known. Both condensers should be set at maximum for it is the maximum value of the unknown which is usually desired and it is also the maximum value of the other which is known.

The antenna ordinarily used with the receiver is connected to one end of the resistance wire and the ground to the other. The receiver input terminals are connected from the junction of the two condensers to a slider on the resistance wire. If the ground side of the input to the receiver is actually grounded or connected to the filament circuit of the receiver, this connection must be cut because the slider must not be grounded.

Tune in Signals

Tune the broadcast receiver to a strong local station as accurately as possible. Then move the slider until the signals disappear or until they are as weak as they can be made. When this balance point has been found the following relation exists among the arms of the resistance wire and the condenser of known capacity: $Cx=R2C/R1$. If the wire is of uniform section, which it is if it is a single wire, the lengths of wire as read from the scale under the wire may be used for the actual resistances. Hence if L2 and L1 are the lengths corresponding to the resistances R2 and R1, respectively, we have the relation $Cx=L2C/L1$ from which to determine the value of the unknown capacity in terms of the known. Suppose the total length of the wire is one yard and that L2 is 20 inches. The length of L1 is therefore 16 inches. Then in this particular case the formula reduces to $Cx=20C/16$. If the capacity of the known condenser is 350 mmfd., that of the other is 437.5 mmfd.

It is of prime importance to keep the order in which the factors occur in the formula for if the ratio is inverted the wrong value will be obtained.

It may be that a condenser of known capacity is not available. Then there is still a simple method of determining the capacity of a tuning condenser, provided there is a station of known frequency around. Wind a coil on a three-inch diameter using 50 turns of No. 24 enameled wire. Wind closely. The inductance of this coil is 233 microhenries. Connect a variable condenser across this coil and, using it as a wave trap, find the setting of the condenser at which a selected broadcast station previously tuned in is cut out. Leave the condenser in this adjustment, locking it if necessary. Calculate the capacity of the condenser at this setting, using the known inductance and the known broadcast frequency. The formula is $C=108.8/F^2$, in which C is measured in microfarads and F in kilocycles. Thus, if the frequency selected is 600 kc the capacity is 298 mmfd. This known capacity can now be used for measuring any other condenser by the bridge method just described.

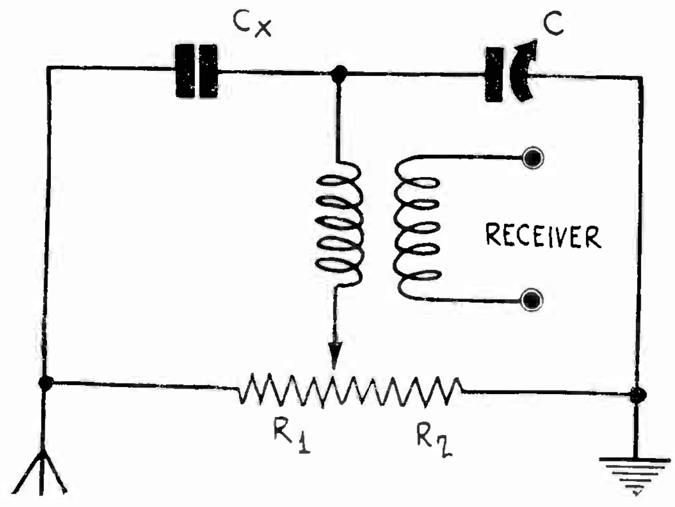


FIG. 1
A SIMPLE SLIDE-WIRE WHEATSTONE BRIDGE FOR COMPARING THE CAPACITIES OF TWO CONDENSERS. IF THE CAPACITY OF ONE IS KNOWN THAT OF THE OTHER MAY BE DETERMINED IN TERMS OF THIS KNOWN CAPACITY AND THE RATIO OF THE TWO RESISTANCES.

Measuring Small Capacities

If it is a question of measuring very small capacities such as those of trimmer condensers, the work may be done by substitution. For example, a calibrated condenser can be put into a wave trap circuit and adjusted to a given frequency, it does not matter which, just so the tuning point falls on the scale. Then the small condenser is put in parallel with the calibrated condenser and the readjustment is made again. The calibrated condenser will now read lower than it did before by the amount of the capacity of the small condenser. It is only necessary to subtract one reading from the other and the difference is a measure of the capacity of the small condenser.

It may be that the condenser used for tuning is not calibrated. In that event the capacity of the small condenser cannot be obtained by this method. However, if the tuning condenser is of the straight line capacity type, and its maximum value is known, a fair approximation to the capacity of each division can be obtained by dividing the total capacity by the number of divisions on the scale. Suppose, for example, that the maximum capacity of the condenser is 500 mmfd. and the scale has 100 divisions. The capacity per division is therefore 5 mmfd. Then if the difference between the reading when the midget is not across the tuning condenser and that when it is across it is 20 divisions, we know that the capacity of the midget condenser is 100 mmfd.

No measurements of any kind can be made without some standard of measurement. If we wish to measure the length of anything we compare it with a yardstick, if we want to measure the weight of anything we compare it with a standard weight, if we wish to measure the capacity of a bin we compare it with a bushel, and likewise, if we want to measure resistance, inductance or capacity we have to compare the unknown with standards of resistance, inductance or capacity. But the standards need not be elaborate.

Sometimes it is desirable to measure the capacity of a large by-pass condenser. The methods previously explained are not suitable for such large capacities. However, if we have an AC ammeter and an AC supply of known voltage and frequency, we can apply Ohm's law directly. The condenser is simply connected in series with the ammeter and the supply and the current noted. The capacity of the condenser is then equal to $C=.00265I/V$. In this equation the capacity is given in farads, the current in amperes and the potential in volts, and it is assumed that the frequency of the current is 60 cycles per second.

The Effect of Shields

By Gerald Converse

"I BUILT the circuit exactly according to the diagram, but I do not cover the broadcast range of wavelengths." That is a complaint often heard concerning sets having shielded coils. It is possible to follow a diagram exactly and yet to build a set most inexactly. Some things that are required, as stated in a list of parts, may not appear on the diagram definitively. Suppose that shielded coils for .00035 mfd. tuning are prescribed. Usually a particular make of coil is mentioned, and that make is provided with a particular size and shape of shield. Now, everything else in the receiver may be just right, except the size of the coil and the shield. Instead of following the directions to the letter the constructor has done some branching out on his own account, which is highly commendable, but which, if done, should be done with a mastery of the facts.

Concerning the use of shielded coils, these facts are that the size and shape of the shield influence the effective inductance of the coil. Suppose that for .00035 mfd. tuning it is explained that the coils consist of 40 turns on the primary, 80 turns on the secondary, No. 28 enamel wire in each instance, outside diameter of tubing, 1¾ inches. The shields are round aluminum, 2½ inches in diameter, with flattened bottom to match an aluminum base furnished with the shield. Now, almost anybody with any experience in radio knows that if no shields are used that 80 turns are entirely too many for .00035 mfd. on a 1¾ inch diameter.

Effect on Dial Settings

Now, a constructor, failing to use the prescribed shield, will select a larger one, say, of the square type, 4 inches from corner to corner. It is quite all right to use larger shields but it must be borne in mind that the larger the shield, up to a limit, the fewer number of turns required.

Let us look at the subject in the light of dial settings. A particular tuning condenser of .00035 mfd. will bring in WABC at 50 on the dial, WJZ at 65, WEAF at 75, WNYC at 90, in the ascending order of wavelength, with the prescribed coils and shields. Suppose that the same coils are used, but, even while maintaining a round shield, the diameter is 3½ inches instead of 2½ inches. Now the dial settings are different. They are as follows, the old ones being cited in parentheses: WABC, 40 (50); WJZ, 56 (65); WEAF, 70 (75) and WNYC, 86 (90). No particular harm has been done at the high wavelength settings. They are represented by lower readings of the dial. But what happens when the lowest wavelength stations are to be tuned in? The process of reducing the numerical readings on the dial simply puts the lowest wavelength stations out of the reception (frequency) range of the receiver.

An easy way to solve the problem is to try out the coils with the larger number of secondary turns, if the shields are larger than prescribed, and hook up simply one stage of radio frequency amplification and a detector, as they will constitute a workable tuner. Determine the range in wavelengths. Does the lowest wave, 200 meters, come in? If so, where? Probably you won't be able to tune as low as 215 meters. Try the other end of the dial. Does the circuit tune in 545 meters? You may not have a station in sensitivity range that is on 545 meters, but you can visualize the result from 526 meters, as there should be at least 10 divisions to spare above where the 526 meter station comes in, if you can't tune in 200 meters.

Cause of Reduced Inductance

Therefore you have too much inductance if you miss out on 200 meters or stop at some other wavelength near it but higher. Hence you may remove turns from the secondaries of the two coils used, until the lowest wavelength station is heard, and then the highest wavelength station should come within the spread of the dial. Count the number of secondary turns removed. Probably you will take off two turns at a time, unless the divergence is great, when your first trial will be the elimination of six or eight turns. At least, keep track of the number taken off, and remove the same number from the secondaries of the coils not in circuit. Then you are all set to wire up the receiver.

The reduction of effective inductance of the coil when any shield is placed over it is due to absorption of energy. In a circuit that affords high radio frequency amplification, that is, a very sensitive receiver, it is necessary to resort to shielding to make the circuit workable. The coils must be safeguarded against interaction and also against direct pickup of signal without benefit of antecedent tuning, and shielding accomplishes these objectives. All receivers having more than one stage of screen grid radio frequency amplification should have all coils shielded.

Shield One, Shield All

It is obvious that if one shielded stage is used, all stages must be shielded, because otherwise the effective inductances would be at sixes and sevens. Also, the shield has a strong capacity effect, and to have a shield around one coil and not around another would render still more difficult the attainment of balance needed for gang tuning, due to capacity effect alone, although while capacity is going up, due to shields, inductance is going down.

The question naturally arises, then, whether a shield is a loss. It is indeed. But it is a gainful loss, like the brake on an automobile. A high-amplifying tuner is like a car racing downhill. Unless some check is put on it the car is uncontrollable. The shield is like the brake on the automobile, in that respect, giving protection and affording control and workability. In the opposite instances, of no shields or no brake on the automobile, the circuit or the automobile runs wild. Either, instead of being a useful machine, it is a useless one, and dangerous. The danger in the case of the receiver is that it will radiate interference to other listeners, because of squealing. The usefulness of the high-gain receiver without shields is that it is not sensitive, it is not even operative. Oscillation kills off reception, except perhaps at the highest wavelengths.

Reversed Regions of Squealing

Another peculiarity about shielding is, since it creates a condition of energy absorption, it introduces resistance into the tuned circuit. It is well-known that the effect of resistance in a tuned radio circuit is that the lower the wavelength the more pronounced the resistance. In fact, the resistance itself is higher, the lower the wavelength. So the condition of squealing on low wavelengths, with quiet operation on high wavelengths, often becomes reversed. The reason is due to the resistance introduced by the shielding. At the lower wavelengths this resistance effect is greater, so the circuit is stabilized here, but at the higher wavelengths the resistance is less, and squealing may result.

So the designer of the circuit must take these facts into consideration in prescribing the parts used and the methods of construction of the circuit. The general practice, when this condition of reversed squealing is encountered, is to make the amplification at the highest receivable wavelength the most that it can be without squealing, whereupon the amplification at the lower wavelengths will not be too great for stability. Hence shielding creates an added benefit, since it is handier to work out a design wherein squealing is encountered at high wavelengths, than one where it is met on the low wavelengths. Lossers to cure low-wavelength squealing usually prove disastrous to amplification at the high wavelengths, hence above 450 meters even local stations then may come in faintly.

Failure to Cover Wave Band

It is not always true that when the lowest wavelength station can be tuned in, the highest can be tuned in. Since the shield not only reduces effective inductance but develops a capacity addition as well, incorrect design of shield or coil, in conjunction with a given condenser, may make it impossible to cover the entire broadcast band of wavelengths.

One contributing factor to capacity, which works to this end, is too close coupling between primary and secondary in a screen grid circuit, where the primary, in the plate circuit of a screen grid tube, has a large number of turns, while the secondary is the tuned circuit. Looser coupling, by winding the primary, if on the outside, over a few layers of Empire cloth separating primary and secondary, or reduction of the number of turns on the primary, will reduce the capacity effect.

With a given effective inductance, the question whether the entire wavelength band will be tuned in depends on the capacity ratio in the circuit. This ratio is the result of the ratio of the tuning condenser, which is usually about 1-to-10, minimum to maximum, as affected by the fixed capacities, i. e., trimmers, distributed capacity of the windings of coils, capacity of the plate-to-cathode or plate-to-filament circuit of the tube, and the capacity arising from close coupling and high amplification. So if the ratio is 35 to 350 mmfd. for the tuning condenser, and the fixed capacities, as a most extreme supposition, total 200 mmfd., the ratio would be 235 to 550 or, roughly, 1-to-2, which is considerably different from 1-to-10. With 1-to-2 you could not hope to tune in even a quarter of the broadcast band of wavelengths.

Good, Bad or Indifferent

From the foregoing it is plain that a shield introduces loss, and that circuits modest in RF amplification can not stand this loss and do not need individual stage shielding. The gainful aspect of individual stage shielding is denied to such circuits.

A distinction should be made between individual stage shielding and common shielding. When a receiver is placed in a metal cabinet common shielding results, but interstage reaction is not averted without individual coil shields.

Dynamic Applications

By John C. Williams

[The following article is the last of a series dealing with dynamic speaker theory and practice.—Editor.]

THE dynamic speaker eventually will be used in conjunction with the automobile receiver, and especially on cars large enough to accommodate the extra power equipment necessary to operate the larger auto receivers.

Automobile dynamics at first thought will seem to be impractical because of two main disadvantages, weight and the pot magnet or field coil. The first objection, weight, may include awkward shape, but can be avoided by careful design.

The second objection, the field coil power, can not be entirely avoided, but a part of the magnetizing coil current can be furnished by the tube filament current and some battery power thereby used in two circuits that would otherwise be spent in one.

In line with what I have previously remarked about theatre speakers being designed for special uses, I think that a speaker for domestic radio cabinet use could be evolved that would consist of at least two or more separate tuned units which would function so as to reproduce some one portion of the musical scale, and a separate unit for voice especially. The big trouble to-day in the speaker design field is that radio buyers want realism, but they only want one speaker—and IF a speaker, or several units are suitably mounted, and I mean in this case **a speaker** that is composed of several units in a single baffle, the results after proper co-ordination of the several units should be very good.

The increasing popularity of automobile radio receiving sets has prompted the writer to evolve a special dynamic speaker to fit in with an automobile radio chassis, and is so designed (on paper) that it contributes materially to the all over amplification of the set—a feature that is also true of regular sized dynamics—but difficult to build into a small dynamic unless it can be mounted in some kind of a baffle.

Countless Variations

The advantage of design adaptability of the dynamic speaker means that it may be arranged in countless different ways and may be used as a microphone in a pinch.

The writer tried out this scheme not so very long ago by arranging a speaker without any external baffle on a table, and piped the output through an amplifying system, obtaining fair results.

This prompted me to try out this same scheme as a stethoscope (an instrument that doctors use when listening to heart beats and other sounds that are of low audibility within the body) with the result that I could very plainly hear the heart beats of my subject issuing from the loudspeaker! For these experiments I used a large paper cylinder as a baffle and mounted it on a speaker chassis in such way that the rear cone surface was completely blocked off and the output from the voice transformer was connected to a sensitive two-stage amplifier which subsequently fed into the regular amplifier within my radio receiver. I did not try to develop this method of listening to sounds of low audibility to any great extent, but it has possibilities, I would say, and is worthy of further investigation and those interested should experiment with very light suspensions and vary the exciting flux with a view to obtaining some helpful resonance effect.

The final brief discussion concerns a pet idea of mine, the dynamic phonograph record pick-up, which I believe could be made to provide reproductive quality and quantity far in excess of present available equipment.

Mechanical Arrangement

A general idea of the mechanical arrangement can be stated briefly, and it is this:

The needle holder, of aluminum, is attached through a support bearing to a lightweight moving core system that carries two coil windings of fine wire so connected that they resemble the secondary connections of a grid input transformer, and these are for connection to an input push-pull audio system similar to the first audio stage of amplification that usually precedes the 245 push-pull power amplier in our ordinary radio receiver. Now, it undoubtedly seems unnecessary to have such an arrangement of inducing coils, but if you could make a graph of the induced voltage due to one coil alone you would see that the contour of this curve would not imitate the record's sound wave track very well; it would, in fact, be distorted by a series of recurring flat spots, on each positive or negative loop, depending on which side of the coil system you were using.

Moving Coils Cut Flux

The magnetic flux that the two moving coils cut across is furnished by an unusually designed double pot magnet that forms the assembly nucleus for the whole instrument. The volume is controlled by varying the magnetization and is very satisfactory, because the magnetizing current is furnished by carefully filtered "B" supply current supplied to the plates of the first push-pull audio stage. The controlling resistance is potentiometer connected, and the disk type is suggested, as there is no danger of a highly magnified scratching sound due to poor contact resistance.

At this point someone will want to inquire about a scratch filter, and right here is a point about which I have thought quite a lot. This type of pickup IS sensitive, but its output characteristic is controllable over a wide range also, and as the **only** audio currents induced are those produced by lateral movement of the moving coils, I think this type of pick-up will provide the **minimum** of scratch without any filtering device, and as a consequence we will obtain very much greater degree of reproductive realism than previously attainable.

Disadvantages Stated

Having now briefly summarized the advantages of this dynamic device, it is only fair to recognize its disadvantages, first of which is weight, because the device requires more careful balancing, and if the magnetizing coils get defective the instrument is **"dead"** instantly (as compared to the gradual fatigue of a permanent magnet), and the fine wire voice, or generator coils, are subject to likely injury if they get out of alignment due to mechanical shock, and so, while this instrument provides results in its class that compare with the advantage of the dynamic speaker over the magnetic type, some further experiment will be necessary.

The above cases in which electro-dynamic principles are applied to the production of sound are not the only ones. Our large electric power houses and distribution stations have hundreds of solenoid switches. These devices are arranged in many forms. The principal one is the main line circuit-breaker, a kind of electrical watch dog, to protect the generators from serious overload.

To return to the subject of interest at present. I would like to show a form of acoustic motor-generator with an operative principle of interest to experimenters.

If you have a magnetic or dynamic speaker in baffled or unbaffled state (that is, the chassis only) you can assemble some simple apparatus to show something of the mechanical response of your speaker, without damaging the speaker in the least.

The scheme is to obtain an old dynamic speaker pot complete with a 6 volt magnetizing coil and make up a voice coil to fit the air-gap of this and mount it with a light-weight push rod attached in the air-gap of the old speaker pot.

Interesting Comparisons

Then suitably arrange the speaker to be tested and the old speaker pot so that the push rod projects directly at the axis of the other speaker cone. Then attach it firmly to the cone apex of speaker to be tested and then connect the voice-coil directly to a small dry disc rectifier using the AC terminals of this and connect the DC terminals of the rectifier to a small disk type portable galvanometer—then with the old speaker pot excited—connect the speaker to be tested to a source of variable frequency, suitably amplified and keeping the voltage applied to the speaker uniform, vary the frequency throughout the audio range and read the corresponding galvanometer deflections.

You will find some interesting comparisons via this simple frequency test and the effect of various baffles can be investigated in this way very nicely.

The source of variable frequency is a beat oscillator, and this device can be assembled by the experimenter easily by consulting a radio measuring instrument maker's catalogue where circuit diagrams for such devices are given.

Mixing Experiment

One form of oscillator, whether of the beat or impulse type, has some interesting surprises in store for the experimenter who builds one. This oscillator is of the double-circuit type whose outputs are coupled to a mixing coil, and the result of this mixing coil effect is that one can reproduce violin tones to an interesting degree of fidelity.

A THOUGHT FOR THE WEEK

DOES Norman Brokenshire pay the Quaker State Oil Co. for the privilege of advertising N. B., or does the Quaker State Oil Co. pay Norman Brokenshire for the privilege of letting N. B. do as he darned pleases? Whatever the answer, N. B. has introduced something new in programs and it's worth whatever it is that somebody pays to somebody else. Eh, Charlie?

A Precision Ohmmeter and

By Herm

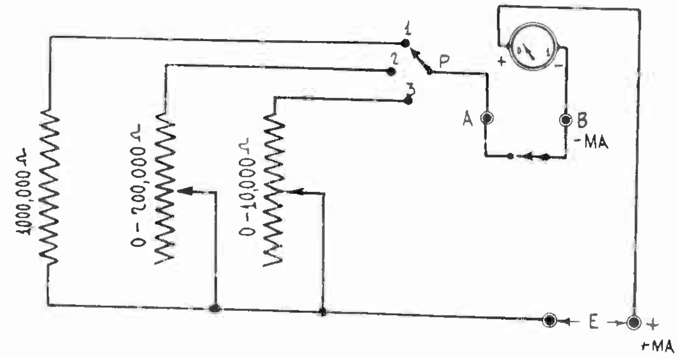


FIG. 1
CIRCUIT DIAGRAM OF THE PRECISION OHMMETER (1,500 TO 200,000 OHMS) AND HIGH RESISTANCE VOLTMETER (0-10 VOLTS, 0-200 VOLTS).

A PRECISE combination measuring instrument that is a 0-1 milliammeter, a high-resistance voltmeter with three scales, and a 200,000 ohmmeter, may be constructed as diagrammed in Fig. 1.

The 0-1 milliammeter is used as such simply by connecting this meter in series with the current to be measured. The two binding posts that extend upward from the meter in the diagram render independent access for this purpose. The meter is used for measuring small values of current, for instance, detector plate current, which is often too small to be measured with meters of lesser sensitivity or greater range, or measuring plate curent in any resistance-coupled single tube circuit.

The milliammeter used divided the scale into fifty equal parts, so that each division represented one-fiftieth of one milliampere, or 20 microamperes.

The internal resistance of this particular meter is 88 ohms, but this fact does not come into consideration when the instrument is used as a current indicating device, but only when it is used as a voltmeter for reading the lower voltages.

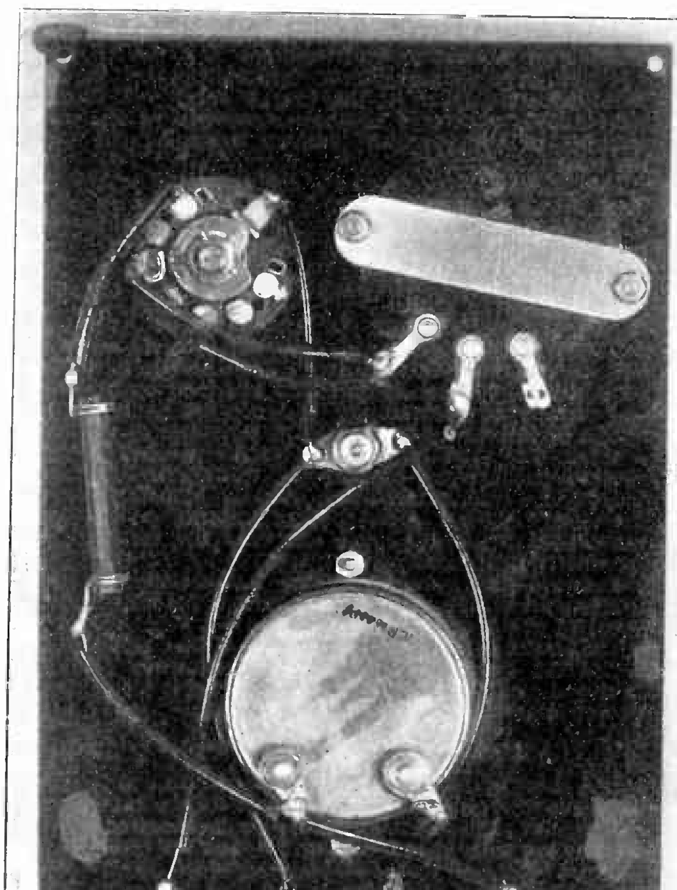


FIG. 2
REAR VIEW OF THE WIRED TESTER.

LIST OF PARTS

One 0-1 milliammeter (Cat. F-0-1).
One Centralab duo potentiometer (0-10,000, 0-200,000 ohms).
One Lynch 1 meg. metallized pigtail resistor specially selected for reasonable accuracy.
One Benjamin on-and-off switch.
Four binding posts.
One 5½x8⅜ inch bakelite panel, with engraved calibrations.
One cabinet to fit.
One pointer knob.
One three-way switch with break between contacts.

Voltmeter at 1,000 Ohms Per Volt

As a voltmeter the instrument consists of the milliammeter with an external series resistor. As a voltmeter the resistance is 1,000 ohms per volt. This is true no matter how small or how large the multiplying resistance may be. The amount of resistance used as multiplier simply determines the range. The greater the resistance the greater the maximum voltage reading.

The resistance per volt of a voltmeter may be determined by dividing the current at maximum deflection into the number 1. Hence the resistance per volt is the number of times the full-scale deflection current has to be multiplied to produce the number 1. If the meter is a 0-1 milliammeter, then .001 ampere flows at full-scale deflection. The resistance per volt therefore is the reciprocal of the full-scale deflection current, and is a function of the meter, having nothing to do with the amount of resistance used for multiplying the scale for voltmeter purposes. For any given needle position the current is always the same. For higher voltages the resistance is higher to obtain the same needle position.

By using two adjustable resistors, one of 0-10,000 ohms, the other 0-200,000 ohms, maximum readings of voltages on each of these inclusions would be 10 volts and 200 volts respectively. This is because every 1,000 ohms represents one volt in a measuring system that has a resistance of 1,000 ohms per volt. The two adjustable resistors may be on one shaft, for simplicity, since only one resistor is used at a time. A switch permits you to cut in either of the variable resistors independently.

Scales Defined

A third tap on the switch cuts in a 1 meg. resistor (1,000,000 ohms), hence affords readings up to a maximum of 1,000 volts. The only object of including this high reading is that sometimes voltages beyond 200 volts are to be measured, but there is hardly ever any occasion for reading more than 532 volts, which is the combination of 450 plate volts and 82 negative grid volts for 250 output tube.

The reason for selecting 1 meg. instead of .5 meg. is not solely that .5 meg. permits less than the required reading in the cited example of the 250 tube, but because the interpretation of the milliammeter scale is much easier. Since full-scale deflection is represented by the number 1 (for 1 milliampere), 0.2, 0.4, 0.6 and 0.8 represent 200, 400, 600 and 800 volts respectively. So, too, the 10,000-ohm resistor at maximum setting makes 0.2, 0.4, 0.6 and 0.8 designate 2, 4, 6 and 8 volts respectively, although the 200,000 ohm resistor makes 0.2, 0.4, 0.6 and 0.8 designate 40, 80, 120 and 160 volts respectively, since the scale is multiplied by 200.

Thus far we have accounted for (a) a 0-1 milliammeter, used independently; (b) a 0-10 voltmeter, resistance 1,000 ohms per volt; (c) a 0-200 voltmeter, resistance 1,000 ohms per volt; a 0-1,000 voltmeter, resistance 1,000 ohms per volt.

The Internal Resistance

In the foregoing considerations of the voltmeter the multiplying resistance has been taken as the total resistance, although there are 88 ohms of internal meter resistance also in circuit. In the lowest-reading range of voltages, maximum is 10 volts, accounted for by 10,000 ohms, therefore an error of .088 volt would be introduced at maximum reading. The actual voltage would be nearly .9 of one per cent higher than the reading. Hence the accuracy at 10 volts would be maintained at more than 99 per cent, which is as high a degree of accuracy as can be reasonably expected. At 1 volt the error would be 8.8 per cent, or ten times as great, which is serious. Nevertheless, this error may be removed, as will be shown.

In fact, the voltmeter depends for its accuracy also on the

High-Resistance Voltmeter

n Bernard

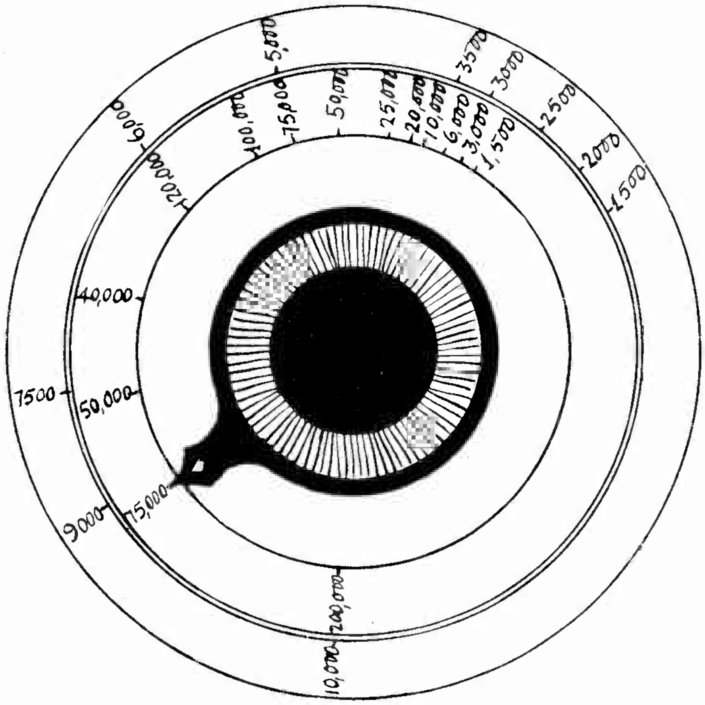


FIG. 3
CALIBRATION OF THE 200,000 OHM ADJUSTABLE RESISTOR, THE ONE NEARER THE SHAFT, AND THE 10,000 OHM RESISTOR

accuracy of the series resistors, particularly the adjustable ones, and their correct calibration. The 1 meg. resistor for 1,000 volts is not highly accurate.

Different types of variation of resistance are used. There is the straight line resistance variation, whereby the resistance cut in or out changes at the same rate as the dial setting.

If accurately made straight line adjustable resistors are used it is not necessary to calibrate them, although advisable to check up to determine whether maximum are 10,000 ohms and 200,000 ohms respectively. Each division of the 100 scale would represent 100 and 2,000 ohms respectively.

The calibration of the resistors may be made with the 0-1 milliammeter and a known source of steady direct voltage.

Getting Minimum Resistance Reading

This brings up the possible necessity of accurate determination of the voltage source by an independent meter of 1,000 ohms per volt. We can not use the present 0-1 milliammeter, because the very series resistor to constitute it an accurate voltmeter is the unknown quantity we are seeking.

But we assume a voltmeter of lesser resistance per volt is handy. It may have 100 ohms per volt. Across a new dry cell or a storage battery the lower resistance voltmeter will give as accurate a reading as the other. We need high resistance voltmeters for measuring voltage drops across resistors and old cells.

As we are interested in obtaining the resistance and in safeguarding the delicate precision meter, we serve both purposes by connecting a fresh 1½-volt dry cell, even of the flashlight type, or part of a C battery, across E, and measuring the actual voltage with a 0-6 voltmeter of the lower resistance type. The reason for measuring the voltage is that it may be 1 3-5 volts.

Turning the knob from maximum resistance setting, extreme left, we go to the right only far enough to obtain full-scale deflection. Now this is 1,000 ohms for every volt of the battery at E. For 1.5 volts at E the full-scale deflection (1 on the meter) represents 1,500 ohms, for 1 3-5 volts it represents 1,600 ohms, etc. We are limited by the voltage at E, and as 1½ volts are the lowest easily obtainable, our ohmmeter will give a minimum reading of 1,500 ohms, for 1½ volts at E.

Suppose full-scale represents 1,500 ohms, at the setting of the resistor obtained. Put on a dial to read 0 here and provide an end-stop to prevent off-scale current damaging the meter. Turn the dial to make the meter read 0.8. Now the resistance is greater (the current being less) and is directly proportionate, i. e., 5-4 of 1,500 or 1875 ohms. Note the dial setting. Do the same operation for 0.7, 0.6, 0.5, 0.4, etc., the resistance being 10-7, 10-6, 10,5, 10-4, etc. of 1500. You will find the maximum resistance, say, at the seventh meter division (0.014 ma. or .00014 amp.). Hence the resistance at maximum would be 1.500 divided by .00014 or 10,700 ohms. It is usual for commercial adjustable resistors to overrun their maximum rating.

Thus do we calibrate for one adjustable resistor, and repeat the process for the other, but use a higher voltage for the 0-200,000 ohm resistor, as 30 to 45 volts, for better definition of the higher resistance settings. Hence two calibrations are needed. These could be represented by two scales engraved on the panel, while a pointer knob is attached to the resistor shaft.

Assuming the adjustable resistors used are as specified, the calibrations given herewith may be used.

Since the adjustables are two potentiometers, either clockwise or counter clockwise calibrations may be used, by having the center arms as one connection, and using either side as the other. The resistance decreases with clockwise motion, and the calibrations given herewith therefore read downward from left to right.

One point to notice is that the positions of exactly 10,000 ohms and exactly 200,000 ohms must be determined, and specially marked, for voltmeter purposes.

Also, of course, the 88 ohms of internal meter resistance have been included, so that error is eradicated.

The adjustable resistors alone are used for resistance measurement. The 1 meg. leak serves no resistance measurement object.

Since different settings of the resistors give different resistance values that are represented by different dial settings, and different equivalent current values as read on the meter. Once the calibrations have been made, the adjustable feature may be used for measuring resistance value.

With one adjustable resistor we may obtain values of resistance from 1,500 to 10,000 ohms or a little more, and with the other adjustable one values of from 1,500 ohms to 200,000 ohms or a little more. We know both the dial settings, for a known applied voltage, and the current indication, for a known applied voltage and known value of resistance in circuit. However, now we want to get rid of any requirement for a known voltage source.

We have calibrated the adjustable resistors, and we know the resistance for every position of the dial. No matter now about the applied voltage, so long as it is enough to give deflection, say 1.5 volts and 22½ volts respectively. So, with the resistance known for all settings, we have a measuring rod. The voltage is of no importance, except that it should not be excessive for the resistance used, to protect the meter. The resistance at any setting is always the same, regardless of voltage.

Directions for Use

(1)—To measure the value of an unknown resistor, plug it into receptacles A and B shown on the minus side of the meter, and put the pointer P to point 1, for 1,000,000 ohms. Always start at point 1 as a safeguard.

2—Apply a voltage across the terminals at E and see that switch SW is closed.

3—If no reading is obtained on the meter, turn the 200,000 ohm adjustable resistor knob to maximum and then change the pointer from 1,000,000 ohms to 200,000 ohms, that is, from point 1 to point 2.

4—While all the 200,000 ohms are still in the circuit, short the unknown by pressing down switch SW and note whether the current indication is greatly increased.

5—If it is not greatly increased turn the resistance knob so as to decrease the resistance in the circuit. Adjust the position of the knob until the reading is just twice as great when the unknown is short-circuited as when it is in the circuit. When this adjustment has been found the unknown is just equal to the resistance read on the scale, obtained by previous calibration.

6—If this adjustment cannot be obtained with the 200,000 ohm resistor in the circuit, or if it cannot be read easily, set the 10,000 ohm resistance at maximum and then shift the pointer from point 2 to point 3. Repeat the process of adjusting the setting of the knob until the reading of the meter is just twice as great when the unknown is shorted as when it is in the circuit. When this adjustment has been found the unknown resistance is just equal to the resistance read on the 10,000 ohm scale.

A substitution method of measuring also may be used. For this we can use either the 200,000 ohm range or the 10,000 ohm range, depending on the value of the unknown. Try the 200,000 ohm range first for the sake of safety. Suppose we use the 200,000 ohm range as an example.

1—First set the knob for maximum resistance.

2—Short-circuit the unknown.

3—Adjust the knob until the meter shows some even reading, that is 0.2, 0.4, 0.6, 0.8, or 1.0, with the meter needle exactly on the line.

4—Note the resistance reading on the scale.

(*Concluded on page* 17)

USED TWELVE GROUNDS, GOT 5 CONTINENTS

Washington.

The cultural effects, if any, that radio has on illiterate "hill billys" will be studied when 100 sets are placed in isolated mountain homes by the United States Office of Education.

The Department of Interior made the announcement, which set forth:

"Many of these homes can be reached only by mule trails and footpaths. In some of the homes live persons who never saw a railroad train, an automobile, or an airplane. Will such folks enjoy listening to a man who has flown over the north and south poles?

"Will they understand the plan of a man who has tried to solve the reparations problems following the World War by organizing a world bank and selling securities of the defeated nation to the victors? What programs will they enjoy most, and how will such programs affect them educationally?

Used Twelve Grounds for DX

"Surprising things already have been discovered concerning the results of radio in isolated homes. Dr. T. H. Harris, State superintendent of public instruction in Louisiana, has found radio receivers in places where he least expected them. While visiting a home 40 miles from a railroad he was asked if he had heard President Hoover's address on flood control.

"The lady of the house told how she had heard it with her radio, and she discussed it with every indication of interest and understanding. The matter was of vital importance to her for her home was in the area occasionally flooded by the Mississippi.

Set Covered World

"A young man on a farm in Rhode Island saved enough money to buy a two-tube receiver. He found by experimenting that an extra ground wire improved the reception and one by one he increased the number to 12. At the end of two years he had a log containing records of programs that he had heard from more than 700 broadcasting stations in 52 countries.

"Many of these records had been verified by comparison with records at the broadcasting stations. He had brought in stations on all five continents and Oceania so many times that six children in the family were mimicking the accents of the foreign announcers.

"When skeptics expressed their doubts, or ascribed his results to 'a freak location,' he referred them to another young man in Pennsylvania who had secured equally remarkable results with a receiver that he built himself.

Educators Interested

The educators will supervise this experiment with no preconceived notion as to what it will prove or disprove. Teachers for centuries have depended on printing to supplement their oral efforts, but much education was accomplished before printing was invented—even before writing was invented. Why should not persons who have received the ideas of others mainly through the sense of hearing be able to hear, understand and learn from fellow humans whose voices come to them by means of radio?"

Stations Must Post Licenses

Washington.

The Federal Radio Commission has "ordered that every station license shall be posted by the licensee in a conspicuous place in the room in which the transmitter is located, and the license of every station operator shall be posted in a conspicuous place in the room occupied by said station operator while on duty."

This order, the Chairman of the Commission, Maj. Gen. Charles McK. Saltzman, explained, was adopted to facilitate the work of radio supervisors and inspectors of the Department of Commerce in inspecting stations.

CONSOLIDATION BILL RECEIVED

Washington.

Immediate transfer of the functions, personnel and apparatus of the radio division of the Department of Commerce to the Federal Radio Commission is proposed in a resolution introduced in the Senate by Senator Dill (Dem.), of the State of Washington.

Declaring there is no apparent opposition to the measure, Senator Dill said he was hopeful that it would pass both houses of Congress. The purpose of the legislation, he said, is to centralize all of the radio activities of the Federal Government in one agency as a forerunner to the projected Federal Commission on Communications.

Senator Dill said he understood that the Secretary of Commerce, Robert P. Lamont, is favorable to it.

Mr. Dill declared he had discussed the measure with members of the House Committee on Merchant Marine and Fisheries and that they favored it. The radio division, he explained, is the "police agency" in radio which works independently of the Commission itself.

The Senate Committee on Interstate Commerce, Senator Dill declared, met in executive session and continued its section-by-section consideration of the Couzens bill for the creation of the proposed communications commission which would take over the functions of the Radio Commission, and would have full authority over telephones, telegraph and cables as well as radio.

A new provision, under which radio inspectors and supervisors would be empowered to seize radio apparatus being operated in violation of the law and to confiscate it, with court approval, was inserted in the measure, Senator Dill stated.

Bill Asks Stations to Disclose Owners

Washington.

A section of the Couzens bill for a department of communications, approved by the Senate Committee, provides that each licensee of a broadcasting station, during the first week of each calendar month, between 7 and 10 o'clock p. m., or if not licensed to operate between those hours, at the time nearest to 7 o'clock p. m. at which the station is licensed to operate, "shall announce over said station the name of the owner thereof, and, if the owner be a corporation, the names of all persons owning 25 per centum or more of the stock of said corporation."

WGY'S VICTORY MADE FINAL IN TIME DISPUTE

Washington.

WGY has won a final victory over the Federal Radio Commission in the dispute regarding the assignment of the station in the 1928 reallocation. The Supreme Court of the United States has dismissed the appeal of the Commission from the decision of the Court of Appeals of the District of Columbia that held WGY was entitled to stay on 796 kc full time. The Supreme Court held that the lower court, in reaching its decision, acted as an appellate court exercising administrative functions, and that such action can not be reviewed by the Supreme Court.

The opinion, written by Justice Van Devanter, set forth:

"We think it is plain that the powers confided to the Commission respecting the granting and renewal of station licenses are purely administrative and that the provision for appeals to the Court of Appeals does no more than make the court a superior and revising agency in the same field.

Calls It Administrative

"The court's province under that provision is essentially the same as its province under the legislation which up to a recent date permitted appeals to it from administrative decisions of the Commissioner of Patents. Indeed, the provision in the act of 1927 is patterned largely after that legislation. And while a few differences are found, there is none that is material here.

"Our conclusion is that the proceeding in that court was not a case or controversy in the sense of the judiciary article of the Constitution, but was an administrative proceeding, and therefore that the decision therein is not reviewable by this court."

Hughes Doesn't Participate

In the Commission's general reallocation of broadcasting stations effected November 11th, 1928, WGY, owned and operated by General Electric, at Schenectady, N. Y., was reduced to limited time operation on the 790 kilocycye channel, on which KGO, at Oakland, Calif., also a General Electric station, was placed on full time. WGY took an appeal to the lower court, which reversed the Commission's decision.

Chief Justice Hughes did not participate in the opinion, as he appeared for WGY in the lower court.

Outlaw Broadcaster Is Ordered Deported

St. Louis.

"Persons operating outlaw radio stations, who do not quit now, will be on their way to Federal prison soon."

So said Paul D. P. Spearman, counsel for the Federal Radio Commission, who appeared against George W. Fellowes, of England, convicted by a jury in Federal Court of operating a station without a license. Fellowes was sentenced to a year in prison, but was paroled, so he could be turned over to the immigration forces for deportation, by agreement between counsel. Fellowes had picked up the programs of licensed stations and rebroadcast them, a procedure termed "air piracy."

MONOPOLY SUIT SPURS A PROBE OF PATENT LAW

Washington.

The suit by the Federal Government against the Radio Corporation of America, General Electric, Westinghouse, American Telephone & Telegraph, and others in the radio patent pool, has prompted a move for a Senate investigation of the patent laws generally. While some senators hold that such an investigation should be made if RCA and its associations are vindicated, others maintain the inquiry should be started no matter what the outcome of the suit.

Wheeler Wants Inquiry

Senator Wheeler (Dem.), of Montana, said:

"I believe that there should be a thorough investigation of our whole patent system with a view of enacting legislation which would do away with many of the evils that exist at the present time. It seems to me that it is absolutely necessary that changes be made in the present patent laws to meet the new and existing conditions of our times.

"When the patent laws were first written they were written to protect the genius of individuals in inventing something new, and the idea of great monopolies getting control of all the patents of an industry was beyond the conception of the lawmakers at that time.

"The patent laws were created to protect the little fellows, but today they are being used by the monopolies and trusts to crush the little fellows.

Asks Ban on Pools

"Regardless of what the courts say as to the pooling of patents in the pending litigation, it seems to me that laws should be passed prohibiting such arrangements."

The suit "strikes at the very fundamentals of the Radio Corporation organization and is most comprehensive," said Senator Dill (Dem.), State of Washington. "If the patent pool finally is adjudged invalid, then the pool will automatically be dissolved, and there will be nothing more to do about it. But if it is held valid, then Congress must decide what to do about the patent laws."

"The case will help clarify the whole radio patent situation and the attitude of the RCA that it has a clean bill of health as to its patent pool," said Senator Dill. "I have been trying to get this case into the courts for the past five years."

Bill Asks Three Government Waves

Washington.

A broadcast wavelength shall be assigned exclusively to each of three Federal Government departments—those of Agriculture, Interior and Labor—is the provision in a bill introduced in the House by Representative Reid (Rep.), of Aurora, Ill.

He set forth that such action was necessary as a preliminary step toward safeguarding public rights in broadcasting, which he says the radio trust is fast monopolizing. He cited that labor has been denied a channel for itself, while the radio trust has six or seven channels at enormous power, from 25,000 to 50,000 watts. He was referring to WCFL, the Chicago Federation of Labor station, having been denied an exclusive channel.

WICC Prohibited from Using 600kc

Hartford, Conn.

The court order issued against the Federal Radio Commission, prohibiting it from interfering with WICC's operation on 600 kc was vacated by Judge Burrows, on application of WGBS, New York City.

Both stations were on 600 kc, but the Commission relegated WGBS back to 1,180 kc, leaving WICC on 600 kc. WGBS got an injunction in the District of Columbia and pending final determination was permitted by the court to stay on 600 kc. Under that ruling the Commission sought to put WICC back on its former channel, which the ruling of Judge Burrows makes possible.

BILL GOVERNS POLITICS ON AIR

Washington.

Broadening of the provisions of the present radio law respecting the use of broadcasting facilities for political discussion was agreed upon by the Senate Committee on Interstate Commerce in considering the Couzens bill for the creation of a Federal commission on communications.

The Committee, in the amended provisions, specifies if a station permits a candidate for public office to utilize his station he shall afford "equal opportunities to all other such candidates for office." The bill makes clear, however, that no obligation is imposed upon any licensee to allow the use of his station by or in the interest or support of any candidate for public office.

The merger provision of the Couzens bill, which now forbids the joint ownership or operation of radio and wire facilities in external communications, also was considered by the Committee, in executive session, but no vote was reached, says "The United States Daily."

License Compulsion Dropped from Bill

Washington.

A provision of the Couzens bill to create a Federal Communications Commission, which provision would have required holders of radio licenses also engaged in manufacturing apparatus to lease or sell such apparatus to any other radio licensees, has been eliminated by the Senate Committee on Interstate Commerce.

This provision, said Senator Dill, of the State of Washington, after the session, would work "too great hardship," in the Committee's opinion and for that reason was voted out. The Radio Corporation of America and the International Telephone & Telegraph Corporation formally protested against the inclusion of the provision in the bill.

The clause was inserted in the bill, Senator Dill explained, as a result of allegations before the Committee during its study of communications generally that the Radio Corporation of America had refused to sell, lease or license certain of its apparatus to competitive companies. He said that the provision might be reinstated on the Senate floor.

LITERATURE WANTED

Lester Tucker, 47 Madison Avenue, Hartford, Conn.

Ebenezer B. Peebles, 2059 W. Roosevelt Rd., Chicago, Ill.

N. Y. CITY HELD OVERFED WITH BROADCASTING

Washington.

A statement of facts in connection with the appeal of WGBS, of Astoria, New York City, against the Federal Radio Commission's order taking the station off the 600 kc channel and assigning 600 kc to WICC, of Bridgeport, Conn., has been filed in the District of Columbia Court of Appeals by the Commission.

WGBS received a temporary assignment to the 600 kc channel. WNYC and WMCA, both of New York, operating on 570 kc, only 30 kc from 600, instead of the usual 50 kc, objected to the assignment on the ground that WGBS was causing interference with their broadcasts.

After a hearing the Commission ordered WGBS off the 600 kc channel and to return to the channel it had previously used. The station obtained a stay order from the court and is still operating on 600 kc, but in the meantime the Commission granted WICC a license to operate on the channel, a grant the court ordered rescinded.

Explaining the assignment to WICC the Commission stated:

"New York City has more radio broadcasting facilities than any other place in the first zone; it has a superabundance of radio broadcasting service, whereas there are only four stations in the entire State of Connecticut."

WRAW Asks Better Frequency Position

Washington.

Representatives of WRAW, Reading, Pa., have presented testimony before the Federal Radio Commission seeking to have the station moved to a more desirable channel with increased power so as to provide adequate radio service to the City of Reading. George O. Sutton, former broadcast engineer of the Commission, presented arguments in support of the application for assignment to the 620 kc channel with full-time operation and 1,000 watts power. The station now uses 100 watts part time on the 1,310 kc channel.

Louis G. Caldwell, former general counsel for the Commission, opposed the application in behalf of WTMJ, Milwaukee, Wis. He explained that this station now operates on the 620 kc channel, with 1,000 watts power at night and 2,500 watts during the day. The service rendered by this station would be curtailed, he said, if the Reading station were allowed to operate on the same channel.

CORNISH HAS NEW CATALOGUE

The Cornish Wire Company, 30 Church Street, New York City, announces that its new catalogue showing a complete line of radio wires, antenna kits and lightning arresters, is ready. The company is offering a complete line of hookup wires for manufacturers. Shielded wires are also included. Mention RADIO WORLD.

GOLENPAUL QUITS CLAROSTAT

Charles Golenpaul, for several years general sales manager of Clarostat Manufacturing Co., Inc., 285 North Sixth Street, Brooklyn, N. Y., has resigned.

RADIO WORLD

The First and Only National Radio Weekly
Eighth Year

Owned and published by Hennessy Radio Publications Corporation, 145 West 45th Street, New York, N. Y. Roland Burke Hennessy, president and treasurer, 145 West 45th Street, New York, N. Y.; M. B. Hennessy, vice-president, 145 West 45th Street, New York, N. Y.; Herman Bernard, secretary, 145 West 45th Street, New York, N. Y.

Roland Burke Hennessy, editor; Herman Bernard, business manager and managing editor; J. E. Anderson, technical editor.

The Anti-Trust Suit

THE main question at stake in the suit by the Federal Government against the Radio Corporation of America, and its associate corporations in the patent pool, concerns the rights under a patent as compared with the anti-monopoly clauses of the Sherman and Clayton Acts.

On the one hand the Federal Government grants a patent to an inventor. The rights thereby attained may be transferred or sold. The defendants did a great deal of patent buying, so obtained whatever rights the sellers had to those patents. Besides, there are valuable patents that were issued directly to the defendant companies.

By gaining control of the patents necessary for lawful transmission and set manufacturing, it is hardly to be disputed that the defendants got the radio situation well within their grasp and control. The dispute concerns not the fact but the law. A patent is in itself a monopoly, granted by the Government, for a term of seventeen years. Now, if one statute prohibits a monopoly, while another statute sanctions and encourages it, which law is to be believed? The object of the suit, the first of its kind to test this peculiar situation under the patent law and the anti-trust laws, is to obtain an official answer.

That there is doubt even on the Government's side seems to be clear enough from the fact that, although the subject-matter of such a suit has been under consideration for five years or more, action is taken only now. The Senate Interstate Commerce Committee prodded the Department of Justice to come to some decision as to whether to sue or not to sue, and the answer was, to sue. The decision to bring suit arose more out of doubt as to whether any law had been violated than from a conviction that any nad been. In announcing the suit the Department of Justice even went to the pains to state: "The defendants . . . have earnestly contended that they are doing nothing more than they are authorized to do under the patent laws." This was followed by the frank admission: "The situation is an intricate one and it is desirable that these vexed questions be settled by the courts."

Hence, there is no denying that the object of the suit is to clear up the vexatious aspect. It is not one of those trust-busting, thunderous and bitter assaults that in other days were frequent and demoralizing. Radio has been raised to a vast industry, and who can say that with radio patent ownership scattered hither and yon the present vastness would have existed now?

This is no time for dire speculation as to what may happen if the Government succeeds in its suit, even though under the radio law a violation of the anti-trust laws visits a penalty of forfeiture of broadcasting licenses by the offenders, and under the patent laws the reversion of patents to their original owners.

It is rather a time to look to the courts of equity to reach a fair judgment and resolve an awkward doubt in the best possible manner. Even should the Government win it is conceivable that no dire consequences would ensue to the defendants.

What 12 Grounds Did

A POOR New England radioist, managing to scrape together enough money for the parts for a two-tube broadcast receiver, and contriving to build it himself, discovered he obtained mediocre results when he used a good aerial and only one ground. So he used two grounds, and improved reception, especially getting more distance. He tried more and more grounds, until he finally reached the considerable number of a dozen grounds! Why he did not use a few more is not disclosed, but perhaps he had no more room.

Why he used a dozen grounds is clear enough, from his own statement to the United States Department of Education; he was able thereby to tune in stations from all over the world, and had a reliable and authenticated log of stations from the five mundane continents, though not a peep from Mars, confound it!

The ground hog, if he may be called that with no intention to offend, became nettled when it was suggested he was benefitting from freak reception conditions. So he referred doubters to another of his ilk, this one a Pennsylvanian, who also had a commensurate distance record.

It is, indeed, interesting to learn what more and more ground connections can accomplish, and it is fair enough to assume that the New Englander's experience will prompt many others to try several or many grounds on their receivers, all worked simultaneously, of course.

Even the humble New Englander has injected himself into a none too well understood scientific problem. More experiments have been made with the sky wave than with the ground wave. It is recognized that the radio wave does take these two courses, the one upward to the heaviside layer, where reflection back to earth is effected by the negative polarization, but much less is known of what happens in the ground course of the radiation. DX enthusiasts will not worry much about the mathematics of the problem, if they can improve their reception range by using more grounds. The motto may well become: More and Better Grounds. And why not, if a multiplicity of grounds does work all these wonders?

Now Tone Control

NOW tone control is to be a feature of receivers. This will be corroborated at the Radio World's Fair at Atlantic City, week of June 2d.

Tone control consists of changing the audio frequency response to a broadcast program, so that besides the duplication of the original, there becomes possible an agreeable falsification of the original, such as predominance of the bass or the treble. Some receivers will have duo-tone control of this sort, while others will have tri-tone control, with accentuation of the middle audio frequencies possible.

The subject of tone quality is always a difficult one to solve to the satisfaction of a large number of customers, because what one group considers good quality another considers poor quality. Heretofore, the manufacturers have decided on their own account what the public regards as good tone quality. Along came prospective customers who were satisfied with every aspect of the receiver, except that they complained that the tone was not quality in any sense. Then the manufacturer might bring forth an audio frequency curve as flat as corrugated cardboard that had been sent by mistake to the laundry, but it mattered not. The curve may be flat on paper, but the response of the receiver fell flat on the ear.

So it is deemed desirable to include tone control. This does not deny the fundamental necessity of a radio receiver as to tone: that the reproduction be a faithful copy of the original as emitted from the studio. Does tone control mean that the manufacturers have given up hope of ever being able to make receivers in quantity that will enable such faithful reproduction, hence the devices for variation are introduced as easy makeshifts? No, it does not mean that. Nor does it mean that the manufacturer need swerve one bit from the highest standards of tone fidelity. In present-day manufacture it is possible to produce receivers in quantity that give faithful audio frequency response. The problem is not an exasperating one, it is not even a problem, since it has been solved.

The reason for a tone control is that, no matter what a curve may show, or an engineer may know about acoustics, it is nevertheless true that a salesman has to have some answer ready for a customer who is sold on everything except the tone. That answer must be in action, not in words. Nothing he can say will save the sale, but something he can do will save it. So the thing to do is to turn a knob and change the "poor tone quality" to "thrilling realism."

The fact that not all of us hear alike, nor does any one have the same aural response throughout his life, makes it advisable to have a tone control. Then we can enjoy, in our ripe old age, the hiss of consonants and squeak of the little finger 'way up on a violin E string, just as we did in boyhood, instead of wondering what has happened to civilization that it has cut not the use of the higher frequencies in enunciation and in music rendition. And if perhaps the ear becomes dull to the basses, the tone control will restore the strength of the low notes to a world that had seemed to have been weaned away from them. Besides, persons born partly deaf to certain frequency realms can enjoy sounds new to them.

A man who builds or buys a set is entitled to have it reproduce broadcasts faithfully, or unfaithfully, but at least so that it gives him what he regards as faithful reproduction, thus making the radio more enjoyable.

Law on Piracy Called Weak

Modifications of the law governing broadcasting in this country and of other laws which have a bearing on radio entertainment are urged by A. L. Ashby, vice president and general attorney of the National Broadcasting Company. Mr. Ashby pointed out as a defect in the radio law the limited right of appeal by broadcasting organizations from decisions by the Federal Radio Commission. He also contended that the law dealing with "pirating" programs is insufficient.

"A novel situation which radio lawyers have to deal with," Mr. Ashby said, "is the pirating of programs. The radio act prohibits the rebroadcasting of a radio program without the consent of the originating station. This does not cover the situation where an organization picks up a program originated by some other organization and by means of a selective radio receiving set and by means of amplifiers and wires retransmits that program to the homes of listeners who are furnished with a loudspeaker for a toll charge of a few dollars per month."

Stations in United States and Canada, Corrected to May 22d.

Star before Call Letter denotes new station.
Star before Station Frequency denotes new frequency.

CANADA

Station	kc
CFAC	690
CFBO	890
CFCA	840
CFCF	1030
CFCH	600
CFCN	690
CFCO	1210
CFCR	960
CFCT	630
CFCY	960
CFJC	1120
CFLC	1010
CFNB	1210
CFQC	910
CFRB	960
CFRC	930
CHCA	690
CHCK	960
CHCS	880
CHCT	840
CHGS	1120
CHLS	730
CHMA	580
CHML	880
CHNS	930
CHRC	880
CHWC	960
CHWK	1210
CHYC	730
CJBC	580, 840, 960, 690
CJBR	960
CJCA	580
CJCB	880
CJCJ	690
CJGC	910
CJGX	630
CJHS	910
CJOC	1120
CJOR	1030
CJRM	600
CJRW	600
CJRX	1120
CJSC	580
CKAC	730
CKCD	730
CKCI	880
CKCK	960
CKCL	580
CKCO	890
CKCR	1010
CKCV	880
CKCF	730
CKGW	690
CKIC	930
CKLC	840
CKMC	1210
CKMO	730
CKNC	580
CKOC	880
CKOW	840
CKPC	1210
CKPR	930
CKSH	1010
CKUA	580
CKWX	730
CKX	540
CKY	780
CNRA	630
CNRC	690
CNRD	840
CNRE	580
CNRL	910
CNRM	730
CNRO	600
CNRQ	880
CNRR	960
CNRS	910
CNRT	840
CNRV	1030
CNRW	780
CNRX	690

UNITED STATES

Station	kc
WAAF	920
WAAM	1250
WAAT	*940
WAAW	660
WABC	860
WBOQ	860
WABI	1200
WABZ	1200
WACO	1240
WADC	1320
WAGM	1310
WAIU	640
*WALR	1210
WAPI	1140
WASH	1270
WBAA	1400
WBAK	1430
WBAL	1060
WBAP	800
WBAX	1210
WBBC	1400
WBBL	1210
WBBM	770
WJBT	770
WBBR	1300
*WBBS	1370
WBBY	1200
WBBZ	1200
WBCM	1410
WBMS	1450
WBNY	1350
WBOW	1310
WBRC	930
WBRE	1310
WBSO	920
WBT	1080
WBTM	1370
WBZ	990
WBZA	990
WCAC	600
WCAD	1220
WCAE	1220
WCAH	1430
WCAJ	590
WCAL	1250
WCAM	1280
WCAO	600
WCAP	1280
*WCAT	1200
WCAU	1170
WCAX	1200
WCAZ	1070
WCBA	1440
WCBD	1080
WCBM	1370
WCBS	1210
WCCO	810
WCDA	1350
WCFL	970
WCGU	1400
WCHI	1490
WCKY	1490
WCLB	1500
WCLO	1200
WCLS	1310
WCMA	1400
WCOA	1340
*WCOC	880
WCOD	1200
WCOH	1210
WCRW	1210
WCSC	1310
WCSH	940
WCSO.	1450
WDAE	1220
WDAF	610
WDAG	1410
WDAH	1310
WDAY	940
WDBJ	930
WDBO	1120
WDEL	1120
WDGY	1180
WDOD	1280
WDRC	1330
WDSU	1250
WDWF	1210
WLSI	1210
WDZ	1070
WEAF	660
WEAI	1270
WEAN	780
WEAO	570
WEBC	1290
WEBE	1210
WEBQ	1210
WEBR	1310
WEBW	560
WEDC	1210
WEDH	1420
WEEI	590
WEHC	1490
WEHS	1420
WELK	1370
WEMC	590
WENR	870
WBCN	870
WEVD	1300
WEW	760
WFAA	800
WFAN	610
WFBC	1200
WFBE	1200
WFBG	1310
WFBL	1360
WFBM	1230
WFBR	1270
WFDF	1310
WFDV	1370
WFDW	1420
WFI	560
WFIW	940
WFJC	1450
WFKD	1310
WFLA	620
WSUN	620
WGAL	1310
WGBB	1210
WGBC	1430
WGBF	630
WGBI	880
WGBS	600
WGCM	1210
WGCP	1250
WGES	1360
WGH	1310
WGHP	1240
WGL	1370
WGN	720
WLIB	720
WGR	550
WGST	890
WGY	790
WHA	940
WHAD	1120
WHAM	1150
WHAP	1300
WHAS	820
WHAT	1310
WHAZ	1300
WHB	860
WHBC	1200
WHBD	1370
WHBF	1210
WHBL	1410
WHBO	1370
WHBU	1210
WHBY	1200
WHDF	1370
WHDH	830
WHDI	1180
WHDI	1180
WHEC	1440
WABO	1440
WHFC	1420
WHIS	1420
WHK	1390
WHN	1010
WHO	1000
WHOM	1450
WHP	1430
WIAS	1420
WIBA	1210
WIBG	930
WIBM	1370
WIBO	560
WIBR	1420
WIBU	1310
WIBW	580
WIBX	1200
WICC	1190
WIL	1200
WILL	890
WILM	1420
WIOD	1300
WMBF	1300
WIP	610
WIS	1010
WISN	1120
WJAC	1310
WJAG	1060
WJAK	1310
WJAR	890
WJAS	1290
WJAX	900
WJAY	610
WJAZ	1490
WJBC	1200
WJBI	1210
WJBK	1370
WJBL	1200
WJBO	1420
WJBU	1210
WJBW	1200
WJBY	1210
WJJD	1130
WJKS	1360
WJR	750
WJSV	1460
WJW	1210
WJZ	760
WKAQ	890
WKAR	1040
WKAV	1310
WKBB	1310
WKBC	1310
WKBF	1400
WKBH	1380
WKBI	1420
WKBN	570
WKBO	1450
WKBP	1420
WKBQ	1350
WKBS	1310
WKBV	1500
WKBW	1480
WKBZ	1500
WKEN	1040
WKJC	1200
WKRC	550
WKY	900
WLAC	1470
WLAP	1200
WLB	1250
WGMS	1250
WLBC	1310
WLBF	1420
WLBG	**1200**
WLBL	900
WLBW	1260
WLBX	1500
WLBZ	620
WLCI	1210
WLEX	1410
WLEY	1370
WLIT	560
WLOE	1500
WLS	870
WLTH	1400
WLVA	1370
WLW	700
WLWL	1100
WMAC	570
WMAF	1410
WMAK	900
WMAL	630
WMAN	1210
WMAQ	670
WMAY	1200
WMAZ	890
WMBA	1500
WMBC	1420
WMBD	1440
WMBG	1210
WMBH	1420
WMBI	1080
WMBI	1500
WMBO	1310
WMBQ	1500
WMBR	1370
WMC	780
WMCA	570
WMMN	890
WMPC	1500
WMRJ	1420
WMSG	1350
WMT	600
WNAC	1230
WBIS	1230
WNAD	1010
WNAX	570
WNBF	1500
WNBH	1310
WNBJ	1310
WNBO	1200
WNBR	1430
WNBW	1200
WNBX	1200
WNBZ	1290
WNJ	1450
WNOX	560
WNRC	1440
WNYC	570
WOAI	1190
WOAN	600
WOAX	1280
WOBT	1310
WOBU	580
WOC	1000
WOCL	1210
WODA	1250
WODX	1410
WOI	640
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WOL	1310
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WOPI	1500
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WOR	710
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WOS	630
WOV	1130
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WPCC	560
WPCH	810
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WRAF	1200
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KFJF	1480
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KFJR	1300
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KFPM	1310
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KFRU	630
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KFUM	1270
KFUO	550
KFUP	1310
KFVD	1000
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KFWI	930
KFWM	930
KFXD	1420
KFXF	920
KFXJ	1310
KFXM	1210
KFXR	1310
KFXY	1420
KFYO	1420
KFYR	550
KGA	1470
KGAR	1370
KGB	1330
KGBU	900
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KGDE	1200
KGDM	1100
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KGEF	1300
KGEK	1200
KGER	1360
KGEW	1200
KGEZ	1310
*KGFE	1420
KGFG	1370
KGFI	1500
KGFJ	1200
KGFK	1200
KGFL	1370
KGFW	1310
KGFX	580
KGGC	1420
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KGHI	1200
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KPQ	1500
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KRMD	1310
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OHMMETER=VOLTMETER

(Concluded from page 13)

5—Remove the short circuit by releasing the switch so that the unknown is thrown into the circuit in series with the calibrated resistance.

6—Readjust the calibrated resistance until the meter again reads the same as before, whatever current value was selected.

7—Again read the resistance on the scale.

8—Subtract the second resistance reading from the first reading. The difference is the resistance of the unknown.

If this substitution method of the unknown turns out to be less than 10,000 ohms, repeat the measurement on the 10,000 ohm scale for a more closely read determination.

By the first, or current-halving method, the lowest resistance value that can be measured is limited by the voltage used. If the voltage is 1.5 volts the lowest resistance is 1,500 ohms. By the second method there is no lower limit except that imposed by the calibration of the scale.

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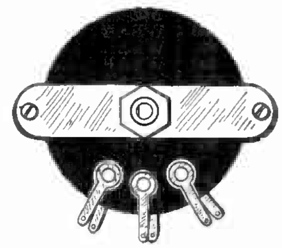
A Double Range Potentiometer



AN instrument containing two electrically independent potentiometers with their sliders mounted to the same shaft. Both are turned when one is turned. It is made by Centralab and has the smooth motion for which variable resistors and potentiometers of this make are known. One unit, next the control knob, has a resistance of 200,000 ohms, and the other, at the rear, has a resistance of 10,000 ohms.

They may be used either as high resistance rheostats (from center to one side) or as potentiometers, singly or together. This makes the instrument exceptionally flexible and applicable to a large variety of uses.

It has been designed for a volume control for which it may be used to vary the plate voltage, the grid voltage, the screen grid voltage, or the signal voltage, or two combinations thereof. For example, the 10,000 ohm section may be used as a potentiometer in the antenna circuit to control the signal input voltage and the 200,000 ohm section may be used at the same time for controlling the audio signal voltage before it is impressed on the first audio amplifier tube. Or the low resistance may be used to control the signal input voltage and the high resistance for controlling a screen grid voltage, or vice versa.

The unit is provided with six soldering lugs for making connections to the instrument either as variable resistance or as potentiometer.

Single hole mounting with quarter inch shaft. The two units are held together firmly by metal clamps and bolts.

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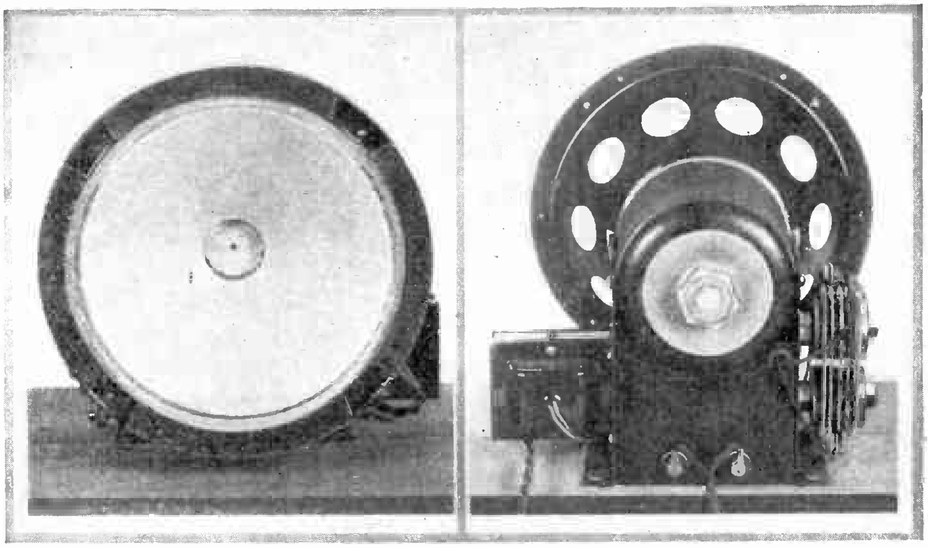

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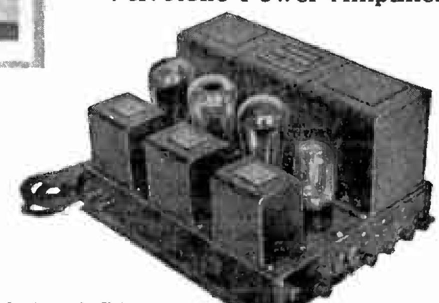

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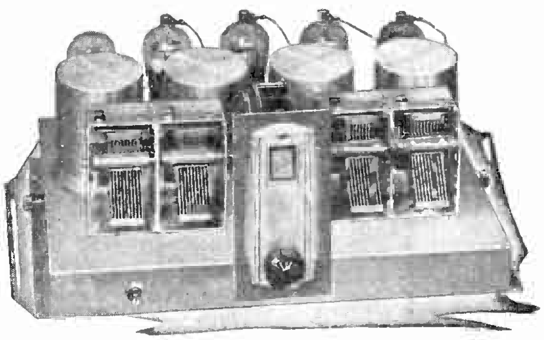

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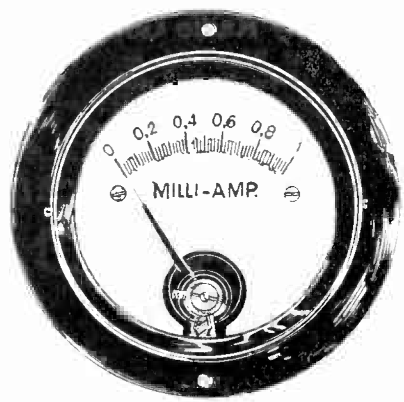

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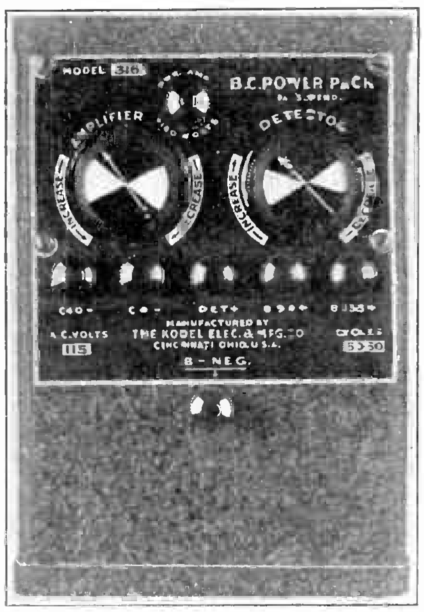

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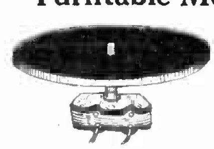

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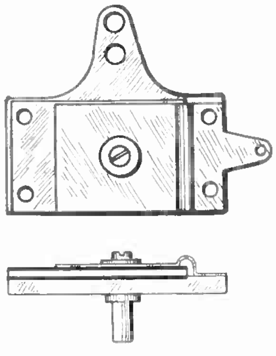
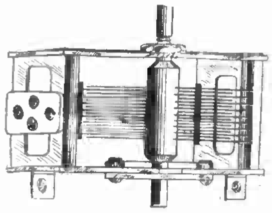


CAT. EQ-100 AT 35c

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. Maximum capacity stamped on side of shaft.

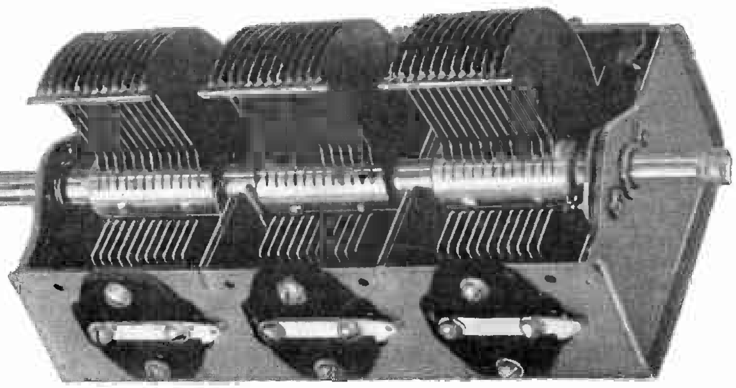
SINGLE .00035



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 ⅝ inch by use of Cat. XS-4. Brackets built in enable direct subpanel mounting, or may be plied off easily. Front panel mounting is practical by removing two small screws and replacing with two 3/34 screws ⅝ inch long. Condenser made by Scovill Mfg. Co.

THREE-GANG SCOVILL .0005 MFD.



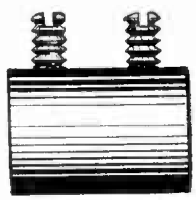
One of the finest, strongest and best gang condensers ever made is this three-gang unit, each section of full .0005 mfd. capacity, with a modified straight frequency line characteristic. The net weight of this condenser is 3¼ lbs. Cat. SC-3G—5 at $4.80.

HERE is a three-gang condenser of most superior design and workmanship, with an accuracy of at least 99¾ per cent. at any setting — rugged beyond anything you've ever seen. Solid brass plates perfectly aligned and protected to the fullest extent against any displacement except the rotation for tuning. It has both side and bottom mounting facilities. Shaft is ⅜ inch diameter and extends at front and back, so two of these three-gangs may be used with a single drum dial for single tuning control. For use of this condenser with any dial of ¼" diameter bore, use Cat. XS-8, one for each three-gang. Tension adjusters shown at right, other side of shaft.

SALIENT FEATURES OF THE CONDENSER

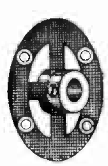
(1)—Three equal sections of .0005 mfd. capacity each.
(2)—Modified straight line frequency shape of plates, so-called midline.
(3)—Sturdy steel frame with rigid steel shields between adjacent sections. These shields minimize electric coupling between sections.
(4)—The frame and the rotor are electrically connected at the two bearings and again with two sturdy springs, thus insuring positive, low resistance contact at all times.
(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.

RIGID AND FLEXIBLE LINKS



CAT. RL-3 AT 12c

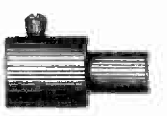
For coupling two ¼ inch diameter shafts, either coil shaft and condenser shaft, or two condenser shafts, a coupling link is used. This may be of the rigid type, all metal, where the linked units are not to be insulated. The rigid link, Cat. RL-3, has two set-screws, one to engage each shaft, and is particularly 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 ⅝" extension, still at ¼". Hence both the extension shaft and the bore or opening are ¼" diameter. Order Cat. XS-4.

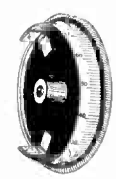
For condensers with ⅜" diameter shaft, to accommodate to dials that take ¼" shaft, order Cat. XS-8 at 15c.

.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

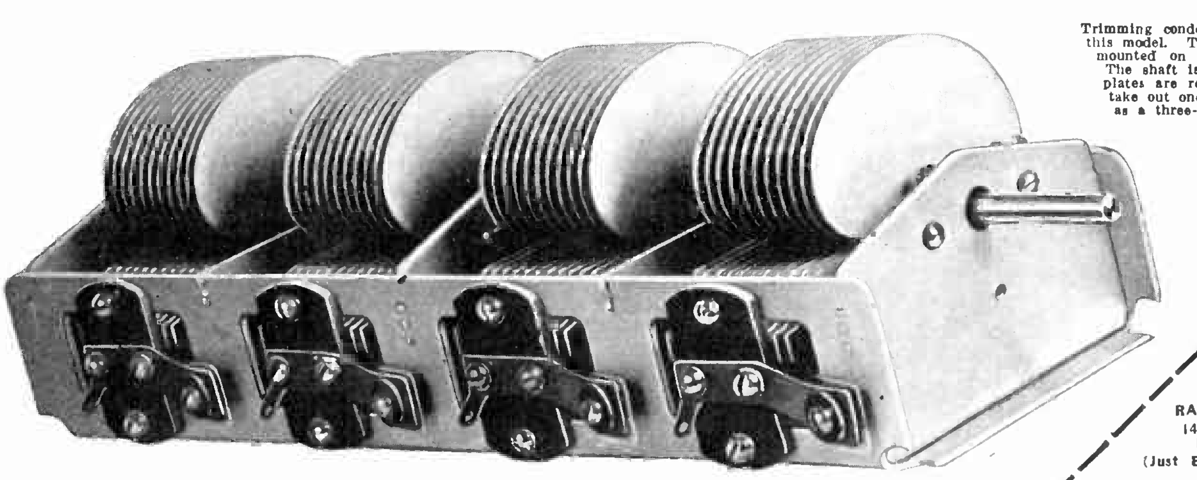
CAT OD-0-100 @ $1.50



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.

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%.

SHORT WAVES

Tuning condensers for short waves, especially suitable for mixer circuits and short-wave adapters. These condensers are .00015 mfd. (150 micro-microfarads) 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.

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☐ 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
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☐ Cat. FL-4 @ 30c
☐ Cat. SW-S-150
☐ Cat. SW-S-250

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"AUDIO POWER AMPLIFIERS"—Anderson and Bernard

"Audio Power Amplifiers" is the first and only book on this important subject. The authors are:

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."

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.

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.—CHAPTER II. (page 20) Circuit Laws, expounds and applies Ohm's laws and those 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, full-wave and half-wave rectification, current flow and voltage derivation. Regulation curves for the 280 tube are given.—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.—CHAPTER VI. (page 90) Principles of Push-Pull Amplifier.—CHAPTER VII. (page 98) Oscillation in Audio Amplifiers, motorboating and oscillation at higher audio frequencies.—CHAPTER VIII. (page 118) Characteristics of Tubes, tells how to run curves on tubes, how to build and how to use a vacuum tube voltmeter, 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 (II) 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.—CHAPTER XI. (page 121) Practical Power Amplifier, give 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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In simple English that any one can understand, the technical side of radio is presented by Anderson and Bernard in their book, "Foothold on Radio." Any one who can read English can understand this book. It is intended for the sheer novice. The treatment is non-mathematical. The origin of the broadcast wave, its radiation, reception, amplification and rectification are set forth in clear language. Side bands are explained simply. The types of receiving circuits are illustrated, described and contrasted. A chapter is devoted to loudspeakers, explaining the different kinds and the principles of their operation. Performance is compared. Audio coupling is fully explained, also the action of the vacuum tube, with a special analysis of plate current and its behavior. Those who have been thirsting for a book that readily reveals the marvels of the radio science will appreciate this little volume. Paper cover 60 pages, fully illustrated. Published May, 1930. Order Cat. **FOR.**

"THE SUPERHETERODYNE"

This is a new volume by Anderson and Bernard dealing with the principles and practice of the Superheterodyne method of receiving. It explains the function of the oscillator, the modulator, the pre-modulator selector, and the intermediate frequency amplifier. It explains the cause of repeat points and gives methods for avoiding them or minimizing their effect. It expounds the relative advantages and disadvantages of high and low intermediate frequencies, and shows the effect of selectivity on the quality.

It illustrates various forms of oscillators and tells of the advantages of each. Different types of modulators and pick-up systems are explained and their advantages stated. Different methods of coupling in the intermediate frequency amplifier are shown.

Image interference is discussed in detail and methods given by which it may be reduced.

A special method of ganging the oscillator to the radio frequency condensers is explained, a method which allows either the high or the low oscillator setting to be selected by means of a variometer in the oscillator circuit.

One section is given over to coil design for the radio frequency tuners, the oscillator, and the intermediate frequency filter.

Audio amplifiers suitable for superheterodynes are also described. These include transformer, resistance, and push-pull amplifiers both for AC and DC.

While the book is primarily intended to expound the principles of the Superheterodyne, the practical phase has not been neglected. Detailed descriptions of AC and DC superheterodynes, designed in conformity with best practice and sound applications of the principles, have been included in the book. These descriptions are well illustrated. Order Cat. **ABSH.**

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Schematic diagrams of 115 latest commercial receivers, including screen grid, collated by John F. Rider, into Supplement No. 1, each diagram on a separate sheet 8½x11 inches. Needed by every service man. "Trouble Shooter's Manual," by Rider, contains 200 diagrams, but the present 115 are additional and up to date. No duplication.

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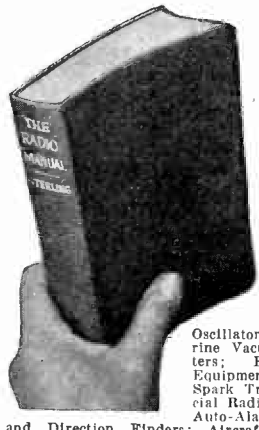

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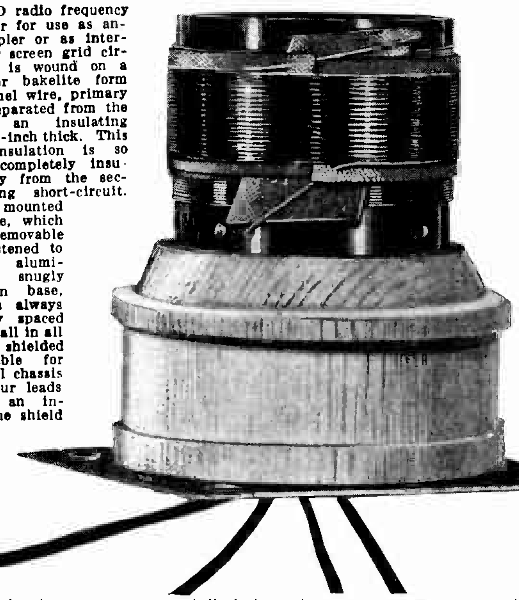
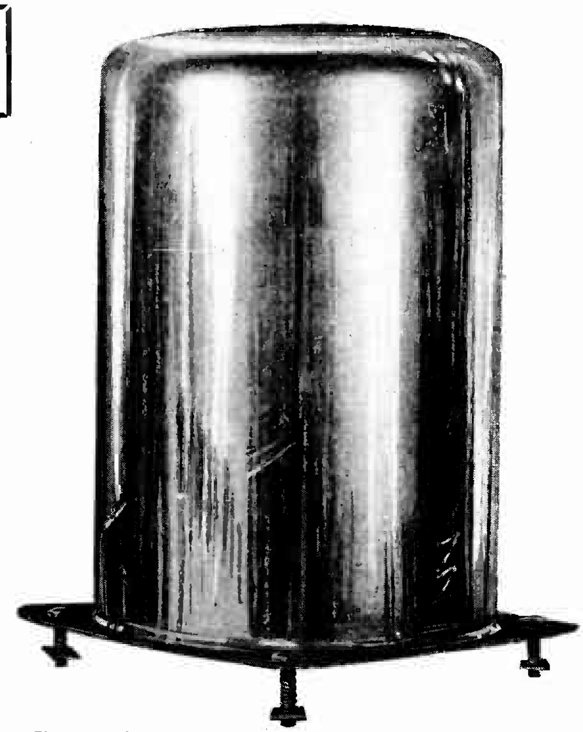
High-Gain Shielded Coils

A SHIELDED radio frequency transformer for use as antenna coupler or as interstage coupler, for screen grid circuits. The coil is wound on a 1¾-inch diameter bakelite form with No. 28 enamel wire, primary on the outside, separated from the secondary by an insulating wrapper 42/10,000-inch thick. This moisture-proof insulation is so shaped that it completely insulates the primary from the secondary, preventing short-circuit. The coil form is mounted on a wooden base, which base has the removable shield bottom fastened to it. The drawn aluminum shield fits snugly over the wooden base, and coils remain always erect and amply spaced from the shield wall in all directions. The shielded coils are suitable for baseboard or metal chassis mounting. The four leads emerge through an insulated hole in the shield bottom.



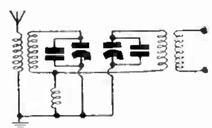
The coil comes already mounted on a shellacked wooden base, which is fastened at the factory to the shield bottom. Series A coil is illustrated.



The external appearance of the shield, with four 6/32 machine screws and nuts, which are supplied with each coil assembly.

Precisely Matched for Gang Tuning

ONE primary lead-out wire from the coil, for antenna or plate connection, has a braided tinned alloy covering over the insulation. This alloy braid shields the lead against stray pick-up when the braid alone is soldered to a ground connection. The outleads are 6 inches long and are color identified. The wire terminals of the windings themselves, and the outleads, are soldered to copper rivets. Each coil comes completely assembled inside the shield, which is 2¾ inches square at bottom (size of shield bottom) and 3¾ inches high. High impedance primaries of 40 turns are used. Secondaries have 80 turns for .00035 mfd. and 70 turns for .0005 mfd.



BP-6 is the coil at bottom.

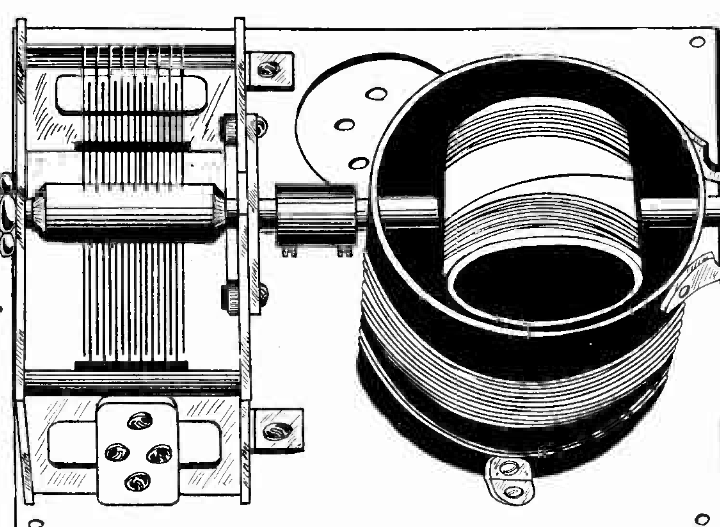
EXTREME accuracy in winding and spacing is essential for coils used in gang tuning. These coils are specially suited for gang condensers, because the inductances of all are identical for the stated size condenser. The coils are matched by a radio frequency oscillator. The color scheme is as follows: shielded wire outlead is for antenna or plate; red is for ground or B plus. (These options are due to use of the same coil for antenna coupling or interstage coupling.) Blue is for grid and yellow is for grid return. For .00035 mfd. the Cat. No. is A-40-80-S. For .0005 mfd. the Cat. No. is A-40-70-S.
Where a band pass filter circuit is used the small coupling coil to unite circuits is Cat. BP-6. The connection is illustrated herewith.

Junior Model Inductances

The Series B coils have the same inductance and the same shields as the series A coils, but the primary, instead of being wound over the secondary, with special insulation between, is wound adjoining the secondary, on the form, with ¼-inch separation, resulting in looser coupling. No wooden base is provided, as the bakelite coil form is longer, and is fastened to the shield bottom piece by means of two brackets. No outleads. Wire terminals are not soldered. Order Cat. B-SH-3 for .00035 mfd. and Cat. B-SH-5 for .0005 mfd.

Coils for Six-Circuit Tuner

Series C coils for use with six tuned circuits, as in Herman Bernard's six-circuit tuner, are wound the same as type A shielded coils, but the shields are a little larger (3 1/16-inch diameter, 3¾ inches high), and there are no shield bottoms, as a metal chassis must be used with such highly sensitive circuits. Fasten the brackets to the shield and then, from underneath the chassis, fasten the other arm of the two brackets to the chassis. Order Cat. C-6-CT-5 for .0005 mfd. and Cat. C-6-CT-5 for .00035 mfd. Five needed for Bernard's circuit. If band pass filter coupling coil is desired order Cat. BP-6 extra.



For a stage of screen grid RF, either for battery type tube, 222, or AC, 224, followed by a grid-leak-condenser detector, no shielding is needed, and higher per-stage amplification is attainable and useful. This extra-high per-stage gain, not practical where more than one RF stage is used, is easily obtained by using dynamic tuners. Two assemblies are needed. These are furnished with condensers erected on a socketed aluminum base. Each coil has its tuned winding divided into a fixed and a moving segment. The moving coil, actuated by the condenser shaft itself, acts as a variometer, which bucks the fixed winding at the low wavelengths and aids it at the high wavelengths, thus being self-neutralizing and maintaining an even degree of extra-high amplification throughout the broadcast scale.

Two assemblies are needed. For AC operation (224 RF and 224 or 227 detector), use Cat. BT-L-AC and BT-R-AC. For battery or A eliminator operation (222 RF and any tube as detector), use Cat. BT-L-DC and BT-R-DC.

BT-L for the antenna stage and BT-R for the detector input. BT-L consists of a small primary, with suitable secondary for the .00035 mfd. condenser supplied. BT-R has two effective coils: the tuned combination winding in the RF plate circuit, the inside fixed winding in the detector grid circuit.
The moving coils must be "matched." This is done as follows: Turn the condensers until plates are fully enmeshed, and have the moving coils parallel with the fixed winding. Tune in the highest wavelength station receivable—above 450 meters surely. Now turn the moving coils half way round and retune to bring in the station. The setting that represents the use of lesser capacity of the condenser to bring in that station is the correct one.
If gang tuning is used, put a 20-100 mmfd. equalizing condenser across the secondary in the antenna circuit and adjust the equalizer for a low wavelength (300 meters or less).

Screen Grid Coil Co., 143 West 45th Street, New York (Just East of Broadway):

Enclosed please find $............ (Canadian must be express or P. O. Money Order), for which send me prepaid the following:

- ☐ A-40-80-S, each $2.25
- ☐ Matched set of four A-40-80-S........ 10.00
- ☐ A-40-70-S, each 2.25
- ☐ Matched set of four A-40-70-S........ 10.00
- ☐ B-SH-3, each $1.00
- ☐ Matched set of four B-SH-3.......... 4.00
- ☐ B-SH-5, each 1.00
- ☐ Matched set of four B-SH-5.......... 4.00
- ☐ BT-L-AC and BT-R-AC, assembled, with condenser, link, socket and base, per pair....... 6.00
- ☐ BT-L-DC and BT-R-DC, assembled, with condenser, link, socket, base, per pair......... 6.00
- ☐ C-6-CT-5, .0005 mfd. shielded coil for six-circuit tuner..........each $2.25
- ☐ C-6-CT-3, .00035 mfd. shielded coil for six-circuit tuner..........each $2.25
- ☐ BP-6 .... .25
- ☐ EQ-100, equalizer of 20-100 mfd. capacity, made by Hammarlund.......... .35

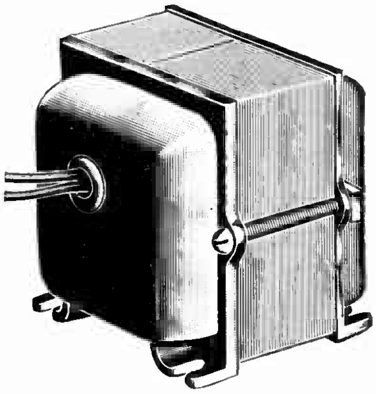
(Note: All coils come with shields, except BP-6 and BT-L.)

NAME.. ADDRESS..

CITY.. STATE..

☐ If ordering C.O.D. put cross here. Post office fee will be added to prices quoted.

New Polo Power Transformers and Chokes



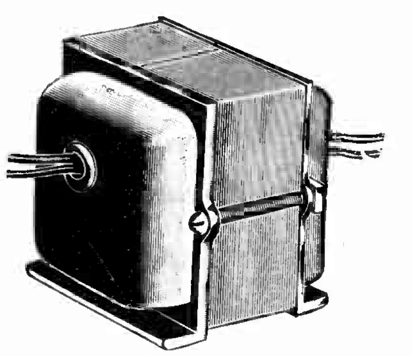
Shielded single choke, 200 ohms D.C. resistance, non-saturable at 100 milliamperes, with two black outleads, each 6 inches long. For filtration of B supplies. Inductance, 30 henrys.
Cat. SH-S-CH, price $5.00

The shielded single choke will pass 100 ma. One will suffice if the current is 100 ma. or less, for filtration of B supplies, provided the capacity at the filter output is 8 mfd. or more. Use two such shielded chokes if less than 8 mfd. is used at the filter output. Also, the shielded single choke may be used as in the power tube circuit for an output filter. In this connection use at least 2 mfd. for the capacity section of the filtered speaker output. Order Cat. SH-S-CH @ $5.00

The shielded double choke may be used for filtration where the B current is 60 ma. or less, with relatively small filter capacities, no less than 4 mfd. at the output, however. This choke consists of one winding, center-tapped. Its use is especially recommended for 171, 171A, 245 or 210 push-pull output. Connect the black leads (extremes of windings) to plates of the push-pull tubes, **red center tap to B plus, and the speaker may be connected** directly to plates without any direct current, but only signal current, flowing through the speaker. This system is applicable only to push-pull. Order Cat. SH-D-CH @ $6.00

In the same type of case a 20-volt secondary filament transformer, for 110 volts, 50-133 cycle, may be obtained for use in conjunction with dry rectifiers, such as Kuprox, Westinghouse, Benwood-Linze and Elkon, in dynamic speakers or A battery eliminators. Not made for 25 or 40 cycles. Order Cat. SH-F-20 @ $2.50

245 Power Transformer for use with 280 rectifier, to deliver 300 volts D.C. at 100 milliamperes, slightly higher voltage at lower drain, and supply filament voltages.
Cat. 245-PT price $8.50



Twenty-volt filament transformer, 110 v. 50-133 cycle input, for use in conjunction with dry rectifiers. It will pass 2.25 amperes.

In a different type case, square, of cadmium plated steel with four mounting screws built in, size 4½ inches wide by 3¾ inches high by 4 inches front to back, a 50-60 cycle filament transformer is obtainable with the same windings as the 245 power transformer, except that the high voltage secondary is omitted. Order Cat. 245-FIL, @ $4.50
For 40 cycles order Cat. 245-FIL-40 @ 7.00
For 25 cycles order Cat. 245-FIL-25 @ 6.50

[Any of the above three in the same case as the 245 power transformer, © $1.00 extra. Add PTC after the Cat. number.]

A single choke, unshielded, 65 ma rating, 30 henrys inductance, for B filtration or single output filter of speaker, is our Cat. US-S-CH @ $1.25

Polo Engineering Laboratories, 143 West 45th St., New York, N. Y.

Enclosed please find $———— for which ship at once:

☐ Cat. 245-PT @...$8.50	☐ Cat. 245-FIL @..$4.50
☐ Cat. 245-PT-40 @ 9.50	☐ Cat. 245-FIL-40 @ 7.00
☐ Cat. 245-PT-25 @ 12.00	☐ Cat. 245-FIL-25 @ 8.50
☐ Cat. SH-S-CH @ 5.00	☐ Cat. SH-F-20 @. 2.50
☐ Cat. SH-D-CH- @ 6.00	☐ Cat. UN-S-CH @. 1.25

☐ F-2.5-D @ 3.75

Note: Canadian remittance must be by post office or express money order.

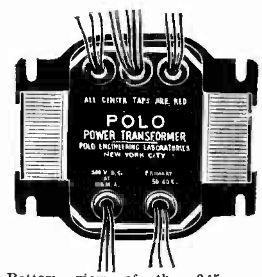
☐ If C.O.D. shipment is desired, put cross here. No C.O.D. on 25 and 40 cycle apparatus. For these full remittance must accompany order. The 25 and 40 cycle apparatus bears the 50-60-cycle label, but you will get actually what you order.

Name ....

Address ....

City .... State ....

The Polo 245 power transformer is expertly designed and constructed, wire, silicon grade A steel core and air gap large enough to stand the full rated load. The primary is for 110v A.C., 50-60 cycles, tapped for 82.5 volts in case a voltage regulator, such as a Clarostat or Amperite, is used. The black primary lead is common. If no voltage regulator is used, connect black lead to one side of the A.C. line, green lead to the other side of the line, and ignore red lead, except to tape the end. For use with a voltage regulator (82.5-volt primary) use red lead and ignore the green except to tape the end. The secondaries are: high voltage for 280 plates, with red center tap to ground; 2.5 volts, 3 amperes, red center tap to C plus, for 245 output, single or pushpull; 5 volts, 2 amperes, red center tap, as positive B lead, for filament of 280 tube; 2.5 volts, 16 amperes, red center tap to ground, for 224, 227 and pentode tubes, up to nine heater type tubes. **Hence there are five windings.**



Bottom view of the 245 power transformer. All leads are plainly marked on the nameplate, including the top row.

A special filament transformer, 110 v., 50-60 cycles, with two secondaries, one of 2.5 v. 3 amp. for 245s, single or push-pull, other 2.5 v. 12 amperes for 224, 227, etc., both secondaries center-tapped. Shielded case. 6 ft. AC cable, with plug. Order Cat. F-2.5-D @ $3.75

The conservative rating of the Polo 245 power transformer insures superb results even at maximum rated draw, working up to twelve tubes, including rectifier, without saturation, or overheating due to any other cause. This ability to stand the gaff requires adequate size wire, core and air gap, all of which are carefully provided. At less than maximum draw the voltages will be slightly greater, including the filament voltages, hence the 16 ampere winding will give 2.25 volts at maximum draw, which is an entirely satisfactory operating voltage, increasing to 2.5 volts maximum as fewer than a total of nine RF, detector and preliminary audio tubes are used.

The avoidance of excessive heat aids in the efficient operation of the transformer and in the maintenance of good regulation, for excessive heat increases the resistance of the windings.

The transformer is equipped with four slotted mounting feet and a nameplate with all leads identified. **It is one of the** very finest instruments on the radio market.

Highest Capacity of Filament Secondary

SPECIAL pains were taken in the design and manufacture of the Polo 245 power transformer to meet the needs of experimenters. For instance, excellent regulation was provided, to effect minimum change of voltage with given change in current used. Also, the 2.5 volt winding for RF, detector and preliminary audio tubes, was specially designed for high current, to stand 16 amperes, the highest capacity of any 245 power transformer on the market. Hence you have the option of using nine heater type tubes. **The shielded case is crinkle brown finished steel, and the assembly is perfectly tight, preventing mechanical vibration.**

The power transformer weighs 11½ lbs., is 7 inches high, 4⅞ inches wide, and 4¼" front to back, overall.

Elevating washers may be used at the mounting feet to clear the outleads, or holes may be drilled in a chassis to pass these leads, and the transformer mounted flush.

Advice in Use of Chokes and Condensers in Filter

With the 245 power transformer either one or two single chokes should be used, or a shielded double choke, depending on the current drain and the capacity of filter condenser used. Where the capacity **at the output is 8 mfd. or more for a drain of 65 to 100 ma., a single choke will suffice** (Cat. SH-S-CH), but where smaller output capacity than 8 mfd. is used on such drain, two such chokes should be used in series. Next to the rectifier, in either instance, use a 1 or 2 mfd., 550 A.C. working voltage rating condenser (D.C. rating, 1,000 volts). You may use your choice of capacity at the midsection.

If the drain is to be 65 milliamperes or less, the double choke, Cat. SH-D-CH, may be used for filtration, instead of two single shielded chokes.

The Polo 245 power transformer may be obtained for 25 cycles or 40 cycles on special order, as these are not stocked regularly, and remittance must accompany order. The same guaranty attaches to them as to all other Polo apparatus—money back if not satisfied after trial of five days. In these the primary and secondary voltages and taps are the same, only the case is deeper (front to back) because of larger core and wire for lower frequency.

For 40 cycles order Cat. 245-PT-40 .... @ $9.50
For 25 cycles order Cat. 245-PT-25 .... @ $12.50

[Note: The filter for 40 cycles should consist of two shielded single chokes, Cat. SH-S-CH, with 2 mfd. next to the rectifier and 4 mfd. minimum at the joint of the two chokes and at the end of the filter. For 25 cycles the same holds true, except that the output capacity at end of chokes should be 8 mfd. minimum.]

We Make Special Transformers to Order