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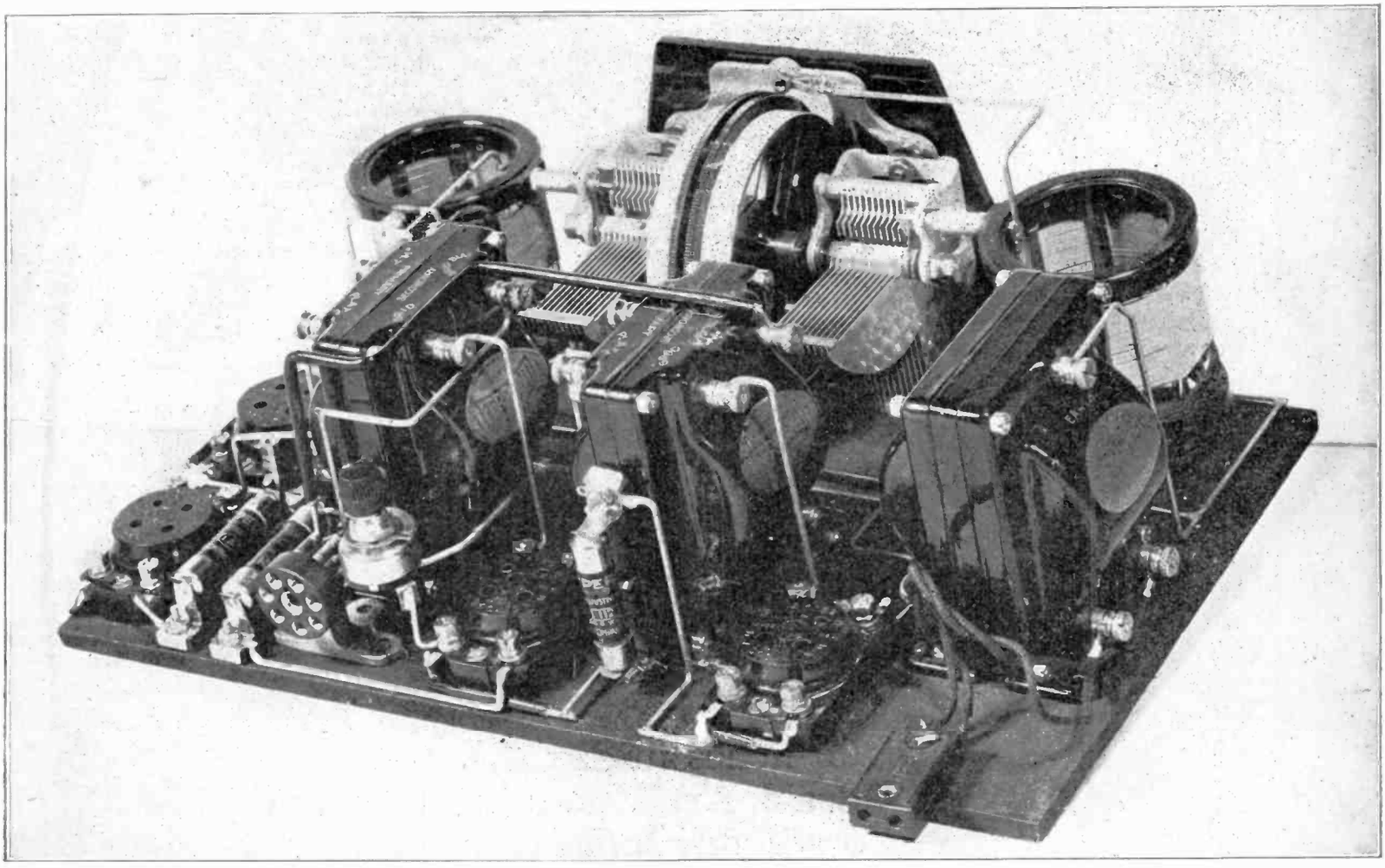
A 3-TUBE LOOP PORTABLE

How to Measure Antenna Capacity

Hookup for AC Tubes

AUGUST 6 15 CENTS

THE 4-TUBE CASH BOX UNITUNE



Back view of the Cash Box Set. See article on page 6.

INTERFERENCE

of the Image Variety in Super-Heterodynes

ARBOR SPEAKER

That You Stick in Garden Soil

PUSH-PULL OUTPUT

Without Using Coupling Condensers

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A Great Deal for a Very Little!

Ordinarily This Seems Too Good to Be True, But Here Is An Instance of Complete Verification

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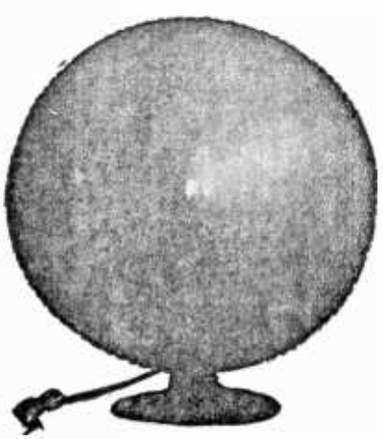

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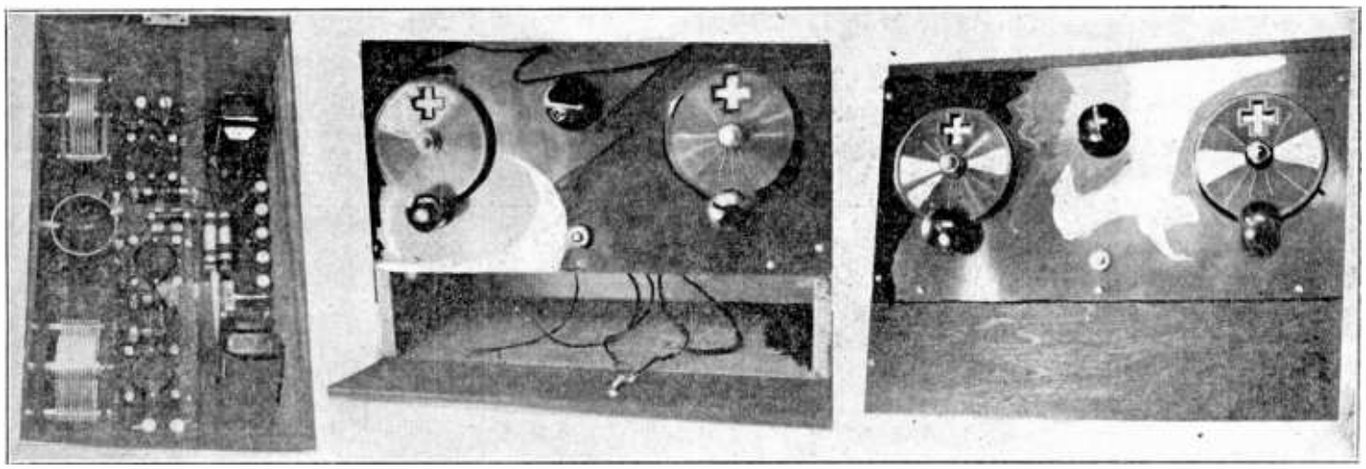
A Portable with Novel Speaker

Sounding Board is at Rear Cabinet Wall

By Michael J. O'Reilly



AT LEFT is shown the layout of the baseboard of the self- contained three-tube reflex portable. The middle photo shows the panel layout and the battery compartment under the set proper. At right is shown the front of the set with the battery compartment closed. Lights and shadows, falling upon the front panel, produced a quaint chiaroscuro effect.

AN important consideration in the construction of a portable receiver is light weight. The lightest possible parts should be used throughout provided that lightness is not gained at a sacrifice of sensitivity and quality. In such a receiver it is also desirable to use as few parts as possible for a given degree of sensitivity.

In view of these requirements the reflex principle, if properly applied, is valuable, as it makes possible discarding one tube without sacrificing any in the sensitivity. With three tubes a receiver having a stage of radio frequency, a regenerative detector and two stages of transformer coupled audio can be built. This represents a popular circuit for home constructors, as it combines sensitivity, volume and low cost.

Let us start the description of the receiver with the loop L. Since the receiver is self-contained, the loop is mounted on the lid of the box containing the set, and the lid is hinged to the box so that it can be placed in a vertical position for use. The size of the lid is 8½ by 14 inches. The loop frame is made of two dowels 14¾ inches long and ⅜ inches in diameter placed diagonally on the lid of the box. The ends of the dowels are slit to a depth of 1½ inches and the wire is placed in these recesses. A total of 19 turns of so-called loop wire is used for a .00025 mfd. condenser. The number of turns in any case would depend on the capacity of the condenser connected across the loop as well as on the value of the distributed capacity.

The tuned loop circuit feeds the radio frequency signal into the first 99 type tube. This tube is also the first audio frequency amplifier and consequently the secondary of the first audio frequency transformer is connected in series with the LC1 tuned circuit.

Between the first tube and the detector is the three circuit tuner L1L2L3, the secondary L2 of which is tuned with a .0005 mfd. condenser C2. The tickler L3 constitutes the volume control.

The grid leak R1 is 5 megohms and the grid condenser C4 is a .00025 mfd.

In the output of the detector tube is a special filter circuit designed to separate radio from audio frequency currents. The filter consists of a radio frequency choke coil RFC of 65 Millihenries and the .0005 mfd. condenser C5. The choke coil is the heart of this filter and is indispensable. Its purpose is to prevent the radio frequency current from

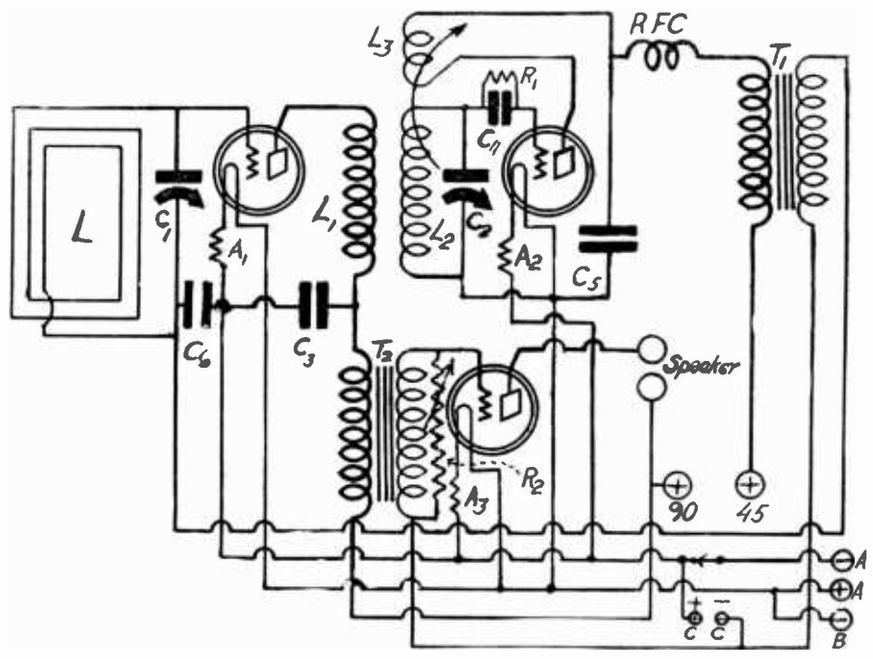
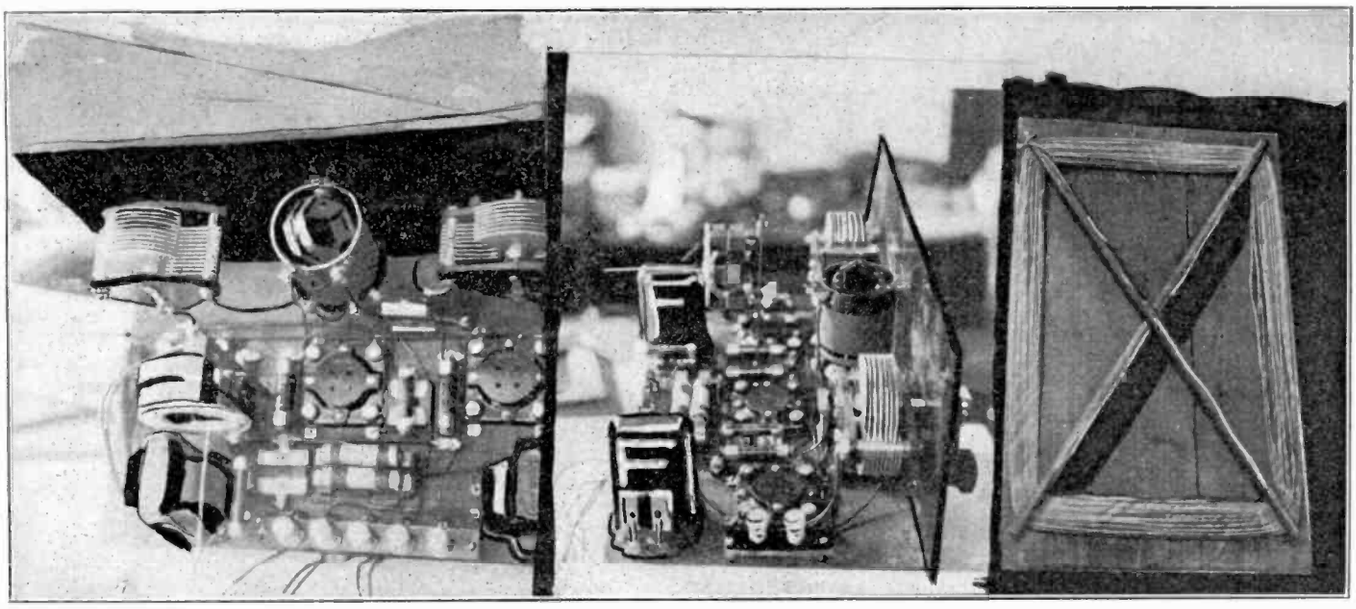


FIG. 1

A portable that gives maximum results from three type 99 tubes is diagrammed above. It is a reflex, the first tube being used as an RF amplifier and as the first stage of audio. This tube is at top, left. The detector tube is at right, top, and is regenerative. Below is the output tube. The set draws only 180 milliamperes filament current, so three No. 6 dry cells in series, as the A battery, should give at least 15 hours' service, if use is not continuous. Condenser C6 and resistor R2 are very important. R2 eliminates a peanut whistle otherwise possibly present.



A CORNER of the reflex set removed from the containing box is shown at left. The middle photo shows a detailed side view of the set removed from the cabinet. At the right is shown the construction of the loop on the under side of the lid.

passing into the primary of the audio transformer.

If the radio frequency current were not prevented from getting into the audio amplifier, it would be amplified to values large enough to give rise to considerable distortion. It would also give rise to an audio squeal which would ruin reception.

A Wise Choice

The higher value of the inductance in the radio frequency choke the more completely would the radio frequencies be suppressed. However, if the inductance is too high, the higher audio frequencies would also be suppressed noticeably, and this is undesirable. A compromise in the value of inductance has therefore been adopted. The value of 65 millihenries represents the optimun compromise between suppression of radio frequencies and the transmission of the higher audio frequencies. But just any 65 millihenry choke will not do. It is of prime importance that the coil be so wound as to have a minimum of distributed capacity in its windings and also a minimum resistance. A coil of high resistance is not a choke coil no matter what its inductance may be. Likewise a coil with a large distributed capacity is not a choke coil but may actually be a by-pass condenser.

Condenser C5 not only aids in filtering the radio from the audio currents, but it also aids the regeneration. If the condenser were not connected into the circuit, the tube might oscillate on account of the radio frequency choke and the tickler, but the tickler might not act as a regeneration control. The circuit might oscillate even when the tickler was set a maximum and the leads reversed. But with the condenser the circuit operates normally over the entire tuning range, and still the suppression of the radio frequencies is satisfactory.

Keeping Set From Howling

Condenser C3, .0005 mfd. is connected across the primary of the second audio transformer T2 to keep the radio frequency signal in the first tube out of the third tube. Distortion would result in the last tube if radio frequency currents were allowed to enter it.

Condenser C6, .0001 mfd. is connected essentially across the secondary of the first audio transformer T1, but directly it is connected from loop tuning condenser to the filament of the first tube. It makes the operation of the circuit more definite in that it furnishes a short path for the radio frequency input to the first tube and eliminates stray pick-up which would creep in by way of the long leads to the transformer T1.

It also serves to eliminate from the input of the first tube any radio frequency energy which has found its way through T1 from the detector tube. It thus serves to prevent undesired and uncontrollable regeneration. Thus C6 is in no small measure responsible for the quietness of operation of the circuit. As is well known, reflex circuits are wont to start squealing of their own accord, and this is due to inadequate by-passing or too high common impedance. Condensers C3 and C6 are largely responsible for confining the radio signal in its proper channel.

Peanut Whistle Eliminated

The two audio frequency transformers T1 and T2 should be chosen with quality of reproduction in mind. Two General Radio type 285D were used in the set.

A variable resistor R2 is connected across the secondary of T2. This suppresses audio frequency oscillations which sometimes interfere with the operation of reflex circuits. The value must be decided by experiment, the object being to suppress a high-pitched squeal. About .5 megohm does it, but a variable leak is preferable. The setting of this variable resistor, once found, is not disturbed,

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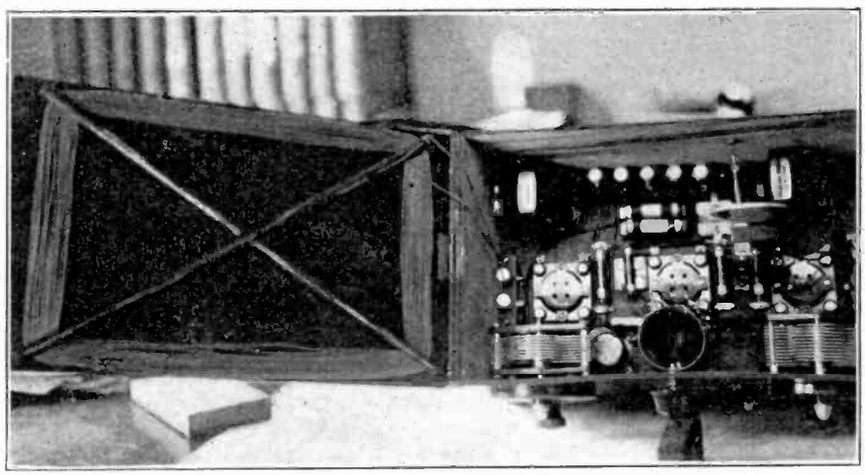


HOW the loop is fitted into the hinged cover. For directional effect the entire set is turned.

LIST OF PARTS

L1, L2, L3—One Bruno three circuit tuner, No. 88 midget.

C1—One .00035 mfd. variable condenser.

C2—One .0005 mfd. variable condenser.

C3, C5—Two .0005 mfd. Polymet fixed condensers.

C4—One .00025 mfd. Polymet fixed condenser.

C6—One .0001 mfd. Polymet fixed condenser.

A1, A2, A3—Three No. 4V-199 Amperites.

T1, T2—Two General Radio audio frequency transformers, No. 285D.

RFC—One 65 millehenry, General Radio RF choke coil.

R1—One 5-megohm Lynch grid leak.

R2—One resistor, preferably variable (Bretwood), or .5 meg. to 1 meg., if fixed.

Nine X-L binding posts, with markers (Speaker—, Speaker+, A+, A—, B—, B+ Det., B+ Amp., Loop, Loop).

Three push tube sockets.

One filament switch.

Two vernier dials.

One knob for tickler.

One 14-inch hard rubber panel (New York Hard Rubber Co.).

One A battery, consisting of three No. 6 Eveready Columbia ignitor dry cells.

One B battery, 90 volts, consisting of four No. 763 Eveready midget B batteries.

One 4½ volt Eveready C battery, No. 771.

One driving unit for loudspeaker (must have pin or stylus on it).

A loop specially constructed as per directions.

A box specially constructed as described.

Measure Your Aerial Capacity!

You Can Do It Without Calibrated Instruments

By Frank P. Sperro

YOU may have a radio installation which is incapable of receiving distant stations when the same set in other locations is capable of receiving real DX. You may have been told that the reason is that you are in a dead spot, that your tubes are dead, or that you are using improper voltages. All of these and countless others may be sufficient causes for lack of reception. But have you ever thought that your antenna may be at fault?

You may not have suspected that, because it is an especially good aerial. The antenna may have the correct length of wire, it may be well insulated, it may be well placed, it may be well-nigh perfect, yet it may be the cause of mediocre reception. Why?

Suppose you couple an antenna rather closely to a tuned circuit and measure the radio frequency resistance of that tuned circuit at different frequencies. In most cases you will find that in one frequency band the effective resistance of the tuned circuit is extremely great, while at other frequencies, either higher or lower, it may be quite low. Now, if that tuned circuit is the first tuner in a radio receiver, the signal intensity will depend on the effective resistance in the tuned circuit, as will the effective selectivity. Where the resistance is high the set will not be at all selective and the volume will not be so good.

Selectivity Up, Volume Down

If the coupling is loosened between the antenna and secondary coils, the selectivity will improve, but the volume will also go down. There will still be a frequency band in which the set will not be selective and where the volume will not be so good, but now the band will be narrower than it was before. If the coupling is reduced very much there will not be enough energy transfer to give any kind of signal strength, hence we are limited in obtaining selectivity in that way.

But why is the effective resistance of the secondary dependent on the primary? Because the antenna circuit absorbs energy from the secondary. It acts as a wave trap at one frequency, and this it does when the inductance and the capacity in the antenna circuit are in resonance with the stated frequency. If a signal is coming in at that frequency and the secondary is tuned to it there is no response, or if there is a feeble response, tuning has no effect on it. If that wave trap effect happens in the middle of the broadcast band, the receiver is of very little use because it will be both insensitive and non-selective over most of the band. Even if it occurs anywhere in the broadcast band the set will be comparatively dead. It is important so to design the antenna circuit as to avoid this condition, and that can only be done if the characteristics of the antenna are known.

Use of Calibrated Condenser

There is a very simple way of measuring the capacity of an antenna, but it requires a calibrated condenser. It can readily be understood by referring to Fig. 1. As will be seen this consists of a simple detector circuit of a single tube. Co represents the capacity to be measured, and is the effective capacity of the antenna. C is a variable and calibrated condenser. L is a tuning coil and Lo a tickler coil whereby the circuit can be set into oscillation.

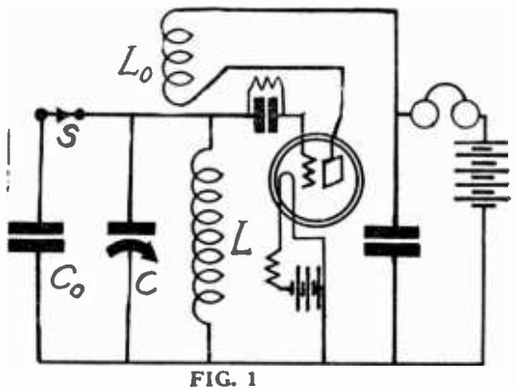


FIG. 1

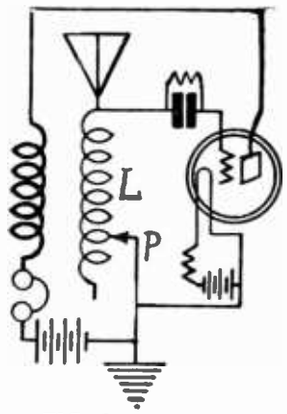


FIG. 2

At left is the circuit arrangement that can be used for measuring the capacity of an antenna by comparing it directly with a calibrated condenser. This is the substitution method. The diagram at right illustrates how the capacity and the distributed inductance of an antenna can be measured without any instruments. The circuit is tuned to two known frequencies by means of a solenoid inductance and the inductance used calculated. Known values can then be substituted in formulas to give the desired values.

Set the circuit into oscillation, with the switch S open. Tune with C until the frequency of the circuit coincides with the frequency of some broadcast station, as evidenced by zero beat. Select the stronger available near the upper end of the band, so that most of C is used, and so that the station can be heard distinctly. Now close switch S and decrease the capacity in C until the same station is tuned in exactly. The difference between the first and second readings of condenser C is the capacity of the antenna. If C is calibrated in micromicrofarads, then the value of Co obtained is also in micromicrofarads.

If C is not calibrated but is a straight line capacity condenser, then it can be used to get an approximate value of the capacity of the antenna. Suppose that the dial used has one hundred divisions and the total capacity of the condenser is known to be .0005 mfd. If the first reading on condenser C is 82 divisions and the second is 25 divisions, the difference is 57 divisions. That represents, approximately, 57% of .0005 mfd., or it represents .000285 micromicrofarads, which would be capacity of the antenna in that case.

An Ingenious Method

There is a very simple method of obtaining the capacity of the antenna without the use of any calibrated instruments, and this method should appeal to the student and true amateur because of its ingenuity. It requires the calculation of inductances of solenoids.

Set up the simple circuit shown in Fig. 2. L is a single layer solenoid about three inches in diameter and wound with heavy wire, say No. 20 double cotton covered, to a length of about four inches. Adjust the tickler coil so that the receiver is very sensitive, or so that it oscillates feebly. P is an insulated sharp-pointed prober of steel whereby contact can be made with the turns of the wire through the insulation.

Tune the circuit by means of the prober to some broadcasting station near the upper end of the broadcast scale. Select one that is loud and the frequency of which is accurately known. The tuning is done by finding the turn at which the signal comes in the loudest, or at which the beat note is the lowest. It may be necessary to estimate fractional turns to make the measurement accurate. When the number of turns has been found for a high wave station, the process is repeated for a station of considerably shorter wavelength, but not one too far down the scale. The smaller the diameter of the coil and the longer it is, the wider may be the separation between the two stations.

Ascertains Distributed Inductance

When the number of turns has been found for each of the known frequency stations, calculate the inductance in the circuit for each case. This can be done quite accurately with the aid of Nagaoka's formula, which can be found in Circular No. 74, Bureau of Standards.

Having found the inductances in the two cases, not only can the capacity of the circuit be determined, but also the distributed inductance of the antenna. Suppose that the frequencies of the two stations used are F1 and F2. Also assume that the values of the two inductances calculated are L1 and L2. Let the true capacity of the antenna be C and let the distributed inductance of the antenna be L.

We first wind the value of the distributed inductance L from the formula $(F1/F2)^2 = (L2+L) / (L1+L)$. Having found L it can be substituted in $(F1)^2 (39.48) C (L1 + L) = 1$ to get C or in the corresponding formula for F2. The second of these formulas is simply the ordinary relation between frequency, inductance and capacity. The first formula is simply the ratio between two formulas of the second type.

Example of Determination

The first method of measuring capacity, that is, by means of a calibrated condenser, is suitable for all capacities less

(*Concluded on page* 15)

The Cash Box Unitune

A Set Worthy of Putting Under Lock and Key

By Wendell Buck

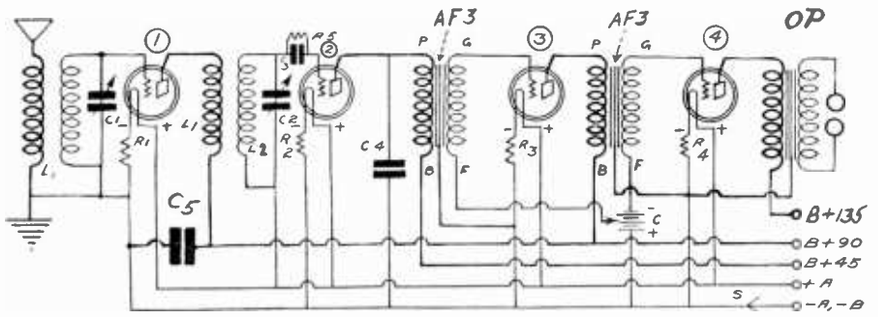


FIG. 2
The wiring diagram of the Cash Box Portable

RUGGEDNESS, sensitivity, selectivity, simplicity, lightness of weight are some of the essential characteristics of a portable receiver, if such a receiver is to meet satisfactorily the demands made on it. If the set is not rugged it may not outlast a single trip to the country; if it is not sensitive it will not bring in any signals to the camp in the country; if it is not selective it will not bring in any desired signal uniquely; if it is not simple it will be a nuisance to tune and operate; if it is not light it will not be portable, though it may be transportable. The set described herein meets requirements satisfactorily.

The demand of ruggedness is met by building the circuit into a metal cash box of dimensions 13 x 9 x 6 inches. This is a very strong case and will withstand a great deal of rough usage. It is adequate in size and it is equipped with a handle so that it can be carried easily. The metallic case for the set also serves as an electric and magnetic shield, thereby cutting out some of the noise in the Summer atmosphere.

The demand of sensitivity is met by using an open circuit antenna, a stage of radio frequency amplification in front of the detector, and by using transformer coupling in the two-stage audio frequency amplifier. The sensitivity is also aided by the use of high plate voltages and the proper use of grid bias voltage.

Set Is Selective Enough

Selectivity is gained by employing sharply tuned circuits in the inputs of the radio frequency and detector tubes, as well as by accurate adjustment of the two tandem tuners. Simplicity of operation is gained by the use of a single tuning control and by the omission of all useless knobs and dials.

Lightness of weight, which is a prime essential in any portable set, has been achieved by employing small parts throughout as well as by making the entire assembly no larger than necessary. While the metal box is heavier than a similar box made of wood or fibre, it does not add enough weight to the assembled set to overcome any of the more desirable features of a metallic container for the set.

As was stated above, the tuning is accomplished by a single dial or rather drum. This double tuning unit is a Bruno Unitune Model RF and consists of two quartzite radio frequency transformers and two .0005 mfd. condensers, all mounted in one unit. In Fig 2. the two RF transformers are designated by L1L2 and L3L4 while the two condensers are designated C1 and C2. The grid condenser C3 is of .00025 mfd. capacity and the grid leak R5 is of two megohms resistance.

Output Transformer Used

There are three transformers used in the receiver, one of which is an output transformer. The two coupling transformers AF3 are Ferranti devices, which have primary windings of very high impedance, and therefore are capable of bringing out the low tones. The output transformer OP is of the same make but is designed to work between a power tube and a loud speaker.

The filament current is entirely controlled by Amperites. Four are used, one for each tube. The first three, R1, R2 and R3 are of the 99 type and R4 is of the 120 type, to match the tubes with which they are used. Of course each amperite is placed in the negative leg of the filament circuits.

The most suitable tubes for use in a portable set are the 99 and the 120, since they do not require much filament current nor a high filament voltage. Three of the 99s and one of the 120 are required for the receiver.

Adequate Plate Voltage

The sockets used in this receiver should be of the UX type so that for home use larger tubes can be substituted. When making the tube substitution it is necessary to change the amperites also. The first three should then be 1A if the tubes have 5-volt filaments and the last Amperite should be a 112 if a 112, or other tube of similar filament characteristics is used.

The plate voltage on the first audio and the RF tubes is 90 volts. The plate voltage on the detector is the usual 45 volts, and the voltage on the plate of the last tube is 135 volts. If desired the RF tube can be put on the same plate voltage as the detector.

The grid bias for the audio frequency tubes is suited to the plate voltage used and the type of tube employed. Since the first audio tube has a plate voltage of 90 and the tube has a mu of 6.5, the proper grid bias on that tube should be about 7.5 volts.

The grid bias on the last tube, if it is of the 120 type, should be 22½ volts. It should be pointed out that it is a fallacy in a portable set to omit the grid battery to keep the weight down. The use of a very small grid batteries of the proper voltage will save the plate current drain—about 50 per cent.—so that much smaller B batteries can be used. Thus a few ounces of grid batteries will make it possible to dispense with several pounds of B batteries. Of course, it is not recommended that exceedingly small B batteries be used, but they may

(*Concluded on page* 15)

LIST OF PARTS

C1C2L1L2L3L4—One Bruno Unitone, Model RF, consisting of two .0005 mfd. condensers and two RF transformers, mounted on a frame; two drums, panel plate.
C3—One Electrad .00025 mfd. condenser with leak mounting.
C4—One Electrad .001 mfd. condenser.
C5—One Electrad .01 mfd. condenser.
R1, R2, R3—Three 99 type Amperites.
R4—One 112 amperite.
R5—One 5 meg. Electrad grid leak.
AF3—Two Ferranti audio frequency transformers.
OP—One Ferranti output transformer.
S—One Carter "Imp" filament switch.
Four Pacent Cushion Sockets No. 83.
One extension Cord connector.
One Jones Multi-plug and Cable, base mounting type..
One wood baseboard, 12½x8½x⅜ in.
Two metal cash boxes, 13x9x6 inches, equipped with handle and lock.
Two ⅛ inch rubber bushings.

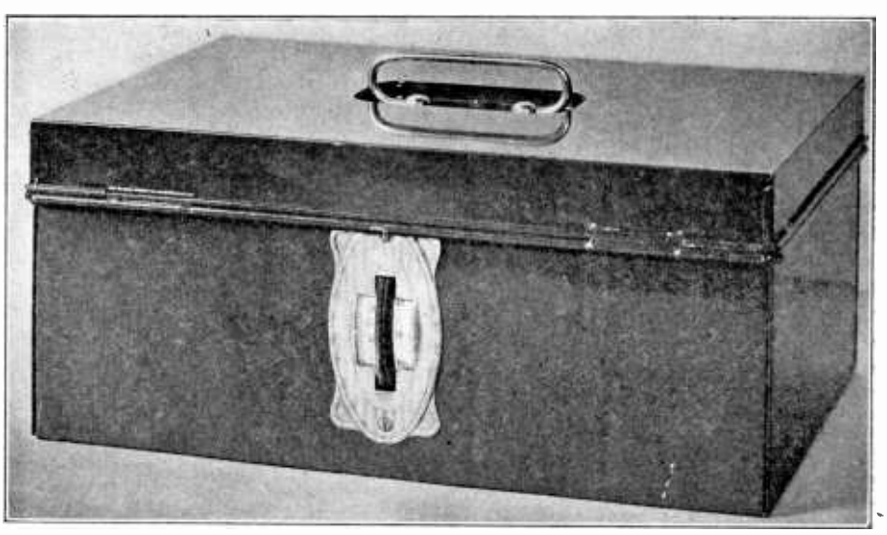


FIG. 3
Front view of the Cash Box Portable Receiver.

How to Use the AC Tubes

Practical and Soon Will Be Rule, Says Expert

By C. T. Burke

Engineering Department, General Radio Co.

THE principal radio trend of the season just past has been toward the elimination of batteries. Many satisfactory plate supplies have been developed, but the problem of filament supply has offered more difficulty.

Larger currents are required for filament than for plate supply, and these mean greatly increased expense in the rectifier and filter circuit. Then too, many of the plans proposed for batteryless filament lighting required rewiring of the tubes in series.

Tubes for alternating current filament supply have been announced by several manufacturers. Many of these tubes will be available in the next few months, and the batteryless receiver will probably be the outstanding development of the coming radio season.

Trend Is Toward AC

This does not imply immediate obsolescence of present receivers. The new tubes will have plate characteristics similar to those now in use, and the present types of tubes will continue to be supplied. The trend will, however, undoubtedly be toward the AC filament tubes.

Two types of AC filament tubes are to be supplied, representing different methods of attack on the problem of AC filament operation.

In the conventional type of tube supplied for direct current operation the filament forms a part of two circuits. The battery circuit through the filament is for the purpose of heating the filament to produce electron emission. This circuit is auxiliary to the main function of the tube, but the filament also forms one side of both input and output circuits of the tube.

Ordinary Tubes Hum

If alternating current is supplied to the filaments of ordinary tubes, a hum will result. Several sources contribute to the hum. As the current through the filament changes during the alternating current cycle, varying from zero to maximum, the temperature of the filament, which depends on the current through it, is also changing. The change in filament temperature results in a cyclic change in the tube characteristics which in turn produces a hum at twice the frequency of the supply. A certain amount of hum is due to capacity effect between the tube elements and to voltage drop along the filament.

Another appreciable source of hum is the grid effect of one side of the filament on the other. The filament of most tubes (except the 199 tube) is triangular in shape (less the base).

It Makes a Difference

When direct current is applied to the filament, conditions are stable, and the grid effect of one end of the filament on the other end introduces no disturbance. When alternating current is applied to the filament, the grid effect is variable. As the current increases through the filament one end of the filament is increasingly negative with respect to the other, and the emission from that end of the filament is reduced, since the other end is more positive and attracts a portion of its emission current. A half cycle later the two ends of the filament are reversed, and the effect repeats. A hum at twice the supply frequency results.

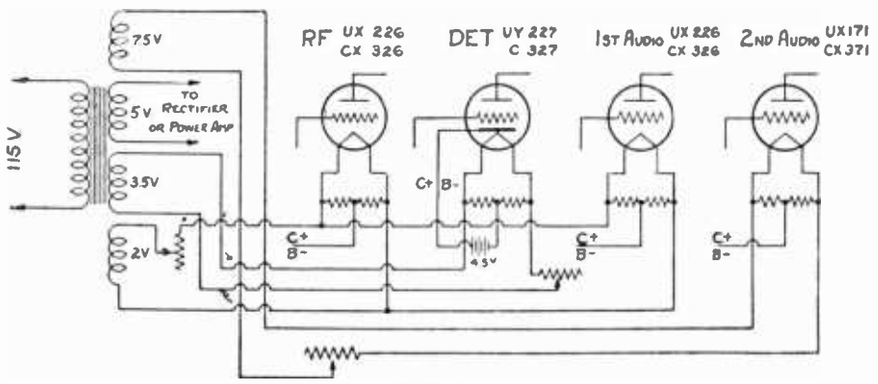


FIG. 1

The AC wiring for a four-tube receiver, with grid return connections shown. AC tubes are used, as identified in the diagram. Note the five-terminal tube used as detector, with the reversed C battery to give positive bias. Mid-tapped resistors across each filament establish the average potential point. Grounding the center makes adjustment critical, particularly in the detector stage, the author observes.

In one type of alternating current filament tube, the design is similar to the direct current type except for the construction of the filament, which is short and heavy, taking materially more current than the modern direct current tubes and operating at a low voltage.

An advantage of the heavy filament is that it retains heat longer than the present type, i.e., there is less heating and cooling as the current goes through its cycle, the heat carrying over from one cycle to another. In fact, sufficient heat remains to produce audible signals for a few seconds after shutting off the current.

There's an Appreciable Wait

It might be expected that such a filament would take longer to reach its operating temperature. This proves to be the case, and there is an appreciable wait between the turning on of the current and the appearance of the signals. It may be noted in passing that some of the direct current tubes have the characteristics of slow heating and cooling of the filament. The WX 12 type can in fact be used with fair results, with low AC on the filament in radio frequency stages, provided care is used. It is also interesting to note that the 199 type of tube, with a straight filament, shows little grid effect.

The filament of the AC tubes is short and straight, which greatly reduces the grid effect. The low voltage across the filament also tends to reduce the hum due to grid effect.

Returns to Average Potential

In order to eliminate hum due to the voltage drop through the filament the grid and plate returns must be connected at the average potential of the filament, i.e., the potential of the center point. Unless this is done a pronounced hum having the same frequency as the source of current will be produced by a periodic fluctuation of both the grid bias and plate voltage. The most satisfactory means of obtaining this connection is by means of a center-tapped resistance across the filament terminals of the tube. The center of the resistance is necessarily at the same potential as the center of the filament.

Tubes of the heavy filament type are generally made to fit the standard UX type of socket. This type of tube is suitable for either radio or audio frequency amplifier work. Some manufacturers do not, however, recommend tubes of this type for use as a detector.

The Fifth-Terminal Tube

In another type of tube for alternating current operation the two circuits which use the filament of the direct current tubes are separated. The cathode is heated from a separate heating element inside the cylindrical electrode, while an additional terminal is provided for the C+ and B— connection and the tube has therefore a five-prong base, requiring a special socket. This type of tube also requires a center-tapped resistance across the heating element.

The center point of the resistance may be grounded in this case. When the midpoint of the potentiometer is grounded, the setting is rather critical for best results. Another less critical method is to connect a 4.5 volt battery between the center tap and the cathode terminal. The negative of the battery is joined to the center tap. This type of tube is particularly recommended for use as a detector.

No power tubes are listed among the new alternating current filament tubes since raw AC can be used with perfect satisfaction on the filaments of present last stage tubes. The output tube should always be the 112, 171 or 210 type. These tubes are connected in the same manner as the AC tubes which use the standard UX base, i.e. with a center-tapped resistance across the filament.

Needs Wire That Suits

Due to the heavy currents drawn by the alternating current types of tube, it may prove necessary to replace the filament wiring in some multi-tube sets with heavier wire, No. 18 wire, for example, should not be required to carry more than three amperes. Portions of the filament bus through which greater current

(*Concluded on page* 15)

Curing Image Interference

Analysis of An Ailment of Super-Heterodynes

By Brunsten Brunn

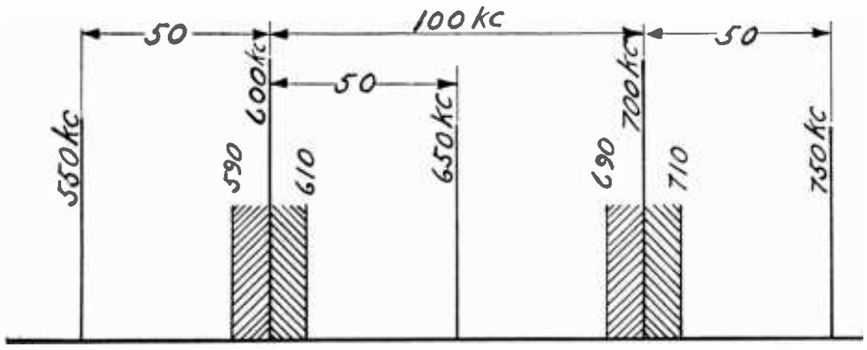


FIG. 1

The production of image interference. When the oscillator is set at 550 kc, a 50 kc frequency is produced with the 600 kc signal and it gets through the filter. When the oscillator is set at 750 kc, a 50 kc frequency is produced with the 700 kc signal and it gets through the filter. When the oscillator is set at 650, a 50 kc signal is made with the 600 kc signal and also with the 700 signal, and both get through the filter at the same time. A squeal is produced.

EVERY system of reception has its ills. The Super-Heterodyne system is no exception. The Super-Heterodyne is immensely popular, which proves its value, but experts are trying to free it from all troubles.

The principal reason the Super-Heterodyne is popular is that it is the "Rolls Royce" of reception. Ownership of a Super is a mark of distinction, of affluence, just as the ownership of a Rolls Royce or a yacht is. Ownership of a Super-Heterodyne is not always a sign of radio satisfaction, of radio tranquility.

Notwithstanding defects of the Super-Heterodyne, it has always been a pet with most technical writers, engineers and advanced radio experimenters. Despite ills to which it is subject it is the non-plus-ultra of receivers.

Time and thought spent in overcoming the shortcomings of the Super-Heterodyne should be regarded as legacies to posterity, because unquestionably the Super-Heterodyne embodies the principles of the receiver of tomorrow, or the day after.

Some Troubles Listed

What are some of the troubles with the Super-Heterodyne? It may be too selective, and many examples of Super-Heterodynes are too selective.

The Super is subject to more interference than any other receiver, with the possible exception of the single circuit crystal receiver.

The Super-Heterodyne also will pick up more noise from the atmosphere and it will develop more noise of its own than any other set.

The greatest trouble with the Super-Heterodyne is that which has been called image interference, which gives rise to most of the squeals heard in the Super-Heterodyne. Indirectly, it is also the cause of over-selectivity, because in an endeavor to get rid of the squealing, designers have increased the selectivity.

It may be well to discuss image interference and tell what it is. Suppose that the intermediate frequency used in the Super-Heterodyne is 50,000 cycles and that it is desired to receive a station operating on a frequency of 600 kilocycles. A local oscillator is started and its frequency is adjusted to differ from the desired frequency of 600 kilocycles by the value of the intermediate frequency, that is, 50 kilocycles. The frequency of the local oscillator can either be 50 kc above 600 or it can be 50 kc below it. That is, the desired station can be received either when the local oscillator is set to 550 kc or to 650 kc.

Image of One, Object of Other

One of these frequencies is just as far below the 600 as the other is above it, or the two bear the same relationship to the 600 kc frequency as the object and the image bear to the plane mirror. It is for this reason that the term image interference is used. We can regard the position of the 600 kc frequency in the scale as a mirror and then the 650 kc frequency can be regarded as image and the 550 as the object, or vice versa. The term image interference is not a very appropriate one, but it is rather widely used.

It should be pointed out that the image can never interfere with the object of the same station. It is the image of one station that interferes with the object of another. For example, suppose that there is another station operating on a frequency of 700 kc, and that this is close enough to the receiver to make itself heard. This station can be received on our 50 kc Super-Heterodyne if we set the local oscillator on either 750 or 650 kc. Therefore both the 600 and the 700 kc station can be received if the local oscillator is set on 650 kilocycles. Therefore, there is a clash between the image of one and the object of the other.

Little damage would be experienced from this clashing if the two stations were really on 600 and 700 and if the 50 kc Super were set on exactly 650 kc, unless the two signals were of about the same intensity at the first detector. The trouble arises when there is enough divergence in frequency so that the clashing image and the object produce a squeal.

Arrives Weak, Interferes Strongly

The Super-Heterodyne is extremely sensitive to this type of interference. The interfering image may be exceedingly weak yet be strong enough to ruin the reception of a strong local station. The reason for this is that the strength of the interference is proportional to the intensity of the local oscillation, which is the same for both the strong local station and for the weak interfering station. It does not take much of a squeal to render reception intolerable.

So far we have seen that the 50 kc Super-Heterodyne cannot receive without interference a 700 or a 600 kc signal when stations of both of these frequencies are operating. It will be noted that the separation between these stations is equal to twice the intermediate frequency. It requires no further demonstration to show that any two stations operating simultaneously on frequencies separated by twice the intermediate frequency will interfere no matter what the absolute values of the station frequencies may be or what the value of the intermediate frequency may be, just so one of the station frequencies lies within the range of the local oscillator. For example, two stations operating on 950 and 1050 kc can be received when the local oscillator is set at 1000 kc on our 50 kc Super-Heterodyne, and therefore these stations will interfere with each other.

Since the broadcast stations are separated by multiples of 10 kc, it appears that if the intermediate frequency is 50 kc no stations would be free from image interference except those operating on frequencies less than 600 kc, that is, 550 plus 50 kc. These long wave stations could be received free of broadcast interference on one point each only. Stations operating near the upper limit of the broadcast scale could not be received without interference because of harmonics of lower frequency stations. If we choose another intermediate frequency which is a smaller multiple of 10 kc, the situation is simply aggravated, because there will be a greater number of chances for interference, and the fact that the selectivity can be made much greater on the lower frequencies will not aid in preventing the interference.

Applies All Over

It is not only the whole multiples of 10 kc which are subject to interference but practically every other frequency that can be selected. Suppose the intermediate frequency is 45 kc. Stations separated by 90 kc will interfere. Suppose again that the intermediate frequency 42,500 cycles. Stations separated by 85 kc would interfere. But there are no stations in this country or Canada which are separated by such an interval, since 85 is not a whole multiple of 10 kc. But that does not prevent interference. In this case there would be much more interference, because neither the 90 nor the 80 kc separations would be exempt. There is nothing to be gained by splitting up the intermediate frequency into fractional multiples of the 10 kc interval.

What can be gained by tuning the intermediate frequency filter? Selectivity and nothing else. No relief from image interference to speak of can be gained, unless the interfering noises are so high in frequency as to be cut off together with the higher frequencies in the side bands. The remedy is worse than the malady.

What then can be done to minimize image interference in a Super-Heterodyne? One thing that can be done is to

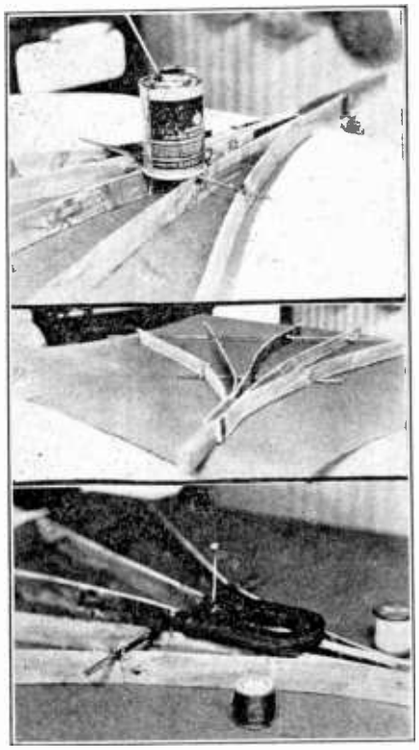
(*Continued on next page*)

An Arbor Speaker

Handy Indeed for Enlivening Garden Parties

By Herbert E. Hayden

Photographs by the Author



FIGS. 1, 2 AND 3

The top photo shows the construction of the fan-shaped trellis or arbor for holding the sounding surface. It also shows the manner in which the paper is placed and trimmed. Fig. 2 shows the fans and the paper which is to be the sounding surface. At bottom (Fig. 1) is the driving unit of the speaker.

WE have heard of the welkin ringing, of brooks murmuring, of boughs sighing, of the wind howling. But we have never heard a vine covered trellis singing and speaking, though we have heard whisperings and cooings inside the arbor formed of the trellis. But now we have a trellis that not only transmits the whisperings and cooings from the lovers inside, but we have a trellis that sings and speaks of its own accord.

This singing trellis is a loudspeaker. It is basically of the cone type. It consists of a trellis arrangement, called an arbor, and sold as garden equipment, which you cover with a sheet of Alhambra Phonotex paper. The trellis or arbor is the form of a fan with a substantial handle at the apex. The construction can be seen from the photographs. First we have the wooden handle and then five radiating strips of wood placed on edge. The fan is spread by means of a couple of wood dowels suitably placed.

In assembling the fan-shaped trellis the work can be facilitated by binding it together with thread. Then glue is applied and the assembly is left to dry, after which the threads can be removed.

In Figs. 1 and 3, the top and bottom photos, you see the structure of the fan, in case you want to make it yourself. After the glue is dry the fan is placed on top of a sheet of Alhambra paper and secured by means of more glue. Then excess paper is trimmed off with a pair of shears and the sound part of the speaker is finished.

But the speaker will not sing without a driving unit. How this is mounted is shown in Fig. 3 in the bottom photograph. This photo merely shows the position. The coupling pin should, of course, be turned toward the sounding paper. The Ensco unit may be used.

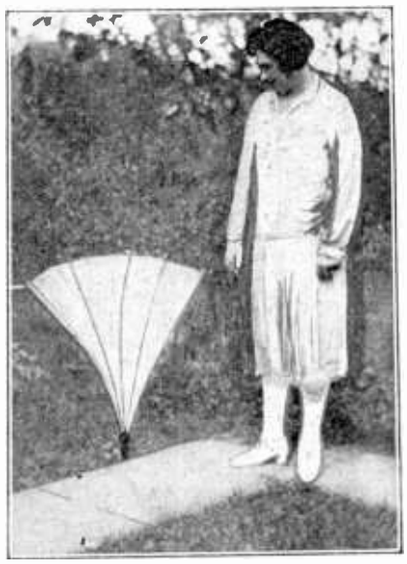


FIG. 4

This shows the finished trellis speaker and a girl entertained by it.

Fig. 4 shows the finished speaker. Its base is pointed and the speaker may be stuck into the earth anywhere in the garden, while extension cords connect to the set in the house. Thus garden parties are enlivened by broadcast music.

RESTAURANT USES AC SET

As a means of entertaining its patrons, Thomas's Restaurant in Newark, N. J., has installed an AC operated receiver. This is used in conjunction with a 36-inch cone speaker. The set is kept going from noon to 1 A. M.

Trapping and Balancing Out Interference

(*Concluded from preceding page*)

increase the intermediate frequency. It might be made 100 or even 250 kilocycles. Increasing the intermediate frequency militates against selectivity as well as the sensitivity.

Safety Factor in Higher Frequency

Vacuum tubes and circuits are not so effective at high frequencies as at low, so that using high intermediate frequencies nullifies one of the main objects of the Super-Heterodyne, and it does so in direct proportion to the increase in frequency. But the loss in amplification can always be offset by a little regeneration. This would also offset some of the loss in selectivity.

The higher the intermediate frequency the fewer chances there will be for image interference. The advantage will mainly be noticeable at the lower end of the scale, but there will also be some advantage at the upper. If the intermediate frequency is fairly high it will represent a considerable part of the total range and there will only be a small band in the middle of the range which will be subject to interference. But this is not the only advantage to be gained from using a high intermediate frequency.

The most effective way of minimizing image interference is to operate on the radio frequency end of the circuit. It might be said that it is the only way of reducing the trouble. The radio frequency tuner must be made so selective that the signal which causes the image interference is reduced to zero as far as its effect on the output is concerned. This elimination of the interfering carrier can be done by making the radio frequency tuner very selective irrespective of the value of the intermediate frequency. But if the intermediate frequency is low, the radio frequency tuner would have to be very much more selective than it has to be when the intermediate frequency is higher, to gain the same suppression of the interfering carrier.

Other Means Suggested

Making the radio frequency tuner selective enough to cut out the interference when the intermediate frequency is low would result in cutting off the side band frequencies in the signal to such a point as to reduce the intelligibility of the signal received. If the intermediate frequency is high the interfering carrier can be nullified without making the tuner so sharp as to interfere appreciably with the quality of the reproduced signal. For this reason a high intermediate frequency is desirable. Recent practice favors intermediate frequencies ranging from 100 to 250 kc, with a few still clinging to the 50 kc frequency.

There are other means of suppressing an interfering carrier which do not necessitate making the radio frequency tuner very selective or without making the intermediate frequency excessively high. One is based on trapping out the interfering carrier by means of a tuned circuit, and another is based on balancing it out. When the trap method is employed a tuned circuit is incorporated in the receiver and coupled loosely to the input. If there is a squeal caused by image interference the trap is set on the carrier which causes the trouble, and the squeal either disappears or is reduced to tolerable intensity. If the balancing method is used the circuit is so arranged that no signal can be received from the direction of the interfering carrier. The simplest way of balancing is merely to turn the loop so that its plane is at right angles to the direction from which the interference comes. This is effective provided that it does not also cut out the station desired. There are other methods of balancing out interference of this type but they are not suitable for broadcast reception.

A Push-Pull Output

Condenser Folly Avoided in This Hookup

By Gen. T. C. H. Branon

WHEN it is desirable to have considerable undistorted power for the loudspeaker and neither power tubes nor high voltages are available, a push-pull amplifier can be rigged up, usually out of parts that are already at hand. Fig. 1 shows such an amplifier. T1 is an audio frequency transformer. It must be one of high grade and preferably of high ratio, say 6 to 1. R1 and R2 are two resistors or about .5 megohm each. R3 is a high resistance potentiometer about .5 megohm. This potentiometer is connected between the two fixed resistors and it is used for the purpose of dividing the secondary voltage equally between the two tubes. It is difficult to find two resistors of exactly equal ohmage to make the potentiometer unnecessary. Of course, if a potentiometer of about one megohm is available, R1 and R2 need not be used, R3 alone being sufficient.

The grid battery is put in the lead which runs to the slider on the potentiometer, with the minus terminal pointing toward the slider.

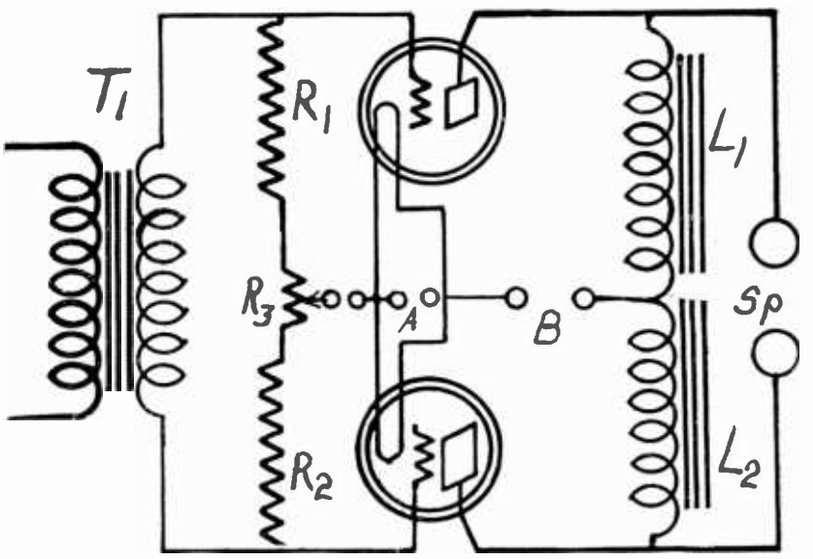


FIG. 1

A push-pull amplifier without the regular input and output transformers. A potentiometer is used to divide the secondary voltage of transformer between the two tubes. Two choke coils are used in the output and the loudspeaker is connected directly across the coils without any stopping condensers.

No Condensers Used

In the output side two choke coils L1 and L2 are used in place of an output transformer. These choke coils can be the secondary windings of audio frequency transformers. Cheap transformers, which should not be used in any high quality amplifier, can be used here to good advantage. The two choke coils are connected in series between the two plates of the tubes. The mid-point, or junction of the two windings, is connected to the positive of the plate battery.

The loudspeaker is connected from plate to plate across the two choke coils. Note that no condensers are used in series with the speaker. Similar circuits have been recommended in which a 2 mfd. condenser has been placed on each side of the speaker, with the admonition that each must stand the voltage of the plate battery. When two condensers of 2 mfd. each are used in series the effective capacity in series with the speaker is only one microfarad, and this is so low that it seriously cuts down the lower notes in the signal. The loss of the low notes is too heavy a price to pay for a habit which serves no purpose. It is apparent that there is no DC voltage across the loudspeaker, and no direct current will flow through the loudspeaker when the condensers are omitted. Hence the condensers should be omitted.

Tubes to Use

Since the loudspeaker is connected from plate to plate without a step-down transformer, the loudspeaker should have a very high impedance to take full advantage of the power delivered by the tubes. The internal resistances of the tubes are in series with the speaker, and therefore the speaker should have twice the usual impedance. We cannot change the impedance of the speaker at will to match the series connection, but we can use two speakers in series. But using two speakers is not a practical solution.

It is better to use two tubes which have a low output impedance, e. g., two 371 tubes, the impedance of which is around 2,000 ohms each, requiring a load impedance of 4,000 ohms each. The impedance of the speaker when connected across two such tubes should therefore be 8,000 ohms. Most good speakers are suitable. Such tubes as the 220 and 112 may be used.

LIST OF PARTS

T1—One good audio transformer, ratio 6 to 1.
R1, R2—Two .5 megohm grid leaks (Lynch).
R3—One .5 megohm potentiometer.
L1, L2—Two audio frequency choke coils or transformers.
One double mounting (Lynch).
Two UX sockets.
Two amplifier tubes of low output resistance.
Ten XL binding posts.
One baseboard 4x7 inches.

Hammarlund Has Two RF Chokes

Two radio frequency choke coils are the latest additions to the line of Hammarlund radio products. A specially developed method of winding, and impregnating with low dielectric compound, produces a coil of minimum distributed capacity and extremely high impedance to currents at radio frequencies. Due to the resistance of the coils and the method of winding, there is no point within the broadcast band at which they become self-resonant and their action is the same throughout this range of frequencies.

The case is 1½ inches in diameter by 1¾ inches high, and the coils are made in two values of inductance for the broadcast band.

R.F.C. No. 85 has an inductance of 85 millihenrys, a capacity of 3 mmfd. and a reistance of 215 ohms.

R.F.C. No. 250 has an inductance of 250 millihenrys. a capacity of 2 mmfd. and a resistance of 420 ohms.

Literature Wanted

THE names and addresses of readers of RADIO WORLD who desire literature on parts and sets from radio manufactures, jobbers, dealers and mail order houses are published in RADIO WORLD on request of the reader. The blank below may be used, or a post card or letter will do instead.

RADIO WORLD,
145 West 45th St., N. Y. City.

I desire to receive radio literature

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Adolpf Sauter, 486 Park Ave., West New York, N. J.
Lee Henderson, R. F. D. No. 2, Jewett, Ohio.
Mr. Jno. Lucas, Box 75, Jewett. Ohio.
Geo. H. Keller, Jr., 254 Delaware Ave., Albany, N. Y. Consoles.
B. R Farris, General Delivery, West Palm Beach, Florida.
Chester L. Davis, Ph.D., School of Engineering of Milwaukee, 163 East Wells Street, Milwaukee, Wisc.

Daven Retains Baron; New Circuit on Way

Baron von Ardenne, 20-year-old German scientist, who recently visited the United States, has been retained by the Daven Radio Corporation, of Newark, N. J., prominent resistor and high and low mu tube manufacturers, as consulting engineer.

The Baron's special anode (plate) bend method of detection will be used in a specially designed receiver.

The Toto Power Well

Dispenses With All Batteries, Provides AF Stage

By Capt. Peter V. O'Rourke

Contributing Editor

PART I

ELIMINATORS in which all the three voltages, A, B and C, are obtained are now rapidly gaining in popularity. Such eliminators should incorporate a stage of power amplification. This the Toto power well does.

The rapid gain in the popularity in these devices is due to the cleanliness and ease of operation as well as to the enormous amount of power or undistorted quality that is available in the output circuit.

It is customary to connect the filaments of most of the tubes in series in such eliminators and to filter the filament current so that all ripple is removed from it. It is this filtering which makes it possible to eliminate not only the B battery but also the A and the C batteries.

The C battery is eliminated by making use of voltage drop in a resistance. The grid bias voltages for most of the tubes can be obtained from the voltage drops in the filaments of the tubes.

May Use Drop in Filament

If 01A tubes are employed the drop in each filament is 5 volts, and therefore grid bias potentials can be obtained in steps of 5 volts. However, in series connected circuits there will always be one tube, and sometimes two, which cannot get bias from a drop in another filament. This tube can often be made the detector, which does not require a negative bias. If the detector cannot be placed in this unique position, it is often possible to place the first radio frequency amplifier there, since such a tube can be operated without any negative bias.

However, it is always best to adjust the grid bias for every amplifier to the proper value. Hence it is customary to introduce a resistance in series with the filament circuit and utilize the voltage drop in that resistance for the bias of the tube which is in the unfavorable position. The voltage for the bias on the power tube is obtained in a similar manner, although in this case the current utilized is only the plate current from the power tube rather than the filament current for the other tubes.

One of the essential things in the eliminator is the filter, as was stated above, and the most important parts in the filter are the by-pass condensers. Without them no satisfactory operation could be obtained.

Good Condensers Spare Trouble

Condensers should be used generously both in size and number.

For example, there should be a by-pass condenser of large value across every filament heated with direct current as a means of reducing the effect of residual hum. This is important because the ripple in the filament current not only affects the heating current but it also affects both the plate and the grid voltages. Since it affects the grid voltages it also affects the input voltages to the amplifier tubes and the detector. The hum is amplified just as the signal is amplified, and what at first was a minute and inaudible ripple is likely to become an audible hum. The by-pass condensers prevent the hum from entering the signal and thus keep the output hum-free.

Another important reason for by-passing generously is that it reduces the tendency to motorboat. Condensers furnish the only means of reducing the cause of motorboating, although there are other means of stopping the oscillation. Another place where condensers must be used is in the voltage divider in the plate supply part of the eliminator.

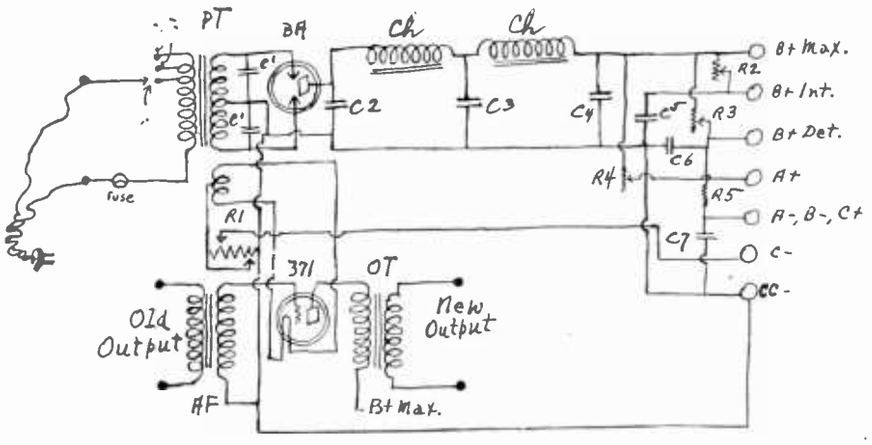


FIG. 1

The circuit diagram of an ABC eliminator and a one-stage power amplifier.

Need of By-passing

Every section of the resistance should be by-passed with a good sized condenser, and the by-passing should always be from the high potential side of the resistor to the lowest potential point in the circuit.

In an eliminator in which A, B and C voltages are to be obtained the voltage at the output of the filter must be higher than when only the B voltage is to be obtained. This requires that the condensers used in by-passing be able to stand a higher voltage. Sometimes the voltage will be as high as 600 volts. The condensers used must then be able to stand continuously at least 1,000 volts. This high limit is set as a matter of safety, not only for the condenser but also for the circuit as a whole and the operator. Short-circuits and break-downs never do any good.

A direct current voltmeter placed in the output of the filter may show a steady reading of 350 volts, but that does not mean that that is the highest voltage to which the condensers will be subjected.

Surges Are High

There are surges in the line which may rise to several times the value of the indicated voltage. These surges do not last long enough to affect the reading of the meter but they may last long enough to break down the condensers or insulation of the leads. A 200% margin of safety in the condensers is not excessive.

A condenser might resist a high voltage for an instant yet break down on a somewhat lower voltage sustained for a considerable period, if not enough margin is left. This will more likely occur when the condensers are carrying an alternating current of some intensity than when the current is feeble. The current heats the insulation and weakens its dielectric strength. So good condensers are necessary, and on the BA circuit are doubly necessary, since here the current drain is heavy.

[Part II, dealing with the construction, will be published next week. The biasing problem will receive special attention then.]

LIST OF PARTS

BA—One Raytheon Type BA tube.
PT—One Acme power transformer for BA tube (.2kw).
AF—One Acme Apparatus audio transformer.
OT—One Acme output transformer.
C1, C1—Two 1,000-volt Flechtheim buffer condensers, each .1 mfd.
C2—One 4 mfd. 1,000-volt Flechtheim condenser.
C3, C4—8 mfd. each, made up of four each of C2 type.
R1—One Amsco Duostat, 2,000 ohms.
R2—One Electrad 5,000-ohm 5-watt Truvolt variable resistor.
R3—One Electrad 10,000-ohm 5-watt Truvolt variable resistor.
R4—One Power Clarostat.
R—One Electrad 1,500-ohm 5-watt Truvolt fixed resistor.
C5, C6, C7—Three Flechtheim 1 mfd. 250-volt by-pass condensers.
Two Acme Apparatus Co. choke coils for BA tube (BA2).
Eleven binding posts.
One fuse and one porcelain fuse socket.
One extension cord and lamp socket plug.
Two vacuum tube sockets.
One CX-371 tube.
One 20x10-inch asbestos board.
One shielded case (optional).

ENSCO OPENS TORONTO OFFICE

Increasing demand in Canada for the Ensco three-foot cone speaker kit, manufactured and marketed by the Engineers' Service Co., 25 Church street, New York City, has caused the opening of the first of a chain of Canadian studios in Toronto. This studio opening was arranged by D. B. Tilson, New England manager for Ensco, and is located at 331 Bay street, Toronto, Canada.

Precautions Assure Fine Summer Reception

(From Information Bureau, Radio Corporation of America)

Just as the family car must be prepared for the Winter driving season by undergoing a thorough overhauling, so must the family radio set be groomed for Summer use. In either event the preparations are simple enough, and should not stand in the way of enjoying to the utmost both these one-time hobbies which have now become such everyday necessities in American family life.

Many things have been done during the past few summers to ameliorate conditions in warm weather radio reception. Transmitting power has been enormously increased. Network station operation has placed the best programs in most parts of the country with the loudspeaker volume of local stations. Receiving equipment has been developed with an eye—or shall we say an ear?—to lessening the static effect while increasing the apparent signal strength. In all, remarkable advances have been scored against Summertime obstacles. A large field for improvement still lies in the homes of the set owner.

Satisfactory radio reception depends primarily upon what radio engineers call the signal-static ratio. In other words, static is present, in varying degree to the signal strength from the broadcasting station.

Question of Signal Strength

With the advent of warm weather, particularly in humid, uncomfortable weather that presages the thunderstorm, the static level rises and becomes evident in as a raspy background to broadcast music or speech. Fortunately, however, it is very rare that the static is sufficiently powerful to interefere with the signals of present-day broadcasting stations within their service range.

It is obvious, then, that the signal must be of sufficient strength to override static interference by a fair margin. Broadcasters have long recognized this fact. Transmitting power has been steadily increased from the early days, when a 500-watt rating was considered ample for broadcasting over a wide area. Today, the 500-watt rating is recognized only for purely local service, with a limited service range throughout the year. Many times that power must and is being employed in Summer for a service range of about 100 miles and over, reaching out into the rural districts.

What is more, the rapid development of network broadcasting, making the best programs available in many parts of the country through local broadcasting stations, has had the greatest influence on popularizing summertime radio not only by providing sufficiently powerful signals, but also in maintaining the highest quality of entertainment.

The first essential in Summertime radio, then. is to tune in the most powerful signals available when conditions are least favorable.

Shorter Antenna

Give a sufficient ratio between signal and static levels, the radio listener can reduce the undesirable background by being satisfied with smaller volume from his loudspeaker.

Another effective method is to employ a smaller antenna. The antenna, normally 60 to 100 feet in length, may be cut down to 30 or 40 feet with sufficient pick-up to intercept powerful local signals during the Summer months. Or an indoor antenna may be substituted, consisting of 20 or 30 feet of wire stretched about the room behind the picture moulding, or otherwise placed about the house. A small fixed condenser of .0005 mfd. capacity, should be placed between the antenna and the ground binding posts of the receiver, to compensate for the reduced wavelength of the antenna, without causing material change in the dial settings of the receiver.

Interesting experiments may be performed with underground antennas, which are less subject to static pick-up. No. 14 rubber covered wire, such as is used for exposed wiring, may be buried several feet deep in a straight trench, and then covered over, with the end brought to the antenna binding post. Sometimes the ordinary gas pipe of the home will serve as a satisfactory Summertime antenna.

Loop Operation Excellent

In the early days of radio communication, two ground connections made at different depths underground so as to tap two different strata, were employed with fair results. The loop-operated receiver provides an almost ideal means of favoring signal as against static interference, because of its sensitive directional pick-up, enabling the operator to swing away from undesirable noises.

Aside from altering the receiving conditions, the volume of the loudspeaker rendition may be lowered so as to make the static background less conspicuous. In fact, most radio listeners do employ too much volume, and this is especially true in Summer reception. The average radio receiver has a satisfactory volume control that may be employed in reducing the loudspeaker volume to the desired degree, to drop out the static background. If the receiver is not provided with a volume control, then a variable high resistance of from zero to least 250,000 ohm range may be connected across the secondary of the first audio transformer as an effective and non-distorting volume control.

Filament Control Attacked

Turning the filaments of the receiver up or down does not constitute an efficient volume control. It should be noted that filaments must be operated at the proper voltage at all times, irrespective of the volume desired. Dimmed filaments may result in severe distortion, while excessively lighted filaments lead to greatly shortened life of tubes.

Distance never fails to add greater realism and maximum enchantment. If we may take this hint with our Summertime radio, do not fail to experiment in loudspeaker placement. The loudspeaker should be tried out in different rooms, with the listeners sitting at various distances. A marked improvement will be noted when the distance between loudspeaker and listeners is increased. Or, if weather permits, the loudspeaker may be brought outdoors, on the porch or even placed on the lawn of the country home. There is a positive thrill of freshness which never fails to arouse even the most blase radio listener-in when the radio is brought outdoors for the first time.

Among the radio listener's Summertime equipment, then, should be an extension cord or at least some wire whereby the loudspeaker may be moved about the home and brought outdoors, if possible. Of course the purpose of the outdoor rendition is for the enjoyment of the immediate family and guests. The volume should be just sufficient for proper enjoyment, and at no time should it be so loud as to disturb the neighborhood, for that is not the purpose of radio entertainment.

These suggestions will help greatly but it is taken for granted that the receiver is in good operating order. After the long and steady use over the indoor season, it is obvious that the receiver should be gone over and put into first-class condition.

First of all, the batteries, if the receiver operates on this form of power supply should be checked over. It is well to remember that dry batteries dry out quicker in Summer than in Winter, and if the batteries have already been in use for many months, the warm weather of Summer

GERMANY TODAY

(Henry Miller)

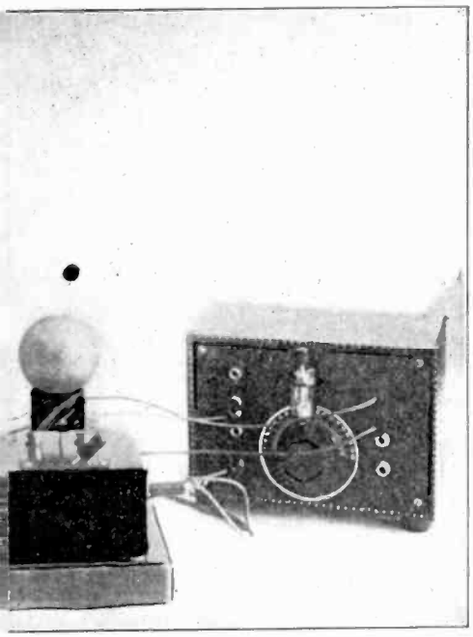
A TYPICAL German radio installation single tuner serves to select the station a multiplex tube amplifier steps up the speaker. Except for the cone the radio

A Phonograph with Ser

If you contemplate using an electrical pickup with your phonograph the audio amplifier of your radio receiver may be used to advantage and it will not be necessary to build a separate amplifier. As most of the electric pickups on the market are supplied with a volume control it will not be necessary to alter the set in any way.

If the filaments of the tubes in the set are wired in series, the tube socket plug-in arrangement supplied with some of these units cannot be used, for if you remove one of the tubes from its socket all the others would go out. It would be best to connect the pickup across the primary of the first audio transformer.

Y LIKE U. S. IN 1922



tion of today. A crystal receiver with a ion desired and to make it audible. Then he volume to make it loud enough for the installation is reminiscent of American in 1922.

mer may soon exhaust them. Start out with a complete set of fresh dry batteries.

In the case of the socket-power receiver, the rectifier tubes should receive attention. In time these rectifier tubes become exhausted, irrespective of type. The best test is to have a fresh rectifier tube on hand. When there is a marked difference in reception between the old and the new tube, then it is time to change rectifier tubes.

The other vacuum tubes of the receiver should also be checked over, again using one or more fresh Radiotrons as the basis of comparison. Nothing will improve results quicker than fresh Radiotrons in all the sockets. However, it is usually possible to switch the same tubes from the audio-frequency sockets to the radio-frequency sockets for longer life, while placing the fresh Radiotrons in the detector and audio-frequency sockets where good tubes are most important. The power tube should also be checked with another power tube of the same type.

oh Pickup ies Filaments

If you want to use the socket plug arrangement connect to it a fixed resistance of about 25 ohms. The resistance is connected across the two filament terminals of the plug. This will complete the circuit which would otherwise be broken.

When using the phonograph the radio frequency stages should be detuned to prevent any external interference. A scratch filter, such as manufactured by National, may be employed to remove the phonograph scratch from the music coming from the loudspeaker. Of course, this will not prevent hearing the scratch directly from the record, and for this reason the lid of the phonograph should be kept closed when playing.

Chopin First in Poll; Herbert Second Choice

Baltimore.

Jazz devotees are growing fewer every day and the musical celebrities are once again ascending to the throne of public favor, according to a recent survey conducted by WBAL, Baltimore.

S. Broughton Tall, head of WBAL's literary and musical research department, has discovered that the works of Frederic Chopin are the most popular compositions on the air, records at this station showing this celebrated Polish composer has "appeared" before WBAL's microphone more frequently than any other musical writer in the world.

Last season, when a similar survey was made by Mr. Tall, it was discovered that the most popular composer at that time was Victor Herbert, one of the most distinguished of all American composers.

This season, however, it is found that Herbert has been displaced by Chopin, whose music breathes the delicacy of a poetic fancy, tinged with a glittering satire and a passionate melancholy, wrought, no doubt, from the deep emotions that stirred his being during his unfortunate romance with the domineering George Sand, famous novelist.

The next two most popular composers, according to WBAL's records, are both Americans—these are Victor Herbert and Edward MacDowell, the former being slightly more popular than the latter. This "musical survey" revealed a number of other interesting facts; for instance, Liszt and Schubert rank equally in popularity, while Tschaikowski and Schumann rank together and Mozart and Brahms are in equal favor. Schumann, however, is far more popular than Schubert, while Tschaikowski leads all other Russian composers by a long way.

Following is a list of the most popular composers in the order of their popularity:

1. Chopin
2. Herbert
3. MacDowell
4. Beethoven
5. Grieg
6. Debussy
7. Tschaikowski
8. Schumann
9. Verdi
10. Liszt
11. Schubert
12. Handel
13. Mendelssohn
14. Massenet
15. Mozart
16. Brahms
17. Friml
18. Nevin
19. Cadman
20. Wagner
21. Chaminade
22. Puccini

These are, of course, just a few of the 510 composers whose works have been heard over WBAL. Among other popular musical writers are: Bizet, Dvorak, Delibes, Hayden, Weber, Gounod, and the modern writers: Campbell Tipton, Teresa del Riego, Carrie Jacobs Bond, Horatio Parker, George Chadwick, A. Walter Kramer, Irving Berlin, and others. Of all the various types of music the negro spirituals seem to be decidedly the most popular, WBAL being one of the few stations on the air to exploit this particular form of American folk music.

Blows Sharkey Got K. O.'d McNamee Also

When Jack Dempsey, the Manassa Mauler, fought Jack Sharkey, the gabby gob from Boston, in the Yankee Stadium, New York City, more than 80,000 persons saw the fight from the ringside and 50,000,000 more heard it at their own firesides, or wherever they happened to be at the time. Radio brought Graham McNamee's blow-by-blow description of the fight to millions more persons than ever before focused their attention on any single event. The story sped with the velocity of light to every State in the Union and to many foreign countries. It went to ships at sea, to moving trains, to remote camps at the seashore and to the hearts of forests.

The 50,000,000 or more persons who heard the description of the fight as related by Mr. McNamee are indebted to the New York Telegram and 25 other Scripps-Howard newspapers throughout the country. Altogether 51 broadcast stations were connected up in this broadcast undertaking sponsored by Scripps-Howard interests. This is one more than was connected up on the occasion of Col. Lindbergh's reception in Washington and constituted a new world's record.

Estelle Taylor, Dempsey's wife, sat in her home in Los Angeles and listened to McNamee's blow-by-blow description of the fight, and thus learned immediately the good news of victory which her husband scored. Mrs. Dempsey, the fighter's mother, listened in on a radio set back stage of a theatre in Salt Lake City.

On the other hand, Sharkey's wife had locked herself in a room in Hotel Bretton Hall in New York City, without the benefit of radio or telephone communication. By prearrangement a message carrying the news of the result was delivered to her immediately after the fight.

Had the vitally interested women known the outcome by intuition?

That there was a knockout is certain. Whether it was by fair means or foul the radio audience could not determine. McNamee, by the way, never gave any hint of a foul. Of one thing listeners were certain, and that was that Jack Sharkey was not the only individual knocked out in the excitement. McNamee was befuddled by the sudden turn of events long enough to be counted out.

WEIL IS SELECTED AGAIN

All advertising for the Fourth Annual Radio World's Fair, Madison Square Garden, New York, September 19-24, will again be handled by Paul S. Weil of Albert Frank & Co., advertising agency, Metropolitan newspapers, radio and allied trade papers will be used, Mr. Weil announced.

KOW SEEKS 1,500 WATTS

Washington.

An error in an announcement by the Commission stipulated 2,500 watts as the power to be sought by KOW, Denver, which has asked for a public hearing August 4. The power it seeks is 1,500 watts in lieu of its present power of 250 watts on a frequency of 630 kilocycles.

Tip or Two to Aid You-All with the All-in-One Set

By Robert Frank Goodwin and Stuart . Bruno

Consulting Engineers

Regarding the All-in-One Receiver, consisting of a 5-tube TRF set and a Q.R.S. ABC eliminator, published in the previous issue (July 30), the RF amplifier depends upon the design of the variable condensers, coils and tubes used. There are condensers and coils of many designs, both efficient and inefficient, and discretion must be used when purchasing the parts.

The construction of the receiver is greatly simplified by the elimination of rheostats and wiring the filaments in series. The series-wired set possibly possesses better stability than the battery operated receiver. Wiring the tubes in series may account for some of this, but the absolutely correct biasing of the grids of each tube and the steady voltage applied to the filaments supplied by the power unit can be credited with the superior performance of the All-in-One batteryless radio receiver. It is, of course, for installation on premises having AC.

During the first tests we noticed that the set was quite simple to tune and that it lacked the violent oscillations present in some battery types. Regeneration was noted in the higher waves. There was an absence of the hum generally inherent in sets employing the ordinary B eliminator. This is due to the proper design of the filter system.

Leads Go Through Bottom

The different leads coming from the supply unit and going to the receiver are brought through the holes at the bottom of the shield. It would be well to mark these holes so as to make it easy to trace the wires when checking. The wires connecting to the resistance bank and those nearby should be No. 18 asbestos covered. The lamps in the Mar-co illuminated control dials may be wired in parallel and a 50-ohm resistance shunted across; this is then to be wired in series with the filaments of the receiving tubes, negative end. The illumination of the dials is an added feature and may be disregarded if the fan so wishes.

After the set is placed in the cabinet the antenna and the ground wires may be brought from underneath and soldered to two Fahnestock clips placed on the back of the cabinet. The two leads from the transformer are brought from underneath the cabinet directly to the control box. The leads to the milliammeter in the control box are also brought through a small hole in the bottom of the cabinet. These may be drilled while the set is in the cabinet.

Where Voltmeter Comes in Handy

Before connecting the wires to the house current check the wiring carefully and make sure that everything is correct. Then turn the rheostat in the control box all the way to the right, insert the rectifier tube in its socket and all the other tubes. Connect to house current and turn the rheostat in the control box to the left until the milliammeter reads approximately 250 mils.

Before proceeding farther check all B and C voltages with the 0-500 voltmeter. This is done by connecting the negative lead of the meter to the negative terminal of the resistance bank. With the red or positive lead make contact to the various B terminals on the resistance bank and determine whether each portion of the receiver is receiving its proper voltage.

The lead coming from the power tube should check 180 volts; if this should read less, due to line variations, we advise placing an additional 200-ohm resistance in series with the positive end of the top resistance unit and placing the leads formerly going to the large bank to the end of the additional resistance.

Do not make any voltage measurements unless the tubes are in the circuit with their filaments turned on. If the filaments of the tubes are turned off and the readings taken of the B voltages it will be noticed that the values are away off. To check the C voltages connect the positive end of the meter to A minus and the negative end of the meter to C-40; this should read 40 volts.

Insulating the Cabinet Lid

To insulate the cover of the cabinet from heat radiated by the tube and chokes it would be advisable to put a small piece of tin directly over these and raised from the surface of the cover with washers. This will allow for the circulation of air. The heat will never rise to any dangerous points. A 1-ampere fuse may be placed in the primary circuit of the power transformer; this can be a cartridge type fuse and may be concealed in the control box. In the writers' set a metal cash box was used.

We have been advised by the manufacturer of the condensers [Dubilier] that the type PL-543 condenser block which contained two 5 mfd. condensers is now made up in two units and will occupy the same space.

The transformers T-2 and T-3 are mounted bottom to bottom and secured together by screws through the holes of their bases and supported to the baseboard with two brackets. T-3 is placed on the top of T-2. The terminals P and G of T-2 are to face the front panel, while P and B of T-3 face the condenser C-1. Care should be taken to allow as much space between the transformer and condenser as possible. Two leads are brought from the output of T-3 and go to two Fahnestock clips on the back of the cabinet. These are for the loud speaker.

WTMJ TO JOIN CHAINS

WTMJ, owned and operated by the Milwaukee "Journal," will become a member of both the Red and Blue Networks maintained by the National Broadcasting Company at some date between August 15 and September 1.

Higher Plate Voltage Cuts Plate Impedance

It is generally understood that to get a flat amplification characteristic of the musical scale—that is, the bass notes are amplified as much as the high notes—the primary impedance of an audio transformer must be higher than the plate impedance of the tube. It is particularly important that we select a transformer of low ratio in the first stage.

Since the voltage used on the plate of the detector tube is in the neighborhood of 22½ to 40 volts, the plate impedance of this tube is very high. Since the inductance of a low ratio transformer is higher because of the greater number of primary turns, we also have a greater impedance.

Both May Be Low Ratio

The tube used in the first audio stage need not be a power tube, since this tube very seldom overloads. The second stage transformer can be of the same ratio as that of the first stage. This transformer will have a lower impedance when operated at a higher current in the plate circuit of the first stage amplifier tube. This is due to the fact that feeding a higher current in the primary of this transformer has a tendency to lower the inductance and, as a consequence, the impedance (due to the D-C saturation of the core).

Now, since a high voltage is being applied to the plate of the first amplifier tube, the plate impedance of this tube is lower than that of the detector tube. It is plain that the impedance characteristic of the two transformers nearly match the operating impedances of the tubes with which they work.

Power Tube for Quality

The tube in the last stage is usually a power tube. When one hears the term "power tube" he immediately is inclined to think that this tube has a greater amplification constant than the ordinary amplifying tube. This is not so, for, as a matter of fact, the amplification factor of the -01A tube is eight while that of the 71 power tube is three.

The power tube is really used to handle power without distortion, rather than to amplify signals to any great extent. The 71 power tube has a maximum undistorted power output of fifty times that of the 01A tube.—R. F. G.

Murdock Licensed Under Group Patents

Announcement was made by D. R. W. Murdock, treasurer of the Wm. J. Murdock Company, 347 Washington Avenue, Chelsea, Mass., that the Murdock Company has signed a license agreement with the Radio Corporation of America which gives the manufacturers of Murdock Radio full right to manufacture under one hundred and forty or more radio patents held and controlled by the Radio Corporation of America, the General Electric Co., the Westinghouse Electric & Mfg. Co., and the American Telephone & Telegraph Co.

The issuance of this license by the Radio Corporation of America places the Murdock Company in that select group of radio set manufacturers whose products are now licensed not only under these patents held by the Radio Corporation of America, and associated companies, but likewise under the patents controlled by the Hazeltine Corporation and the Latour Corporation.

Examples of Capacity of Receiving Antenna

(*Continued from page* 5)

than the range of the calibrated condenser, and it is particularly suitable for the measurement of small capacities. The second method is particularly suitable for measuring capacities between 100 and 1,000 micromicrofarads.

An example of the determination of the capacity and distributed inductance of an antenna by this method will help to make the method clear. The stations used in the determination were WEAF and WGBS, operating respectively on 610 and 950 kilocycles. Thus F1 was 610 and F2 was 950 kilocycles. The inductances in the two cases as calculated from the turns used and the dimensions of the coil were respectively 255 and 95.3 microhenrys. The square of the ratio 610-950 is .4125, which according to the first formula is equal to the ratio (95.3+L)/-(255 + L). Therefore the value of L is 17 microhenrys. When this value of L is substituted in the second formula together with the other known values, the capacity is found to be 250 micromicrofarads.

The capacity thus found includes the capacity of the coil and of the leads to the detecting circuit. The assumption is made that the capacity of the coil does not change when the number of turns is changed. This is allowable.

Use of Series Condenser

Since the capacity of this antenna is .00025 mfd. and the distributed inductance is 17 microhenrys, the natural frequency of the antenna is 2.44 megacycles. However, there will always be a loading coil in the antenna circuit which will lower the frequency at which the antenna might act as a wave trap, and this loading coil is the primary of the input transformer. Suppose that this is 20 microhenrys. The total inductance in the antenna is therefore 37 microhenrys, and the frequency of oscillation or absorption is 1.65 megacycles. This is very close to the upper frequency limit of the broadcast range, which is 1.5 megacycles. Hence in this antenna the primary should not be made larger than 20 microhenrys, and in the interest of selectivity it should not be more than 15 microhenrys.

Another way of preventing the antenna circuit from being resonant in the broadcast range is to put a condenser in series with the primary. If this condenser is small the natural frequency of the antenna circuit will be so far removed from the broadcast range that no wave trap effect will be met. Still another way of overcoming the difficulty if it occurs is to put in a very large inductance in series with the antenna, so that the frequency of it will be much below the lowest frequency in the broadcast range. The inductance of this coil should be more than 3 millihenrys.

Turns—Inductance Table

As an aid in obtaining the inductance of a solenoid of 3-inch diameter when wound with No. 20 D. C. C. wire the following table is appended:

N	L	N	L
10	13.8	55	186.7
15	26.75	60	210.0
20	42.20	65	234.0
25	60.50	70	258
30	78.30	75	282
35	98.40	80	307
40	119.3	85	332
45	141.1	90	368
50	163.5	95	407

Intermediate values can be obtained from the tabular values by plotting a curve on a large scale and reading off the inductances opposite the given number of turns.

Grid Battery Is Called Vital in Portable Sets

(*Continued from page* 6)

be when low weight is absolutely necessary. A grid battery must be used at all times because it not only saves the B battery but it also saves the quality of reproduction of the receiver.

Stability is Excellent

One by-pass condenser C4 of .001 mfd. is connected across the primary of the first audio transformer and another by-pass condenser C5 of .01 mfd. is connected across that portion of the B battery which is serving the R. F. tube.

Stability of operation of the receiver is aided by grounding the cores of the three audio transformers and also by grounding the metallic box in which the receiver is built.

All the batteries are placed in a metal cash box of exactly the same specifications as the receiver box. The battery leads are cabled and brought from one box to the other through holes lined with hard rubber bushings to prevent short-circuits. The antenna and loud speaker leads are similar brought out of the receiver case through rubber lined holes.

In laying out the parts on the baseboard due regard should be given to balance of the set, in view of the fact that the set is to be carried. If the parts are suitably placed the weight of the set will be distributed evenly and no difficulty will be experienced in carrying the box.

(Other Photo on Front Cover)

THE 5-TUBE DIAMOND

Fully described by Herman Bernard in a booklet, with diagrams, including blueprint, and sent on receipt of 25 cents. The Diamond is automatically adaptable to phonograph pickup. RADIO WORLD, 145 West 45th St., N. Y. City.

CONNECTION FOR —00A TUBE

When inserting an —00A type detector tube, in place of the —01A tube, it is advisable that the grid return be changed. Instead of the return being made to plus A or plus filament, it is brought to the minus filament post on the socket. Unless this is done sensitivity is sacrificed.

Watch Wire to Filaments of AC Tubes

(*Continued from page* 7)

than this would flow should be replaced if No. 18 had been used in the original wiring. As some of the new tubes draw two amperes each, quite large currents may flow in parts of the filament wiring carrying current for several tubes.

Another change which is necessary in all cases where a set is altered to accommodate the new tubes is the shifting of the plate and grid return connections. In the direct current types of tube the C+ and B— connections are made to one side of the filament.

Uses Step-Down Transformer

When using the five-prong type of AC tube, the C+ and B— connections are made to the fifth prong. In the other type of tube, using the UX base, the center of the resistance across the filament is used for the C+ and B— connections.

All the new tubes operate on low voltage and a transformer is required between the line and the tube. The transformer should be designed to provide a higher voltage than the tube requires, to allow for voltage drops in the wiring. Rheostats will be required, but once set no further adjustment will be necessary, so that rheostats may be placed behind the panel.

While variations may be necessary to meet the requirements of individual receivers, the diagram of filament wiring for a typical four-tube receiver (Fig. 1) will be a useful guide in changing over a receiver for the new tubes. No other changes will be required than in the circuits shown.

Wire Sizes and Current

These data will be found helpful in determining the size of wire to use in rewiring filament circuits for AC operation:

Size	Diameter (Mils)*	Current
12	80	20 amperes
14	64	11 amperes
16	51	6 amperes
18	40	3 amperes
20	32	1.5 amperes

*Mil=0.001 inch.

THE NEW AC TUBES

Everybody should have on hand for ready reference full data on the new AC tubes. The filaments of these tubes are heated by alternating current from a step-down transformer and anybody having AC can put these tubes into a set by making some wiring changes. Those who have AC and who are about to build a set also should possess this full information. Send 15c for the June 4 issue that contains the data on the AC tubes and also on two new rectifier tubes for B eliminators. Radio World, 145 W. 45th St., N. Y. C.

NEW CORPORATIONS

Atwater Kent, Wilmington, Del. (Corporation Trust of America), 10,000 shares no par.

Standard Telephone Co., Philadelphia, Pa. (Corporation Guarantee & Trust Co.), $100,000.

J. A. Zavorski, Wilmington, Del., Electrical equipment (Corporation Trust Co. of America), $5.000.

SIXTH YEAR

RADIO WORLD

The First and Only National Radio Weekly

Member, Radio Publishers Association

Radio World's Slogan: "A radio set for every home."

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ADVERTISING RATES
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½	Page, 7¼"x5½"	231 lines	150.00
½	Page, 3¼" D. C.	231 lines	150.00
¼	Page, 4¼" D. C.	115 lines	75.00
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National Radio Day Proposed for Sept. 21

The Radio Industries Banquet Committee, regulating and operating the Fourth Annual Radio Industries Banquet, after three months of active work in planning the program for the banquet has decided that the broadcasting of this program will be of sufficient interest to justify the designation of Wednesday, September 21, as National Radio Day for the United States.

The banquet program, as in the past, will be broadcast by a tremendous chain of stations. On the occasion of the third annual banquet last year the record of 42 stations operating on the same program at the same time was established. This was not beaten until Lindbergh Day. The broadcasting committee for the Fourth Annual Banquet announces the intention of lining up at least sixty broadcasters for this year's program.

L. A. Nixon and Associates will handle the management and publicity of the Radio Industries Banquet and National Radio Day.

FITZNER APPOINTED

The International Resistance Company, Philadelphia, announced the appointment of B. J. Fitzner, 159 E. Elizabeth Street, Detroit, Mich., as sales representative.

Board Explores Air, Hands Self Bouquets

Washington.

General satisfactory conditions in both the third and fourth radio zones of the United States are reported by the respective members of the Federal Radio Commission from those districts, Eugene O. Sykes and H. A. Bellows, who have just returned from inspection trips lasting about one month.

With the exception of scattered complaints, broadcasting and reception throughout the South and Middle West, embraced in these zones, were described as good. Listeners were reported to be well satisfied with Summer reception, which they generally agreed has improved, and most of the broadcasters are raising no objections to the frequencies assigned them by the Federal Radio Commission under the June 15 allocations.

The Commissioners returned in time to join with Admiral W. H. G. Bullard, chairman, and Commissioner O. H. Caldwell, of New York, to conduct public hearings on 19 applications filed by as many stations for changes in wavelength or power.

South Fares Well

Judge Sykes, in an oral statement, asserted that both broadcasting and reception in the South are quite good, although static is bad on account of the season. He said he spent a large part of his time away from Washington at his home in Jackson, Miss., where many broadcasters conferred with him on broadcasting problems.

"Everybody says we have improved conditions very much," said Judge Sykes. "There are some problems left to us down there, but in general everything is quite satisfactory and listeners are satisfied."

In the 11 States which his district embraces, said Judge Sykes, there are from 75 to 100 applicants who would like to build new stations, and some were said to have good claims to right to build such stations in order to furnish local programs. However, the Commission has taken the stand that no construction permits for new stations will be issued.

The states in Judge Sykes' zone are North Carolina, South Carolina, Georgia, Florida, Alabama, Tennessee, Mississippi, Arkansas, Louisiana, Texas and Oklahoma.

Middle West Has Problems

Mr. Bellows' zone comprises the States of Indiana, Illinois, Wisconsin, Minnesota, North Dakota, Iowa, Nebraska, Kansas and Missouri. With Chicago, it includes a large share of the program stations of the country and many of the large broadcasters.

There are a number of problems which must be faced in the Middle West, said Commissioner Bellows. Notably, these are matters of interference between stations, constancy of frequency, and dissatisfaction with assigned wavelengths. Public hearings before the Commission will settle many of these difficulties, in Mr. Bellows' opinion.

The schedule of hearings was augmented by the application of WSEA, Virginia Beach, Va., which seeks a frequency of 680 kilocycles in lieu of its assignment to 1,370. Stations that have been notified to appear at the hearing because they are on or near the frequency applied for are: WJR and WCX, Pontiac, Mich., and WEEI, Boston. NAA, Arlington, operated by the United States Navy, was also notified.

Opening the docket of hearings before the Commission are the applications of WFRL, New York City, and WFBE, Cincinnati.

WFRL seeks a frequency of 1,170 kilocycles instead of its assigned frequency of 1,370 kilocycles, 500 watts. The following stations were notified to appear: WBBR, Rossville, N. Y.; WJBI, Red Bank, N. J., and WEBJ, New York.

WFBE seeks an increase in power from 250 to 500 watts on a frequency of 1,220 kilocycles. Notified to appear were WGBB, Freeport, N. Y.; WAAT, Jersey City; WSOM, New York; KFH, Wichita, Kan.; WHDI and WLB, Minneapolis, and WDOD, Chattanooga, Tenn.

Some News from First District

Orestes H. Caldwell, of New York, reported for his district:

"Local conditions in the cities I visited are much better. It is still difficult to determine how far some of the stations cover. Strange to say, several of the more powerful transmitters up-State, which we might think would cover at least 100 miles, only get out about forty to sixty miles. Reception in Buffalo is in fine shape and every one seems to be well pleased.

"Although Canadian stations are not far distant from several broadcasters in Western New York, there is only one complaint, and that is against one station within ten kilocycles of a New York State transmitter. However, I think we can straighten it out easily."

WGR Not Faring So Well

Mr. Caldwell said that station WGR of Buffalo has received reports that the waves do not get out as well on the present wave of 303 meters. It was formerly on 319 meters. He said that the Summer weather, which reduces the range of stations, might be responsible.

"We plan to hold more public hearings in Washington," said Mr. Caldwell. "Most of the hearings will deal with power outputs rather than requests for wavelength changes.

"Judge Rutherford of WBBR on Staten Island has applied to the District Court in Washington to get part time on WJZ's wave. He is not contesting the law but following it. The Commission ruled that WBBR should not share WJZ's channel, but under the Radio act of 1927 a station can appeal to the court in an effort to reverse the Commission's decision."

Klemm Dedicates Song to His Station's Tenor

Baltimore.

A new song that bids fair to be one of the popular hits of the late summer, has just been written by Gustav Klemm, program supervisor at WBAL, Baltimore's super power station. This song, entitled "A Vagabond Am I," was dedicated to John Wilbourn, WBAL staff tenor, who sang it over the air for the first time a few weeks ago. The song will be published this month, Mr. Klemm advised friends.

Klemm has been program supervisor of WBAL ever since this station first went on the air in November, 1925. Prior to joining the staff of this station, Mr. Klemm was conductor of the City Park Band, and his composition work had already given him a very definite place among the American composers. Mr. Klemm studied composition with Victor Herbert and also with Gustav Strube at the Peabody Conservatory of Music. Mr. Klemm's song, "It's Me," a negro spiritual, is now being featured by Roland Hayes in programs abroad.

Many Stations Far Off Wave

Washington.

Preliminary reports received by the Radio Division of the Department of Commerce and transmitted to the Federal Radio Commission indicate that a large percentage of the broadcasting stations of the United States are transmitting their programs off their assigned frequencies. Lack of frequency control apparatus in the transmitters is ascribed as the reason for the deviations, which, it was stated at headquarters of the Commission, are causing much needless interference in the ether.

Radio inspectors of the Department of Commerce have submitted reports which point out specific cases of deviation from assigned frequencies, involving some of the largest broadcasting stations in the country. The order of the Federal Radio Commission is to the effect that stations may not deviate more than 500 cycles, (one-half kilocycle above or below their assignments).

Wide Deviation

Reported deviations indicate many stations as far off their frequencies as five kilocycles, some as high as 10 and 15 and at least one station is reported to have gone 25 kilocycles away on account of an unstable antenna.

It is the intention of the Commission, it was stated, to enforce its order when consistent violations are detected. The Commission has recommended the installation in all stations of crystal controls or meters which measure the frequency and maintain it at standard. Up to now, the manufacturers have reported to Washington that they have been unable to meet their orders for crystals, which maintain practically an absolute frequency, but a leading Boston firm has advised Commissioner Caldwell that it is now able to fill several hundred orders which it has on hand.

Will Act Soon

Installation of these controls is not expensive for broadcasting stations, but requires considerable adjustment of apparatus. When the controls are installed, it is anticipated that much of the hetrodyning now being checked against stations will have been eliminated.

From Commission headquarters, however, it is announced that the Commission intends to enforce its order permitting no more than one kilocycle leeway to broadcasters. As soon as the entire Commission returns to Washington from the field survey now being conducted, this matter will be taken up. The revocation of licenses may be ordered under the law by stations violating the Commission's order.

Victoreen Moves To Bigger Factory

The Victoreen Radio Co., and their merchandising company, the George W. Walker Co., have moved to 2825 Chester Ave., Cleveland, Ohio. Their former factory became entirely inadequate to meet production demands for the coming season.

The new factory has approximately three times the floor space of the other and is so arranged that additional space may be used when necessary. The Walker Co., from reports of their jobbers and dealers, will have a very successful radio season and every effort is being made in advance to anticipate the early season demand.

WBBR Sues for Right To Choose Own Wave

Washington.

Notice of appeal from the decision of the Federal Radio Commission, denying the applications of WBBR, of Rossville, N. Y., for change in its assignment of frequency, was filed in the Court of Appeals of the District of Columbia. The notice, entered by Frederick W. Sparks, of Brooklyn, attorney for the Peoples Pulpit Association, owners and operators of the broadcasting station, asked for a temporary injunction restraining the Commission from interfering with WBBR's use of the frequency of 660 kilocycles (454.3 meters) or 720 kilocycles (416.4 meters), to either of which channels, it maintains, it is entitled under the Communications Act of 1912.

Constitutionality of the Radio Act of 1927 is not questioned in the WBBR case, which was the subject of recent public hearings before the full Commission which decided against its applications for a different wave length and ordered it to remain on its assigned frequency of 1,170 kilocycles (256.3 meters) under the June 15 allocations.

The appeal denies the power of the Commission to shift it from the frequencies it formerly used, stating that it was entitled to one of them by virtue of "preemption right and user." It is also stated that the act of the Federal Radio Commission in assigning it to a different wave length amounted to a confiscation of property rights in violation of the Constitution. The value of WBBR is given as $140,000.

The appellants further argue that no order or proceeding has ever been made by the Commission to show that a change in the wavelength ofWBBR would promote the public convenience or interest, stating that the appellant's license under the Communications Act of 1912, under which it was permitted to operate on 720 kilocycles, has never been revoked.

This phase of the suit is expected to be one of the tests of the validity of the Radio Act of 1927, which in effect superseded the Communication Law of 1912, after the Attorney General in July, 1926, decided that the Department of Commerce was powerless to regulate radio under the 1912 laws.

Fans are greatly interested.

A Portable with a Novel Speaker

(*Concluded from page* 4)

hence it is not necessary to place the control on the panel.

The high-pitched squeal in the set is due to feedback of energy through the batteries, leads, and mutual coupling between the transformers. Usually the feedback is not sufficient to cause oscillation at more than one frequency where phase relations are right. If the amount of energy fed back can be controlled by varying the amplification or otherwise the squeal can be stopped.

By means of the variable resistor across the secondary of T2 the amplification can be reduced until the squealing stops. Only a small reduction is necessary in most cases to stop the oscillation.

The reason the amplification is reduced by connecting a resistance across the secondary is found in the regulation of the transformer. Most audio frequency transformers are designed to work into an infinite impedance. For that reason it does not matter how high the resistance of the secondary winding is. Often the resistance is around 5,000 ohms. When a resistance is connected across the secondary a current flows. The voltage in the transformer is then divided between the resistance of the transformer winding and the resistance connected across the terminals. It is only such part of the total voltage which drops in the external resistance which is effective on the grid, and this is always less than the total as long as any current flows. When no resistance is connected across the terminals, no current flows, and then there is no voltage drop in the transformer winding, and all the voltage induced in the secondary is effective on the grid. It should be pointed out that the resistance slightly improves the quality of reproduction of the amplifier.

Small Drain

The filament current is limited by Amperites A1, A2, A3. Each of these is a No. 4V-199, suitable for 99 type tubes when the voltage source is 4 to 4½ volts. This voltage is supplied by three No. 6 dry cells, series-connected. The filament current consumption is only .018 ampere.

A grid bias battery is required to give the grids of the two amplifier tubes the correct bias. Since both of these tubes have the same effective plate voltage and they are both the same type, they may have the same grid bias. Hence the grid return leads from these tubes have been joined to the negative terminal of the C battery. This battery should preferably be small type 4½ volt battery, but one of the 6-volt units can be used, for it takes up less width, though it is slightly longer.

The panel is 7x14 inches and is of hard rubber. On this are mounted the two tuning condensers C1 and C2, the three-circuit tuner and the filament switch, together with the appropriate knobs and dials.

Optional Type C Battery

The radio frequency choke coil is near the panel, between first tuning condenser and the three-circuit tuner. By-pass condensers are placed in various suitable positions.

A two-cell battery of small dry cells can be seen mounted in clips in the middle of the baseboard. This constitutes a three-volt C battery, which may replace the C battery previously discussed, if there is no room in the regular battery compartment underneath. But you will find sufficient room indeed if you follow directions.

A unique feature of this receiver is the manner in which the loudspeaker has been built in. The double magnet driver unit can be seen near the right end of the box secured by a stiff brass mounting. A coupling rod runs from the unit to the back wall of the set, which is used as the sound radiating surface. Since the sounding surface must be very thin, the back of the set will not be strong.

This can be remedied in the following way:

May Use Balsa Wood

First a substantial back wall is put in place and a small hole cut in it opposite the driving rod. Two ¼-inch strips of wood are glued at left and right, to this board, inside the box. Then a sheet of Lata Balsa wood is mounted to the strips and the coupling unit fastened to the Balsa wood. Of course, this leaves full protection for the sounding surface, i. e., the outer wall.

LIST OF STATIONS

With new wavelengths, frequencies, location and power, corrected to July 27. Time sharers in parentheses.

Station	Kc	M	Watts
WAAD—Cincinnati, O.	1120	267.7	25
WAAF—Chicago, Ill. (WBBM, WJBT)	770	389.4	500
WAAM—Newark, N. J. (WGBS)	860	348.6	500
WAAT—Jersey City, N. J. (WGBB), WSOM)	1200	245.8	300
WAAW—Omaha, Neb. (6 to 7 only).	860	348.6	500
WABC—Richmond Hill, N. Y. (WBOQ)	920	325.9	2500
WABF—Pringleboro, Pa.	1460	205.4	250
WABI—Bangor, Me.	770	389.4	100
WABO—Rochester, N. Y. (WHEC)	1290	232.4	100
WABQ—Philadelphia, Pa.	1410	212.6	500
WABR—Toledo, O. (WTAL)	1070	280.2	50
WABW—Woester, O.	1210	247.8	50
WABY—Philadelphia, Pa.	1210	247.8	50
WABZ—New Orleans, La.	1210	247.8	50
WADC—Akron, O.	1250	239.9	1000
WAFD—Detroit, Mich. (WTHO)	1370	218.8	250
WAGM—Royal Oak, Mich.	1330	225.4	50
WAGS—Somerville, Mass.	1390	215.7	5
WAIT—Taunton, Mass	1400	214.2	10
WAIU—Columbus, O. (WEAO)	1060	282.8	5000
WALK—Bethayres, Pa. Portable).	1490	201.6	50
WAMD—Minneapolis, Minn.	1330	225.4	500
WAPI—Auburn, Ala.; daytime only.	610	491.5	1000
WARS—Brooklyn, N. Y. (WSDA, WBBC)	1320	227.1	500
WASH—Grand Rapids, Mich.	1170	256.3	250
WASN—Boston, Mass.	990	302.8	100
WATT—Boston, Mass	1490	201.6	100
WBAA—West Lafayette, Ind (WRM)	1100	272.6	500
WBAK—Harrisburgh, Pa. (WPSC)	1000	299.8	500
WBAL—Baltimore, Md.	1050	285.5	3000
WBAO—Decatur, Ill.	1120	267.7	100
WBAP—Fort Worth, Tex. (WFFA)	600	499.7	1500
WBAW—Nashville, Tenn.	1210	247.8	100
WBAX—Wilkes Barre, Pa. (WBRE)	1200	249.9	100
WBBC—Brooklyn, N. Y. (WARS, WSDA)	1320	227.7	500
WBBL—Richmond, Va.	1210	247.8	100
WBBM—Chicago, Ill. (WJBT, WAAF)	770	389.4	1000
WBBP—Petoskey, Mich.	1250	239.9	100
WBBR—Rossville, N. Y. (WJBI and WEBJ)	1170	256.3	1000
WBBW—Norfolk, Va.	1270	236.1	50
WBBY—Charleston, S. C.	600	499.7	75
WBBZ—Chicago, Ill. (Portable)	1470	204.0	100
WBCN—Chicago, Ill. (WENR)	1040	283.3	250
WBES—Takoma Park, Md.	1010	296.9	100
WBET—Boston, Mass.	1240	241.8	500
WBKN—Brooklyn, N. Y. (WWRL, WIBI, WBMS)	1120	267.7	100
WBMH—Detroit, Michigan	1420	211.1	100
WBMS—Union City, N. J. (WBKN, WWRL, WIBI)	1120	267.7	100
WBNY—New York, N. Y. (WHAP, WMSG)	1270	236.1	500
WBOQ—Richmond Hill, N. Y. (WABC)	920	325.9	500
WBRC—Birmingham, Ala.	1230	243.8	250
WBRE—Wilkes Barre, Pa. (WBAX)	1200	249.9	100
WBRL—Tilton, N. H.	1290	232.4	500
WBRS—Brooklyn, N. Y. WCDA, WCGU, WRST)	1420	211.1	100
WBSO—Wellesley Hills, Mass. (WDWF)	780	384.4	100
WBT—Charlotte, N. C.	1160	258.5	500
WSMK—Dayton, Ohio	1010	296.9	200
WBZ—Springfield, Mass.	900	333.1	15000
WBZA—Boston, Mass.	900	333.1	500
WCAC—Mansfield, Conn. (WDRC)	1090	275.1	500
WCAD—Canton, N. Y.	820	365.6	500
WCAE—Pittsburgh, Pa.	580	516.9	500
WCAH—Columbus, Ohio	560	535.4	250
WCAJ—Lincoln, Neb. (KMMJ)	790	379.5	500
WCAL—Northfield, Minn. (KFMX)	1270	236.1	500
WCAM—Camden, N. J.	1340	223.7	500
WCAO—Baltimore, Md. (WCBM)	780	384.4	250
WCAT—Rapid City, S. D.	1210	247.8	100
WCAU—Philadelphia, Pa.	1150	260.7	500
WCAX—Burlington, Vermont	1180	254.1	100
WCAZ—Carthage, Ill.	880	340.7	50
WCBA—Allentown, Pa. (WSAN)	1350	222.1	100
WCBD—Zion, Illinois (WLS)	870	344.6	5000
WCBE—New Orleans, La.	1320	227.1	5
WCBH—Oxford, Miss.	1240	241.8	100
WCBM—Baltimore, Md. (WCAO)	780	384.4	100
WCBR—Providence, R. I. (Portable)	1490	201.6	100
WCBS—Springfield, Ill.	1430	209.7	250
WCCO—Minneapolis, Minn.	740	405.2	5000
WCDA—Brooklyn, N. Y. (WRST, WBRS, WCGU)	1420	211.1	500
WCFL—Chicago, Ill. WLTS)	620	493.6	1500
WCGU—Coney Island, N. Y. (WCDA, WBRS, WRST)	1420	211.1	500
WCLO—Camp Lake, Wisc.	1320	227.1	100
WCLS—Joliet, Ill. (WKBB)	1390	215.7	150
WCMA—Culver, Ind.	1160	258.5	250
WCOA—Pensacola, Fla.	1200	249.9	500
WCOC—Columbus, Miss.	1300	230.6	100
WCOM—Manchester, N. H.	1260	238.0	100
WCOT—Olneyville, R. I.	1330	225.4	50
WCRD—Chicago, Ill. (WFKB & WPCC)	1340	223.7	500
WCSH—Portland, Me.	830	361.2	500
WCSO—Springfield, Ohio	1170	256.3	500
WCWK—Fort Wayne, Ind. (WOWO.	1310	228.9	500
WCWS—Bridgeport, Conn. (Portable)	1490	201.6	100
WDAD—Nashville, Tenn.	1330	225.4	500
WDAE—Tampa, Fla.	1120	267.7	500
WDAF—Kansas City, Mo.	810	370.2	1000
WDAG—Amarillo, Texas	1140	263.0	250
WDAH—El Paso, Texas	1280	234.2	100
WDAY—Fargo, N. Dak.	830	361.2	250
WDBJ—Roanoke, Va.	1300	230.6	250
WDBK—Cleveland, Ohio (WJAY)	1320	227.1	250
WDBO—Winter Park Fla.	1250	239.9	500
WDBZ—Kingston, N. Y. (WOKO)	1390	215.7	50
WDEL—Wilmington, Del.	1130	265.3	100
WDGY—Minneapolis, Minn. (WRHM)	1150	260.7	500
WDOD—Chattanooga, Tenn.	1180	254.1	500
WDRC—New Haven, Conn. WCAC)	1090	275.1	250
WDWF—Cranston, R. I. (WBSO)	780	384.4	500
WLSI—			
WDWM—Newark, N. J. (WHAP, WMSG)	1270	236.1	500
WDZ—Tuscola, Ill. (Daytime only).	1080	277.6	100
WEAF—New York, N. Y.	610	491.5	5000
WEAI—Ithaca, N. Y. (WOAX)	620	483.6	250
WEAM—North Plainfield, N. J.	1250	239.9	250
WEAN—Providence, R. I. (WNAC).	1130	265.3	500
WEAO—Columbus, O. (WAIU)	1060	282.8	750
WEAR—Cleveland, O. (WTAM)	750	399.8	1000
WEBC—Superior, Wisc.	1240	241.8	250
WEBE—Cambridge, Ohio	1210	247.8	10
WEBH—Chicago, Ill. (WJJD)	820	365.6	2000
WEBJ—New York, N. Y. (WJBI and WBBR)	1170	256.3	500
WEBQ—Harrisburg, Ill.	1340	223.7	15
WEBR—Buffalo, N. Y.	1240	241.8	200
WEBW—Beloit, Wisc.	1160	258.5	500
WEDC—Chicago, Ill. WGES)	1240	241.8	500
WEEI—Boston, Mass.	670	447.5	500
WEHS—Evanston, Ill.	1390	215.7	100
WEMC—Berrien Springs, Mich.	1260	238.0	1,000
WENR—Chicago, Ill. (WBCN)	1040	283.3	500
WEPS—Gloucester, Mass.	1010	296.9	100
WEW—St. Louis, Mo.	850	352.7	1000
WFAA—Dallas, Texas (WBAP)	600	475.9	500
WFAM—St. Cloud, Minn.	1190	252	10
WFBC—Knoxville, Tenn.	1280	234.2	50
WFBE—Cincinnati, Ohio	1220	245.8	250
WFBG—Altoona, Pa.	1070	280.2	100
WFBJ—Collegeville, Minn.	1100	272.6	100
WFBL—Syracuse, N. Y.	1160	282.8	750
WFBM—Indianapolis, Ind.	1330	225.4	250
WFBR—Baltimore, Md.	1330	225.4	100
WFBZ—Galesburg, Ill. (WRAM)	1210	247.8	50
WFCI—Pawtucket, R. I.	1330	225.4	50
WFDF—Flint, Mich.	860	348.6	100
WFHH—Clearwater, Fla.	820	365.6	500
WFI—Philadelphia, Pa. (WLIT)	740	405.2	500
WFIW—Hopkinsville, Ky.	1220	245.8	500
WFKB—Chicago, Ill. (WCRW)	1340	223.7	500
WFKD—Philadelphia, Pa.	1460	205.4	10
WFLA—Boca Raton, Fla.	1410	212.6	1000
WFRL—Brooklyn, N. Y. (WKBQ, WKBO, WBNY)	1370	218.8	500
WGAL—Lancaster, Pa. (WKJC)	1190	252.0	15
WGBG—Freeport, N. Y. (WAAT, WSOM)	1220	245.8	400
WGBC—Memphis, Tenn.	1080	277.6	15
WGBF—Evansville, Ind.	1270	236.1	250
WGBI—Scranton, Pa. WQAN)	1300	230.6	100
WGBS—Astoria, L. I., N. Y. (WAAM)	860	348.6	500
WGCP—Newark, N. J. (WNJ)	1070	280.2	500
WGES—Chicago, Ill. (WEDC)	1240	241.8	500
WGHP—Mt. Clemens, Mich.	1230	243.8	1,500
WGL—New York, N. Y. (WODA)	1020	293.9	500
WGM—Jeannette, Pa.	1440	208.2	50
WGMU—New York, N. Y., Portable (WRMU)	1490	201.6	100
WGN—Chicago, Ill. WLIB)	980	305.9	15000
WGR—Buffalo, N. Y.	990	302.8	750
WGST—Atlanta, Ga. (WMAZ)	1110	270.1	500
WGWB—Milwaukee, Wisc.	1370	218.8	500
WGY—Schenectady, N. Y. (WHAZ).	790	378.5	30000
WHA—Madison, Wisc. (WLBL)	940	319.0	750
WHAD—Milwaukee, Wis. (WTMJ).	1020	293.9	500
WHAM—Rochester, N. Y.	1080	277.6	500
WHAP—New York, N. Y. (WBNY) WMSG)	1270	236.1	1000
WHAR—Atlantic City, N. J. (WPG)	1100	272.6	750
WHAS—Louisville, Ky.	650	461.3	500
WHAZ—Troy, N. Y. (WGY)	790	379.5	500
WHB—Kansas City, Mo. (WOQ)	890	336.9	500
WHBA—Oil City, Pa.	1150	260.7	10
WHBC—Canton, Ohio	1270	236.1	10
WHBD—Bellefontaine, Ohio	1350	222.1	100
WHBF—Rock Island, Ill.	1350	222.1	100
WHBL—Chicago, Ill. (Portable-Carrell)	1470	204.0	100
WHBM—Chicago, Ill. Portable-Carrell)	1490	201.6	100
WHBN—St. Petersburg, Fla.	1010	296.9	10
WHBP—Johnstown, Pa.	1310	228.9	250
WHBQ—Memphis, Tenn.	1290	232.4	100
WHBU—Anderson, Ind.	1360	220.4	15
WHBW—Philadelphia, Pa. (WIAD).	1360	220.4	50
WHBY—West De Pere, Wisc.	1200	249.9	50
WHDI—Minneapolis, Minn (WLB)	1220	245.8	500
WHEC—Rochester, N. Y. (WABO)	1290	232.4	100
WHFC—Chicago, Ill.	1390	215.7	200
WHK—Cleveland, Ohio (WJAY)	1130	265.4	500
WHN—New York, N. Y. (WQAO)	760	394.5	500
WHO—Des Moines, Iowa	560	535.4	5000
WHPP—New York, N. Y.	1450	206.8	10
WHT—Chicago, Ill. (WIBO)	720	416.4	5000
WIAD—Philadelphia, Pa. (WHBW)	1360	220.4	50
WIAS—Burlington, Iowa	630	475.9	100
WIBA—Madison, Wisc.	12050	239.9	100
WIBG—Elkins Park, Pa. Sunday, day time only)	680	440.9	50
WIBI—Flushing, N. Y. (WBKN, WWRL, WBMS)	1120	267.7	100
WIBJ—Chicago, Ill. (Portable-Carrell)	1490	201.6	100
WIBM—Chicago, Ill. (Portable-Carrell)	1490	201.6	100
WIBO—Chicago, Ill. (WHT)	720	416.4	500
WIBR—Steubenville, Ohio.	1200	249.9	50
WIBS—Elizabeth, N. J. (WTRC, WLBX)	1470	202.6	150
WIBU—Polynette, Wisc.	1380	217.3	20
WIBW—Chicago, Ill. (Portable-Carrell)	1470	204.0	100
WIBX—Utica, N. Y.	1260	238.0	150
WIBZ—Montgomery, Ala.	1300	230.6	15
WICC—Bridgeport, Conn.	1400	214.2	250
WIL—St. Louis, Mo.	1160	258.5	250
WIOD—Miami Beach, Fla.	1210	247.8	1000
WIP—Philadelphia, Pa. (WOO)	590	508.2	500
WJAD—Waco, Texas	670	447.5	500
WJAG—Norfolk, Nebr.	1350	222.1	250
WJAK—Kokomo, Ind.	1280	234.2	50
WJAM—Cedar Rapids, Ia. (KWCR)	780	384.4	100
WJAR—Providence, R. I.	620	483.6	500
WJAS—Pittsburgh, Pa. (KQV)	1110	270.1	500
WJAX—Jacksonville. Fla.	890	336.9	1000
WJAY—Cleveland, Ohio (WHK)	1130	265.3	500
WJAZ—Mt. Prospect, Ill. (WMBI)	1140	263.0	5000
WJBA—Joliet, Ill.	930	322.4	50
WJBB—St. Petersburg, Fla.	870	344.6	250
WJBC—LaSalle, Ill.	1320	227.1	100
WJBI—Red Bank, N. J. (WBBR and WEBJ)	1170	256.3	250
WJBK—Ypsilanti, Mich.	1360	220.4	15
WJBL—Decatur, Ill.	1410	212.6	250
WJBO—New Orelans, La.	1140	283.3	100
WJBR—Omro, Wisc.	1320	227.1	100
WJBT—Chicago, Ill. (WBBM, WAAF)	770	389.4	100
WJBU—Lewisburg, Pa.	1400	214.2	100
WJBW—New Orleans, La.	1260	238.0	50
WJBY—Gadsden, Ala.	1200	234.2	50
WJBZ—Chicago Heights, Ill.	1440	208.2	100
WJJD—Moosebeart, Ill. (WEBH)	820	365.6	1000
WJPW—Ashtabula, Ohio	1440	208.2	50
WJR-WCX—Pontiac, Mich.	680	440.9	5000
WJZ—Bound Brook, N. J.	660	454.3	30000
WKAF—Changed to WTMJ Milwaukee, Wis.			
WKAQ—San Juan, P. R.	880	340.7	500
WKAR—East Lansing, Mich. (WREO)	1300	230.6	1000
WKAV—Laconia, N. H.	1340	223.7	50
WKBB—Joliet, Ill. (WCLA)	1390	215.7	150
WKBC—Birmingham, Ala.	1370	218.8	10
WKBE—Webster, Mass.	1310	228.9	100
WKBF—Indianapolis, Ind.	1190	252.0	250
WKBG—Chicago, Ill. (Portable)	1490	201.6	100
WKBH—La Crosse, Wis.	1360	220.4	500
WKBI—Chicago, Ill.	930	322.4	50
WKBL—Monroe, Mich.	1460	205.4	15
WKBM—Newburgh, N. Y.	1440	208.2	100
WKBN—Youngstown, O. (WMBW)	1480	214.2	50
WKBO—Jersey City, N. J. (WKBQ WBNY WFRL)	1370	218.8	500
WKBP—Battle Creek, Mich.	1410	212.6	50
WKBQ—New York, N. Y. (WKBO WBNY WFRL)	1370	218.8	500
WKBS—Galesburg, Ill. (WLBO)	1380	217.3	100
WKBT—New Orleans, La.	1190	252.0	50
WKBU—New Castle, Pa. (Portable)	1470	204.0	50
WKBV—Brookville, Ind.	1380	217.3	100
WKBW—Buffalo, N. Y.	1380	217.3	500
WKBZ—Ludington, Mich.	1500	199.9	15
WKDR—Kenosha, Wis.	930	322.4	15
WKJC—Lancaster, Pa. WGAL)	1190	252.0	50
WKRC—Cincinnati, Ohio	900	333.1	500
WKY—Oklahoma City, Okla.	1040	283.3	150
WLAP—Louisville, Ky.	1120	267.7	30
WLB—Minneapolis, Minn. (WHDI)	1220	245.8	500
WLBC—Muncie, Indiana	1430	209.7	50
WLBF—Kansas City, Mo.	1430	209.7	50
WLBG—Petersburg, Va.	1400	214.2	100
WLBH—Farmingdale, N. Y. (Portable)	1490	201.6	30
WLBI—East Wenona, Ill.	1260	238.0	250
WLBL—Stevens Point, Wis. (WHA)	940	319.0	1000
WLBM—Boston, Mass.	1420	211.1	50
WLBN—Chicago, Ill. (Portable)	1470	204.0	50
WLBO—Galesburg, Ill. (WKBS)	1380	217.3	100
WLBP—Ashland, Ohio	1480	202.6	15
WLBT—Crown Point, Ind.	930	322.4	50
WLBR—Belvidere, Ill.	930	322.4	15
WLBT—Crown Point, Ind.	930	322.4	50
WLBV—Mansfield, Ohio	1450	206.8	50
WLBW—Oil City, Pa.	1020	267.7	500
WLBX—Long Island City, N. Y. (WIBS, WMBQ, WTRC and WLBX)	1470	204.0	250
WLBY—Iron Mountain, Mich.	1430	209.7	50
WLBZ—Dover-Foxcroft, Me.	1440	208.2	250
WLCI—Ithaca, N. Y.	1210	247.8	50
WLIB—Chicago, Ill. (WGN)	980	305.9	500
WLIT—Philadelphia, Pa. (WFI)	740	405.2	500
WLS—Chicago, Ill. (WCBD)	870	384.4	5000
WLTS—Chicago, Ill. (WCFL)	620	483.6	100
WLW—Cincinnati, Ohio	700	428.3	5000
WLWL—New York, N. Y. (WMCA)	810	370.2	1000
WMAC—Cazenovia, N. Y. (WSYR)	1330	225.4	500
WMAF—South Dartsmouth, Mass.	700	428.3	500
WMAK—Lockport, N. Y.	550	545.1	750
WMAL—Washington, D. C.	1310	228.9	100
WMAN—Columbus, Ohio	1280	234.2	50
WMAQ—Chicago, Ill. (WQJ)	670	447.5	1000
WMAY—St. Louis, Mo.	1210	247.8	100
WMAZ—Macon, Ga. WGST)	1110	270.1	500
WMBA—Newport, R. I. (Portable)	1470	204.0	100
WMBB—Chicago, Ill. (WOK)	1190	252.0	500
WMBC—Detroit	1420	211.1	100
WMBD—Peoria Heights, Ill.	1460	205.4	250
WMBE—St. Paul, Minn.	1440	208.2	10
WMBF—Miami Beach, Fla.	780	384.4	500
WMBG—Richmond, Va.	1450	206.8	15
WMBH—Chicago, Ill. (Portable-E. D. Aber.)	1470	204.0	100
WMBI—Chicago, Ill. (WJAZ)	1140	263.0	500
WMBJ—Monesson, Pa.	1290	232.4	50
WMBL—Lakeland, Fla.	1310	228.9	50
WMBM—Memphis, Tenn.	1430	209.7	10
WMBO—Auburn, N. Y.	1360	220.4	100
WMBQ—Brooklyn, N. Y. (WTRC, WIBS, WLBX)	1470	204.0	100
WMBR—Tampa, Fla.	1190	252.0	100
WMBS—Harrisburg, Pa.	1280	234.2	250
WMBU—Pittsburgh, Pa.	1380	217.3	50
WMBW—Youngstown, O. (WKBN)	1400	214.2	50
WMBY—Bloomington, Ill. (WNBL).	1500	199.9	15
WMC—Memphis, Tenn.	580	516.9	500
WMCA—New York, N. Y. (WLWL)	810	370.2	500
WMPC—Lapeer, Mich.	1280	234.2	30
WMRJ—Jamaica, N. Y. (WTRL, WHPP)	1450	206.8	10
WMSG—New York, N. Y. (WHAP, WBNY)	1270	236.1	500
WNAB—Boston, Mass. (Changed to WASN).			
WNAC—Boston, Mass.	850	352.7	500
WNAD—Norman, Okla.	1250	239.9	500
WNAL—Omaha, Nebr. (KOCH, KFOX)	1160	258.5	250
WNAT—Philadelphia, Pa. (WRAX).	1040	263.0	100
WNAX—Yankton, S. D.	990	302.8	250
WNBA—Forest Park, Ill.	1440	208.2	200
WNBF—Endicott, N. Y.	1450	206.8	50

Station	Kc	M	Watts
WNBH—New Bedford, Mass.	1150	260.7	250
WNBJ—Knoxville, Tenn.	1450	206.8	50
WNBL—Bloomington, Ill. (WMBY).	1500	199.9	15
WNBO—Washington, Pa.	1420	211.1	15
WNBQ—Rochester, N. Y.	1480	202.6	15
WNBR—Memphis, Tenn.	1310	228.9	20
WNJ—Newark, N. J. (WGCP)	1070	256.3	500
WNOX—Knoxville, Tenn.	1130	265.3	1000
WNRC—Greensboro, N. C.	1340	223.7	500
WNYC—New York, N. Y.	560	535.4	500
WOAI—San Antonio, Texas	990	302.8	2000
WOAN—Lawrenceburg, Tenn.	1050	260.7	250
WOAX—Trenton, N. J. (WEAM)	1250	239.9	500
WOC—Davenport, Iowa	850	352.7	5000
WOCL—Jamestown, N. Y.	1340	223.7	25
WODA—Paterson, N. J. (WGL)	1020	293.9	1000
WOI—Ames, Iowa; 5000, daytime, 6 to 6 (WSUI)	1130	265.3	2500
WOK—Chicago, Ill. (WMBB)	1190	252.0	5000
WOKO—Peekskill, N. Y.	1390	215.7	250
WOKT—Rochester, N. Y.	1430	209.7	500
WOMT—Manitowoc, Wis.	1350	221.1	50
WOO—Philadelphia, Pa. (WIP)	590	508.2	500
WOOD—Furnwood, Mich.	1150	260.7	500
WOQ—Kansas City, Mo. (WHB)	890	336.9	250
WOR—Newark, N. J.	710	422.3	500
WORD—Batavia, Ill. (WTAS)	1090	275.1	5000
WOS—Jefferson City, Mo.	760	394.5	500
WOW—Omaha, Nebr.	590	508.2	1000
WOWO—Ft. Wayne, Ind. (WCWK)	1310	228.9	1000
WPAB—Norfolk, Va.	1430	209.7	100
WPCC—Chicago, Ill., (WFKB, WCRW)	1340	223.7	500
WPCH—New York, N. Y. (WRNY).	970	309.1	500
WPDQ—Buffalo, N. Y. (WSVS)	1460	205.4	50
WPEP—Waukegan, Ill.	1390	215.7	250
WPG—Atlantic City, N. J. (WHAR)	1100	272.6	2500
WPRC—Harrisburg, Pa.	1430	209.7	100
WPSC—State College, Pa. (WBAK)	1000	299.8	500
WPSW—Philadelphia, Pa.	1480	202.6	50
WQAA—Parkersburg, Pa.	1390	215.7	500
WQAE—Springfield, Vt.	1200	249.9	50
WQAM—Miami, Fla.	930	322.4	750
WQAN—Scranton, Pa. (WGBI)	1300	230.6	100
WQAO-WPAP—Cliffside, N. J. (WHN)	760	394.5	500
WQJ—Chicago, Ill. (WMAQ)	670	447.5	500
WRAF—La Porte, Ind.	1440	208.2	100
WRAH—Providence, R. I.	1500	199.9	250
WRAK—Escabana, Mich.	1060	282.8	50
WRAM—Galesburg, Ill. (WFBZ)	1210	247.8	50
WRAV—Yellow Springs, Ohio	880	340.7	100
WRAW—Reading, Pa.	1260	238.0	50
WRAX—Philadelphia, Pa. (WNAT).	1040	283.3	250
WRBC—Valparaiso, Ind.	1260	238.0	250
WRC—Washington, D. C.	640	468.5	500
WRCO—Raleigh, N. C.	1380	217.3	250
WREC—Memphis, Tenn.	1180	254.1	50
WREN—Lawrence, Kans. (KFKU)	1180	254.1	750
WREO—Lansing, Mich.	1300	230.6	500
WRES—Quincy. Mass.	1380	217.3	50
WRHF—Washington, D. C. (Daytime only)	940	319.0	50
WRHM—Minneapolis, Minn. (WDGY)	1150	260.7	1000
WRM—Urbana, Ill.; 1000 watts before 6 p.m. (WBAA)	1100	272.6	500
WRMU—New York, N. Y. (Portable)	1490	201.6	100
WRNY—New York, N. Y. (WPCH).	970	309.1	500
WRPI—Terre Haute, Ind.	1440	208.2	100
WRR—Dallas, Texas	850	352.7	500
WRRS—Racine, Wis.	930	322.4	50
WRSC—Chelsea, Mass.	1460	205.4	15
WRST—Bay Shore, N. Y. (WCDA, WBRS, WCGU)	1420	211.1	250
WRVA—Richmond, Va.	1420	211.1	250
WSAI—Cincinnati, O.	830	361.2	5000
WSAJ—Grove City, Pa.	1340	223.7	250
WSAN—Allentown, Pa. (WCBA)	1350	222.1	100
WSAR—Fall River, Mass.	1190	252.0	100
WSAX—Chicago, Ill.	1470	204.0	100
WSAZ—Huntington, W. Va.	1240	241.8	100
WSB—Atlanta, Ga.	630	475.9	1000
WSBC—Chicago, Ill. (WWAE)	1290	232.4	500
WSBT—South Bend, Ind. (WEMC)	1350	222.1	250
WSDA—New York, N. Y. (WARS, WBBC)	1320	227.1	250
WSEA—Virginia Beach, Va.	1370	218.8	250
WSIX—Springfield, Tenn.	1410	212.6	150
WSKC—Bay City, Mich.	610	491.5	250
WSM—Nashville, Tenn.	940	319.0	2000
WSMB—New Orleans. La. (WAAT)	930	322.4	500
WSMK—Dayton, O.	1220	245.8	500
WSOE—Milwaukee, Wis.	1010	296.9	200
WSOM—New York, N. Y. (WGBB,	1100	270.1	500
WSRO—Hamilton, Ohio	780	384.4	100
WSSH—Boston, Mass.	1300	230.6	100
WSUI—Iowa City, Iowa (WOI)	1130	265.3	500
WSVS—Buffalo, N. Y. (WPDQ)	1460	205.4	50
WSYR—Syracuse, N. Y. (WMAC).	1330	225.4	500
WTAD—Quincy, Ill.	1270	236.1	250
WTAG—Worcester, Mass.	1040	283.3	500
WTAL—Toledo, Ohio (WABR)	1070	280.2	100
WTAM—Cleveland, Ohio (WEAR)	750	399.8	3500
WTAQ—Eau Claire, Wisc.	1180	254.1	500
WTAR—Norfolk, Va.	1090	275.1	500
WTAS—Batavia, Ill. (WORD)	1090	275.1	3500
WTAW—College Station, Texas	970	309.1	500
WTAX—Streator, Ill.	930	322.4	50
WTAZ—Lamhertville, N. J.	1360	220.4	15
WTHO—Detroit, Mich. (WAFD)	1370	218.8	250
WTIC—Hartford, Conn.	650	461.3	500
WTMJ—Milwaukee, Wisc. (WHAD).	1020	293.9	1,000
WTRC—Brooklyn, N. Y. (WIBS, WMBQ, WLBX)	1470	204	50
WTRL—Midland Park, N. J. WJBI, WIBI, WBMS)	1120	267.7	100
WWAT—Chicago, Ill. (WSBC)	1290	232.4	500
WWJ—Detroit, Mich.	800	374.8	1000
WWL—New Orleans, La.	1090	275.1	100
WWNC—Asheville, N. C.	1010	296.9	1000
WWRL—Woodside, N. Y. (WBKN, WJBI, WIBI, WBMS)	1120	267.7	100
WWVA—Wheeling, W. Va.	770	389.4	100
KDKA—East Pittsburgh, Pa.	950	315.6	30000
KDLR—Devils Lake, N. D.	1300	230.6	15
KDYL—Salt Lake City, Utah	1160	258.5	100
KELW—Burbank, Calif. (KPPC)	1310	228.9	250
KEX—Portland, Ore.	1250	239.9	2500
KFAB—Lincoln, Nebr. (5000 before 7 p. m.)	970	309.1	2000
KFAD—Phoenix, Ariz.	1100	272.6	500
KFAU—Boise, Idaho (4,000 watts daytime)	1050	285.5	2000
KFBB—Havre, Mont.	1090	275.1	50
KFBC—San Diego, Calif.	1210	247.8	100
KFBK—Sacramento, Calif.	560	535.4	100
KFBL—Everett, Wash.	1340	223.7	50
KFBS—Trinidad, Colo.	1260	238.0	15
KFBU—Laramie, Wyo.	700	428.3	500
KFCB—Phoenix, Ariz.	1230	243.8	125
KFCR—Santa Barbara, Calif.	1420	211.1	50
KFDM—Beaumont, Texas	800	374.8	500
KFDX—Shreveport, La.	1270	236.1	250
KFDY—Brookings, S. Dak.	760	394.5	500
KFDZ—Minneapolis, Minn.	1300	215.7	10
KFEC—Portland, Ore. (KFIF)	1400	214.2	50
KFEL—Denver, Colo.	1210	247.8	250
KFEQ—St. Joseph, Mo.	1300	230.6	1000
KFEY—Kellogg, Idaho	1290	232.4	10
KFEQ—St. Joseph, Mo.	1300	230.6	1000
KFH—Wichita, Kansas	1220	245.8	500
KFHA—Gunnison, Colo.	1180	254.1	50
KFHL—Oskaloosa, Iowa.	1410	212.6	10
KFI—Los Angeles, Calif.	640	468.5	5000
KFIF—Portland, Ore. (KFEC)	1400	214.2	50
KFIO—Spokane, Wash. (KEPY)	1220	245.8	100
KFIQ—Yakima, Wash.	1440	208.2	100
KFIU—Juneau, Alaska	1330	225.4	10
KFIZ—Fond du Lac, Wisc.	1120	267.7	100
KFJB—Marshalltown, Iowa	1210	247.8	15
KFJF—Oklahoma, Okla.	1100	272.6	750
KFJI—Astoria, Ore.	1200	249.9	15
KFJM—Grand Forks, N. Dak.	900	333.1	100
KFJR—Portland, Ore. (KTBR)	1060	282.8	100
KFJY—Ft. Dodge, Iowa	1250	239.9	100
KFJZ—Fort Worth, Texas	1200	249.9	50
KFKA—Greeley, Colo.	750	399.8	200
KFKB—Milford, Kansas	1240	241.8	1000
KFKU—Lawrence, Kansas (WREN).	1180	254.1	500
KFKX—Hastings, Nebr. (KYW)	570	526.0	2500
KFKZ—Kirksville, Mo.	1330	225.4	15
KFLR—Albuquerque, N. M.	720	416.4	100
KFLU—San Benito, Texas	1270	236.1	15
KFLV—Rockford, Ill.	1120	267.7	100
KFLX—Galveston, Texas	1110	270.1	100
KFMR—Sioux City, Iowa	680	440.9	100
KFMX—Northfield, Minn. (WCAL)	1270	236.1	500
KFNF—Shenandoah, Iowa (KMA)	1110	270.1	1000
KFOA—Seattle, Wash.	670	447.5	1000
KFON—Long Beach, Calif.	1240	241.8	500
KFOR—Lincoln, Nebr.	1380	217.3	100
KFOX—Omaha, Nebraska (KOCH, WNAL)	1160	258.5	100
KFOY—St. Paul, Minn.	1050	285.5	100
KFPL—Dublin, Texas	1090	275.1	15
KFPM—Greenville, Texas	1300	230.6	15
KFPR—Los Angeles, Calif. (KFQZ)	1290	232.4	250
KFPW—Carterville, Mo.	1140	263.0	50
KFPY—Spokane, Wash. (KFIO)	1220	245.8	250
KFQA—St. Louis, Mo.	930	322.4	50
KFQB—Ft. Worth, Texas	1150	260.7	1000
KFQD—Anchorage, Alaska	870	344.6	100
KFQU—Holy City, Calif.	1200	249.9	100
KFQW—Seattle, Wash.	1380	217.3	100
KFQZ—Hollywood, Calif. (KFPR)	1290	232.4	100
KFRC—San Francisco, Calif.	660	454.3	500
KFRU—Columbia, Mo.	1200	249.9	500
KFSD—San Diego, Calif.	680	440.9	500
KFSG—Los Angeles, Calif.	1090	275.1	500
KFUL—Galveston, Texas	1160	258.5	500
KFUM—Colorado Springs, Colo.	1270	236.1	100
KFUO—St. Louis, Mo. (KSD)	550	545.1	500
KFUP—Denver, Colo.	1320	227.1	100
KFUR—Ogden, Utah	1330	225.4	50
KFUS—Oakland, Calif. (KRE)	1170	256.3	50
KFUT—Salt Lake City, Utah	600	499.7	50
KFVD—Venice, Calif. (KGFJ)	1440	208.2	250
KFVE—St. Louis, Mo.	1280	234.2	1000
KFVG—Independence, Kans.	1330	225.4	50
KFVI—Houston, Texas	1260	238.0	50
KFVR—Denver, Colo.	630	475.9	250
KFVS—Cape Girardeau, Mo.	1340	223.7	50
KFWB—Los Angeles, Calif.	830	361.2	500
KFWC—San Bernardino, Calif.	1350	222.1	100
KFWF—St. Louis, Mo.	1400	214.2	250
KFWH—Eureka, Calif.	1180	254.1	100
KFWI—San Francisco, Calif.	1120	267.7	500
KFWM—Oakland, Calif. (1000 watts day time)	1270	236.1	500
KFWO—Avalon, Calif.	1370	218.8	250
KFWV—Portland, Ore.	1310	228.9	50
KFXB—Los Angeles, Calif.	190	252.0	500
KFXF—Denver, Colo.	1060	282.8	500
KFXH—El Paso, Texas	1240	241.8	100
KFXJ—Near Edgewater, Colo.	1390	215.7	15
KFXR—Oklahoma City, Okla.	1400	214.2	15
KFXY—Flagstaff, Ariz.	1460	205.4	25
KFYF—Oxnard, Calif.	1260	238.0	25
KFYR—Bismarck, N. Dak.	1250	239.9	250
KGA—Spokane, Wash.	1150	260.7	2000
KGAR—Tuscon, Ariz.	1280	234.2	100
KGBS—Seattle, Wash.	1480	202.6	100
KGBU—Ketchikan. Alaska	1310	228.9	500
KGBX—St. Joseph, Mo.	1040	283.3	100
KGBY—Shelby, Nehr.	1480	202.6	50
KGBZ—York, Nebr.	1410	212.6	100
KGCA—Decorah, Iowa	1480	202.6	10
KGCB—Oklahoma City, Okla. (KGFG)	1390	215.7	50
KGCG—Newark, Ark.	1340	223.7	100
KGCH—Wayne, Nebr.	1020	293.9	250
KGCI—San Antonio, Texas (KGDR)	1480	202.6	15
KGCL—Seattle, Wash. KPCB)	1300	230.6	50
KGCN—Concordia, Kansas	1440	208.2	50
KGCR—Brookings, S. Dak.	1440	208.2	15
KGCU—Mandan, N. Dak.	1440	208.2	100
KGCX—Vida, Mont.	1230	243.8	10
KGDA—Dell Rapids, S. Dak. (Day time only)	1280	234.2	15
KGDE—Barrett, Minn.	1460	205.4	50
KGDJ—Cresco, Iowa	1480	202.6	10
KGDM—Stockton, Calif.	1380	217.3	10
KGDP—Pueblo, Colo.	1340	223.7	10
KGDR—San Antonio, Texas	1480	202.6	15
KGDW—Humboldt, Nebr.	1450	206.8	100
KGDX—Shreveport, La.	1410	212.6	250
KGDY—Oldham, S. Dak.	1450	206.8	15
KGEF—Los Angeles, Calif.	1140	263.0	500
KGEH—Eugene, Ore.	1490	201.6	50
KGEK—Yuma, Colo.	1470	204.0	10
KGEN—El Centro, Calif.	1330	225.4	15
KGEO—Grand Island, Nebr.	1460	205.4	100
KGEQ—Minneapolis, Minn.	1480	202.6	50
KGER—Long Beach, Calif. (KRLO)	1390	215.7	100
KGES—Central City, Nebr.	1470	204.4	10
KGEU—Lower Lake, Calif.	1320	227.1	50
KGEW—Fort Morgan, Colo.	1370	218.8	10
KGEY—Denver, Colo.	1490	201.6	15
KGEZ—Kalispell, Mont.	1460	205.4	100
KGFB—Iowa City, Iowa	1340	223.7	10
KGFF—Ava, Okla.	1460	205.4	25
KGFG—Oklahoma City, Okla.(KGCB)	1390	215.7	50
KGFH——La Crescenta, Cal. (KMIC)	1340	223.7	100
KGFI—Ft. Stockton, Tex.	1360	220.4	15
KGFJ—Los Angeles, Calif. (KFVD)	1440	208.2	100
KGFK—Hallock, Minn.	1340	223.7	50
KGFL—Trinidad, Colo.	1350	222.1	50
KGFM—Yuba City, Calif.	1420	211.1	15
KGFN——Aneta, N. Dak.	1500	199.9	15
KGFO—Terra Haute, Ind.	1470	204.0	100
KGFP—Mitchell, So. Dak.	1410	212.6	10
KGO—Oakland, Calif.	780	384.6	5000
KGRC—San Antonio, Texas (KGCI)	1360	220.4	50
KGRS—Amarillo, Texas	1230	243.8	150
KGTT—San Francisco, Calif.	1450	206.8	50
KGU—Honolulu, T. H.	1110	270.1	500
KGW—Portland, Ore.	610	491.5	1000
KGY—Lacey, Wash.	1230	243.8	50
KHJ—Los Angeles, Calif.	740	405.2	500
KHQ—Spokane, Wash.	810	370.2	1000
KICK—Anita, Iowa	650	461.3	100
KJBS—San Francisco, Calif.	1360	220.4	50
KJR—Seattle, Wash.	860	348.6	2500
KKP—Seattle, Wash.	1130	265.3	15
KLDS—Independence, Mo.	1260	238.0	1500
KLIT—Portland, Oregon	1450	206.8	10
KLS—Oakland, Calif. (KZM)	1220	245.8	250
KLX—Oakland, Calif.	590	508.2	500
KLZ—Denver, Colo.	1120	267.7	500
KMA—Shenandoah, Iowa (KFNF)	1110	270.1	500
KMED—Medford, Oregon	1120	267.7	50
KMIC—Inglewood, Calif. (KGFH)	1340	223.7	250
KMJ—Fresno, Calif.	820	365.6	50
KMMJ—Clay City. Neb. (WCAJ)	790	379.5	500
KMO—Tacoma, Wash.	1180	254.1	250
KMOX—St. Louis, Mo.	1000	299.8	5000
KMTR—Los Angeles, Calif.	570	526.0	500
KNRC—Santa Monica, Calif.	800	374.8	500
KNX—Los Angeles, Calif.	890	336.9	500
KOA—Denver, Colo. (10,000 until 7 p. m.)	920	325.9	5000
KOAC—Corvalis, Ore.	1110	270.1	500
KOB—State College, N. M. (KWSC, KTW)	760	394.5	5000
KOCH—Omaha, Nebr. (WNAL, KFOX)	1160	258.5	250
KOCW—Chickasha, Okla.	1190	252.0	250
KOIL—Council Bluffs, Iowa	1080	277.6	1500
KOIN—Portland, Ore.	940	319.0	1000
KOLO—Durango, Colo.	1500	199.9	5
KOMO—Seattle, Wash.	980	305.9	1000
KOWW—Walla Walla, Wash.	1000	299.8	500
KPCB—Seattle, Wash. (KGCL)	1300	230.6	50
KPJM—Prescott, Ariz.	1400	214.2	15
KPNP—Muscantine, Iowa	1420	211.1	100
KPO—San Francisco, Calif.	710	422.3	1000
KPPC—Pasadena, Calif. (KELW)	1310	228.9	50
KPRC—Houston, Texas	1020	293.9	500
KPSN—Pasadena, Calif.	950	315.6	1000
KQV—Pittsburgh, Pa. WJAS)	1110	270.1	500
KQW—San Jose, Calif.	1010	296.9	500
KRAC—Shreveport, La.	1360	220.4	50
KRE—Berkeley, Calif. (KFUS)	1170	256.3	100
KRLD—Dallas, Texas	1350	222.1	500
KRLO—Los Angeles, Calif. (KGER).	1390	215.7	250
KROX—Seattle, Wash. (KRSC3	1420	211.2	50
KRSC—Seattle, Wash (KROX)	1420	211.1	50
KSAC—Manhattan, Kans.	900	333.1	500
KSBA—Shreveport, La.	1120	267.7	1000
KSCJ—Sioux City, Ia(KWUC)	1230	243.8	500
KSD—St. Louis, Mo. (KFUC)	550	545.1	500
KSEI—Pocatello, Idaho	900	333.1	250
KSL—Salt Lake City, Utah	990	302.8	1000
KSMR—Santa Maria, Calif.	1100	272.6	100
KSO—Clarinda, Iowa	1320	227.1	500
KSOO—Sioux Falls, S. D.	1430	209.7	250
KTAB—Oakland, Calif.	1070	280.2	500
KTAP—San Antonio, Texas	1310	228.9	10
KTBI— Los Angeles, Calif.	1040	282.3	500
KTBR—Portland, Ore. (KFJR)	1060	282.8	50
KTCL—Seattle, Wash.	1080	277.6	500
KTHS—Hot Springs, Ark.	880	340.7	750
KTNT—Muscatine, Iowa	1170	256.3	3500
KTSA—San Antonio, Tex. (formerly WCAR)	1130	265.3	2000
KTUE—Houston, Tex.	1410	212.6	5
KTW—Seattle, Wash. (KWSC, KOB)	760	394.5	1000
KUJ—Seattle, Wash.	1500	199.9	10
KUOA—Fayetteville, Ark.	1010	96.9	500
KUOM—Missoula, Mont.	800	374.8	500
KUSD—Vermillion, S. D.	620	483.6	250
KUT—Austin, Texas	1280	232.4	500
KVI—Tacoma, Wash.	1280	232.4	50
KVOO—Bristow, Okla.	860	348.6	1000
KVOS—Seattle, Wash.	1430	209.7	50
KWBS—Portland, Ore.	1500	199.9	15
KWCR—Cedar Rapids, Ia. (WJAM)	780	384.4	250
KWG—Stockton, Calif.	870	344.6	50
KWJJ—Portland, Ore.	1310	228.9	50
KWKC—Kansas City, Mo.	1350	222.1	100
KWKH—Shreveport, La.	760	394.5	1000
KWLC—Decorah, Iowa	1210	247.8	50
KWSC—Pullman, Wash.	760	394.5	500
KWTC—Santa Ana, Calif.	880	340.7	5
KWUC—LaMars, Iowa (KSCJ)	1230	243.8	1500
KWWG—Brownsville, Texas	1080	277.6	500
KXL—Portland, Ore.	1360	220.4	50
KYA—San Francisco, Calif.	970	309.1	500
KWY—Chicago, Ill. (KFKX)	570	526.0	2500
KZM—Oakland, Calif. (KLS)	1220	245.8	100

A DC Galvanometer You Can Make at Home

THERE is nothing mysterious or complicated about a galvanometer. The two essentials are a coil of wire and a magnet, one of which must be suspended so as to be capable of rotation. If the coil is suspended in the field of the magnet the type of galvanometer is known as the D'Arsonval, or the moving coil type. If the magnet is suspended in the field of the coil, it is called a moving magnet type. The first of these is the more common. It is used in many electrical voltmeters, ammeters, galvanometers and other instruments. The moving magnet type is not used so extensively, though it is much easier to make.

Interesting Work

For those who are experimentally inclined it is both interesting and useful to make one of the moving magnet type. First obtain a small magnetic needle of the type used in pocket compasses, or make one out of a steel needle by stroking it with a larger horseshoe magnet. Now make a coil. This should be preferably in the form of a rectangle considerably longer than it is wide. The length should be such that the needle may swing inside it lengthwise. Say for the sake of definiteness that the length of the needle is 1¼ inches. The inside dimension of the coil should then be about 2 inches. The coil should be wound in a compact form and covered with collodion to hold it together and make it self-supporting. As to the number of turns and size of wire a wide latitude is allowable since there is no definite requirement to be met. One hundred turns of No. 28 silk covered wire are suggested.

The mounting may be made very simply. Use a small piece of wood cut from a cigar box as a base. Then glue a cork to the center of this. Then mount the finished coil on top of the cork, likewise using glue for the purpose. The coil should be mounted with its plane vertical and its long axis horizontal.

For an indicator scale cut out a circle of cardboard and inscribe on it a scale similar to that used on radio dials. Mount this cardboard inside the rectangular coil on the side next to the cork, making its plane as nearly horizontal as practicable.

Now we come to the mounting of the needle. This should be placed in the exact center of the coil measured both in the short and in the long directions. The matter of suspension of the needle is important. If the object is merely to indicate the passage of a current through the coil it may be placed on a pivot without any elastic reactance, that is, without the use of any spring to resist the motion. If an attempt is made to get a value of the current flowing it will be necessary to use a spring of some sort. One of the simplest springs is a fine wire. The needle is then merely suspended over the center of the indicator scale and no supporting pivot is used. A No. 40 copper wire may be used for suspension. The current is then measured by the amount of twist in the wire.

May Get Definite Reading

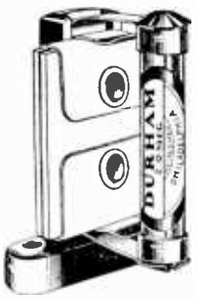
In some cases a definite reading may be obtained by using the earth's magnetic field as the restoring force instead of the supporting wire. The lower pivot may then be used. If the earth's magnetic field is used the coil should be placed so that the earth's field is at right angles to the field set up by the current. The direction of the field set up by the current is at right angles to the plane of the coil. The direction of the earth's field is shown by the magnet when no current is flowing through the coil. The coil should be turned so that the plane of the coil is parallel with the magnet when no current is flowing. Then when the current is turned on the needle will deviate from the north and south alignment and will try to swing around to a direction of east and west. The needle will come to rest at an intermediate direction, depending on the strengths of the two opposing forces.

THE RADIO TRADE

New Set Tester Made by Weston

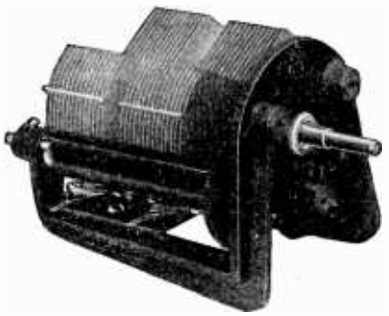
What may be aptly termed as the "Serviceman's Delight" has just been placed on the market by the Weston Electrical Instrument Corporation, Newark, N. J., one of the oldest and foremost electrical houses in the country. It is known as the Weston Model 519 Radio Set Tester. It is very light in weight and compact. Various voltages in either a battery or a battery eliminator operated set, both at the battery terminals and at the tube sockets, as well as the continuity and actual condition of all circuits, regardless of intricacy, may be determined with this device. No additional batteries are required for any of these tests. The instrument which forms a part of this tester is a special Weston model, having three voltage ranges, e.g., 200, 80 and 8, as well as a 20 milliampere range. The voltage ranges have a sensitivity of 1,000 volts ohms per volt, which means that full scale deflection is produced with only one milliampere of current. A plug and socket of the UX type, as well as two adapters are furnished. One adapter is used to change the socket and one to change the plug on the tester from the UX type to the UV type. Adapters for the UV 199 tubes are also obtainable.

Upright Leak Mount



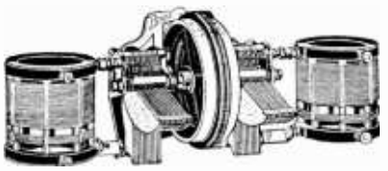
The International Resistance Co. announced an upright mounting base for grid leaks, especially designed for "tight places." This is part of the Durham line, which includes the metallized resistors.

Remler 2-in-Line Among New Parts



Two-in-line Remler Condenser, of the familiar and efficient twin rotor design

Besides having a three-in-line condenser, Remler has a two-in-line model. This also is in straight wave and frequency models and embodies the twin rotor design. Gray and Danielson, Remler Division, are the manufacturers. Pat Kiley, 30 Church Street, New York City, is the Eastern representative.



THE BRUNO "RF" UNITUNE, illustrated in an article in this issue on the **Cash Box Portable,** is **only** one of several models adaptable to various circuits. List price - - - - - - **$17.00**

The basic unit "2C," from which all other UNITUNES are built, consists of two bakelite shaft condensers, mounted on an aluminum frame; a pair of moulded bakelite drums; a bronze escutcheon plate and two mounting screws. It can be bought in all capacities for - - - - - **$11.00**

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Get them at your dealer or send 25 cents to us for NEW 36-page booklet about our complete line.

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Long Island City New York

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Fully described by Herman Bernard in a booklet, with diagrams, including blueprint, and sent on receipt of 25 cents. The Diamond is automatically adaptable to phonograph pickup. RADIO WORLD. 145 West 45th St.. N. Y. Citv

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Good Back Numbers of RADIO WORLD

The following illustrated articles have appeared in back issues of RADIO WORLD: 1926-1927:

1926

Oct. 9—A Practical "A" Eliminator, by Arthur H. Lynch. Building the Equamatic, by Capt. P. V. O'Rourke.

Oct. 16—The Bernard, by Herman Bernard. How to Box an "A" Supply, by Herbert E. Hayden.

Oct. 23—The 5-tube P. C Samson, by Capt. P. V. O'Rourke. Getting DX on the Bernard by Lewis Winner.

Oct. 30—The Singletrol Receiver, by Herbert E. Hayden. How to Get Rid of Squeals, by Herman Bernard.

Nov. 6—Reduction of Interference, by A. N. Goldsmith. Variations of Impedances, by J. E. Anderson

Nov. 13—The 4-tube Hi-Power Set, by Herbert E. Hayden. A Study of Eliminators, by Herman Bernard.

Nov. 20—Vital Pointers About Tubes, by Capt. P. V. O'Rourke. The 4-tube Diamond of the Air, by Herman Bernard.

Dec. 4—The regenerative 5-tube Set, by Cap. P. V. O'Rourke. The 8-tube Lincoln Super, by Sidney Stack.
Winner's DC Eliminator, by Lewis Winner.

Dec. 18—Selectivity on One Tube, by Edgar Speare. Eliminating Interference, by J. E. Anderson.

Dec. 25—A New Coupling Device, by J. E. Anderson. Function of Eliminators, by Herman Bernard.

Jan. 1, 1927—The 2 Tube DeLuxe Receiver, by Arthur H. Lynch. The Twin-Choke Amplifier, by Kenneth Harkness.

Jan. 8—Tuning Out Powerful Locals, by J. E Anderson. A Choice Superheterodyne, by Brunsten Brunn. The 2-Tube De Luxe Receiver, by Arthur H. Lynch (Part 2).

Jan. 15—The DeLuxe Receiver, by Arthur H. Lynch (Part 3) The Simple Meter Test Circuit by Herbert E. Hayden. The Superheterodyne Modulator Analyzed, by J. E. Anderson.

Jan. 22—The Atlantic Radiophone feat, by Lewis Rand. An Insight Into Resistors, by J. B. Anderson. A Circuit for Great Power, by Sidney Stack.

Jan. 29—The Harkness KH-27 Receiver (Part 1), by Kenneth Harkness. Use of Biasing Resistors, by J. E. Anderson.

Feb 5—5-Tube, 1 Dial Set, by Capt. P. V. O'Rourke. The Harkness KH-27 (Part 2), by Kenneth Harkness. What Produces Tone quality, by J. E. Anderson.

Feb. 12—Phone Talk Put On Speaker, by Herbert E. Hayden. All Batteries Eliminated, by Herman Bernard. The Harkness KH-27 Receiver, by Kenneth Harkness (Part 3). Conclusion,

Feb. 19—The 6-Tube Victoreen, by Herman Bernard (Part 1.) The Big Six Receiver, by Wentworth Wood. "B" Eliminator Problem, by Wm. P. Lear. The Phasatrol Circuit, by Capt P. V. O'Rourke. The 5-Tube Victoreen, by Herman Bernard (Part 2). Conclusion.

Feb. 26—The 5-tube Diamond in a Phonograph, by Hood Astrakan. How To Read Curves, by John F. Rider. Proper Tubes for 5-Valve Receiver, by J. E. Anderson.

Mar. 5—Introduction of 4-tube Universal, by Herman Bernard. Discussion on DX, by Capt. P. V. O'Rourke. Sensible Volume Control, by Chas. Gribben.

Mar. 12—Ten Tell-Tale Points, by J. E. Anderson. How To Figure Resistors, by Frank Logan. The 4-tube Universal, by Herman Bernard, (Part .)

Mar. 19—Psycho-Analysing Circuits by Thomas L. McKay. The Universal, by Herman Bernard (Part 2). How To Use a Wave Trap, by James H. Carroll.

Mar. 26—The Universal, by Herman Bernard, (Part 3). Flow of Current in a Vacuum Tube, by Radcliffe Parker. Broadcasting Hypnotism.

April 2—Facts Every Experimenter Should Know, by J. E. Anderson. A Ship Model Speaker, by Herbert E. Hayden. The 8-tube Compact, by Jasper Henry. The Nine-in-Line Receiver, by Lewis Rand (Part 1.)

April 9—A 5-tube Shielded Set, by Herbert E. Hayden. The Power Compact, by Lewis Winner. The Nine-in-Line Receiver, by Lewis Rand, (Part 2.)

April 16—The Schoolboy's Set, by Wally Frost. The Melo-Heald 11-tube Set, by Herbert E. Hayden. The Nine-in-Line Circuit (Part 3), by Lewis Rand.

April 23—The Melo-Heald Set, by Herbert E Hayden (Part 2). The Nine-in-Line, by Lewis Rand. (Conclusion). How Frequencies Are Cut-off, by J. E. Anderson.

April 30—A 1-tube Portable, by Jasper Jellicoe. A Ship Model Receiver, by Smedley Farnsworth. A Double Three Foot Cone, by W. H. Sinclair.

May 7—The Adams-Griffin 6-tube Set, by Dana Adams-Griffin (Part 1). A 2-tube Portable, by Hood Astrakan. How to Improve Super-Heterodyne Sets, by John L. Barrett.

May 14—A 3-tube Portable, by Herbert E. Hayden. The Adams-Griffin Receiver, by Dana Adams Griffin. (Conclusion).

May 21—The Victoreen Portable Receiver, by Capt. P. V. O'Rourke. A Low-Pass Filter, by J. E. Anderson.

May 28—The Console Cone, by Thorvald Larsen. The 3-tube Reflex by Edgar B. Francis. The Victoreen Portable Receiver, by Capt. P. V. O'Rourke. (Part 2).

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I HAVE BEEN GIVEN a five tube tuned radio frequency set, and been told to stop it from squealing when tuned. I don't know where to tap the coils to neutralize it. Can you tell me of any other way that will work?—John R. Stritt.

You can connect a 50,000 ohm-maximum variable resistance in the B battery lead to the primaries of the RF transformers (not the antenna coupler), and use this to cut down their plate potential to the proper value. Also, you can connect the grid returns of the first two tubes to the arm of a non-inductive potentiometer, and connect its outside terminals across the A battery leads in the set, to give a control of RF grid bias. If you decide to use the latter method, be sure that the filament switch is between the potentiometer and the A battery, to avoid a constant current drain. Use a potentiometer that has a resistance of 400 ohms, and the current passed through it will be only .015 ampere.

* * *

I WISH to install a set in a hotel room, where I have no facilities for erecting an aerial. I have tried to make the set work on a loop, but without succeeding. It is a regenerative set, using three tubes. How can I get along without an aerial, or if this cannot be done, how can I change the set?—W. Hall.

There are several acceptable antenna substitutes on the market. Some attach in an electric light socket. Examples are the "Antenella" and the "Ducon." There is also a metal plate which may be placed under a telephone. Its name, I believe, is the "Antennaphone." Another way that usually works well is to use the steam pipe or gas-pipe as an aerial. In all cases use the cold water pipe as the ground.

* * *

MY SET has a rather raspy tone, that I would like to overcome. Tubes and batteries are new, so I assume that they are all right and the loud speaker sounded fine when the dealer demonstrated it to me. Do you think that if I added a stage of resistance coupled amplification it might help?—Irving Hendon.

No. If you were to remove the second audio transformer and replace it with a better one or with two stages of resistance coupling, the tone would probably be improved. Before doing this, try connecting a ¼ to 5 megohm variable resistance across the primary of the first transformer. Then try it across the primary of the second transformer. It is likely that you will find that this will remove the rasp without necessitating rebuilding.

* * *

CAN YOU TELL me an easy way to determine the primary to secondary ratio of an audio transformer?—Ira Hoff.

An approximate idea can be had by connecting first the primary and then the secondary in series with a 0-50 milliammeter and a 22½ volt B battery. Suppose that the reading shows a current of 2 mils through the secondary and 10 mils through the primary. Then the transformer has a 5-1 ratio, as 10 divided by 2 equals 5. This test holds good only if the primary and secondary are wound with the same size wire, as is almost always the case.

HELPFUL HINT

In soldering, use good flux, because it assures clean contact.

COMPLETE DETAILS on what ohmage resistances may be used with B eliminators to also obtain C bias, were given by Frank Logan in the March 12 issue of RADIO WORLD. Either send 15c for his issue or begin your subscription with this iesne. RADIO WORLD, 145 West 45th St., New York City.

Be sure to take RADIO WORLD along with you on your vacation, or read it while you are at your summer home so that you will not miss a copy; send $1.50 for three months subscription and RADIO WORLD will be sent to you all summer. RADIO WORLD, 145 W. 45th St., N. Y. C.

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How the Service Man Peps Up Weak Sets

Quite frequently, the service man is called in to give his views on the failure of a home-built tuned radio frequency set to afford volume and selectivity. Often this can be traced to the grid returns of one or more of the RF coils or the detector coil secondary being run to the wrong filament lead. There is a quick way to check up on the former, if the set is the usual type, using 90 volts of B battery potential on the plates of all amplifier tubes and 45 volts on the detector tube, with a 4½ volt negative bias on the audio amplifier grids. It is to insert a 0-50 scale milliammeter in the wire running from the negative terminal of the B battery to the common A and B battery connection. If all is well, the deflection of the needle on the meter will indicate that a current of 17 mils or less is flowing. When a greater amount of current is being consumed, first see that the polarity of the C battery is correct, and that its positive terminal is connected to the negative A lead. Next, inspect the set and make sure that the RF amplifier grid returns are connected to the negative side of the lamenfit circuit and that those of the audio tubes are run to the negative C battery terminal. If a 201-A type tube is being used as detector, it should have a positive grid return, and if the detector is of the 200 or 200-A type, the grid return should be negative.

The milliammeter reading of about 17 mils, as mentioned above, will hold good for storage battery operated sets that do not use power tubes, as these tubes will require higher B and C voltages and draw a greater amount of plate current. Sets using various types of dry-cell tubes will draw slightly less.

Many owners of factory-made sets are replacing their type 201-A tubes with the type 200-A in the detector stage—and are neglecting to change the grid return. This is a point that must be watched, if the new tubes are to function properly. If ever you hear a set owner complaining that a special detector is not performing as it should, check up on the grid return before going to any further trouble.

INTERESTING FACTS

A hissing noise in the loud speaker is due often to a defective conductor or contact. Carbon resistors are most frequently to blame. The trouble may be traced to the transmitting microphone, to a grid leak, or to a plate coupling resistor. Sometimes the cause is a corroded contact and most frequently occurs at the positive terminal of the storage battery.

If the A battery has been accidently reversed it will produce a very noisy signal, characterized by scratches and hisses.

A run down dry cell will cause a similar noise, but it will be more severe.

All sets radiate unless they have been completely shielded.

Most of the whistles heard at this time in a radio set are not due to faults in the set. The true cause is double in nature.

Do not worry about the quality of a tuning condenser.

LIFE OF A C BATTERY

If the grid is correctly biased no current flows in the grid circuit, and the C battery will last as long in the set as it will on the shelf.

KEEP FILAMENTS NORMAL

Do not burn the filaments in the radio set brighter than normal. Nothing is gained and the life is unduly shortened. If more power is required, use a larger tube.