APRIL 12th 1930

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RADIO WORLD

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The First and Only National Radio Weekly

420th Consecutive Issue—NINTH YEAR

ANY RECEIVER MADE INTO SUPER-HETERODYNE

THE 6-CIRCUIT TUNER

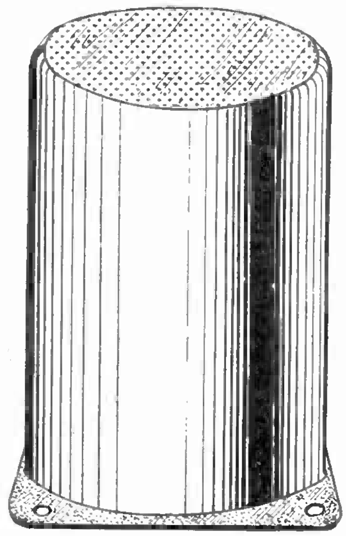
INDUCTANCE AND CAPACITY EFFECTS ON DYNAMIC SPEAKERS

DOES POSITIVE GRID SWING NEGATIVE?

Fallacies About Selectivity Exploded!

The Latest in Tuning Equipment

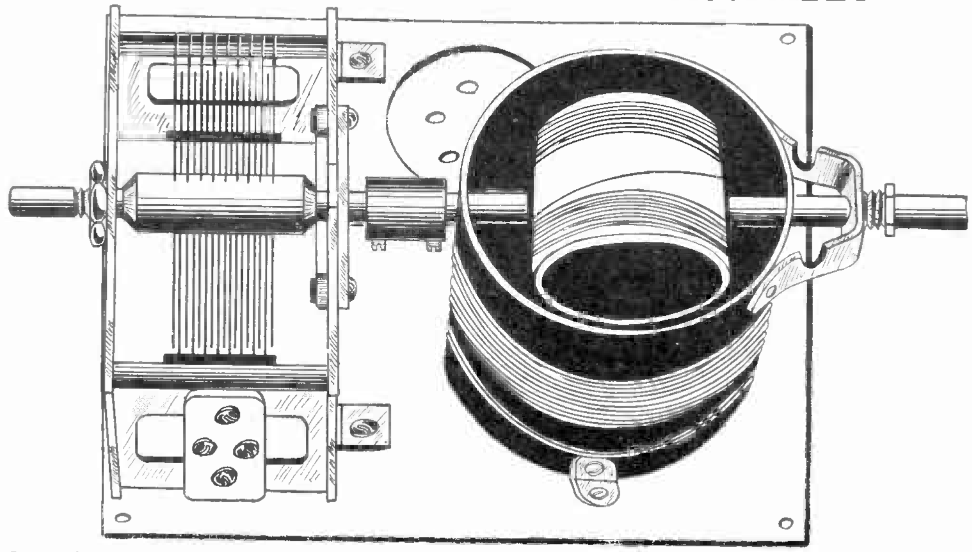
SHIELDED COIL



RF transformer in aluminum shield 2¾" square at bottom, 2¾" high. If metal sub-panel is used no extra base is needed.
Coils have brackets on. You must assemble in shield yourself and solder winding terminals to built-in lugs. For all circuits and stages, including screen grid tubes.

Cat. No. SH3 for .00035 mfd. $0.95
Cat. No. SH5 for .0005 mfd. $1.00
Cat. SHB (extra base) $0.10

BERNARD TWO-TUBE TUNER ASSEMBLY



For building a tuner consisting of a stage of screen grid radio frequency amplification and a detector, AC or battery-operated, use the Bernard two-tube tuner assembly. Suitable for single control with one drum dial or separately tuned stages with two flat-type dials. The assembly consists of antenna stage (BTL-AC or BTL-DC), having Bernard Tuner BT3A, a .00035 mfd. condenser, socket, link and aluminum base. The detector input stage (BTR-AC or BTR-DC) consists of the same parts, but the coil has a tuned primary with untuned input to detector. Assemblies are unwired but are erected.

The condenser has shaft protruding at rear, so if two dials are used coil is put at front panel in either instance and condenser at front panel for the other.

For AC operation, 224 RF and 224, 227 or 228 detector, order Cat. No. BTL-AC and BTR-AC at $6.00 for both.

For battery operation of filaments, 222 RF and 222, 240, 201A or 112A detector, order Cat. No. BTL-DC and BTR-DC at $6.00 for both.

[Note: for drum dial single control an 80 mmfd. equalizing condenser is necessary. This is extra at $0.35. Order Cat. EQ-80.]

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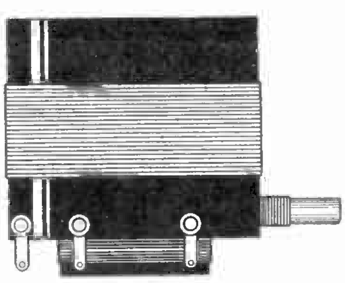
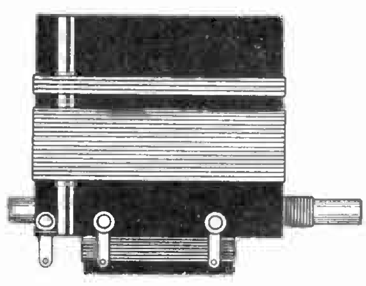


Cat. No. VA5—$0.85
FOR .0005 MFD. CONDENSER

Moving primary and fixed secondary, for antenna coupling. Serves as volume control
Cat. No. VA3 for .00035 mfd. $0.90

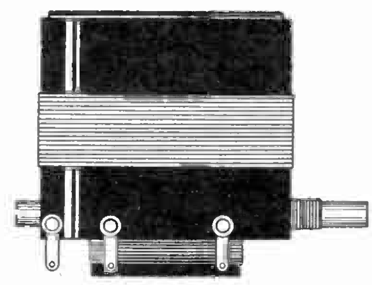
BERNARD TUNERS



Cat. No. BT5A—$1.35
FOR .0005 MFD. CONDENSERS

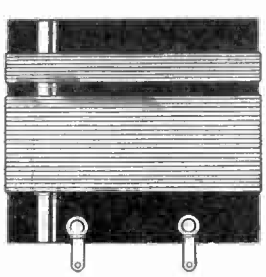
Bernard Tuner BT5A for .0005 mfd. for antenna coupling, the primary being fixed and the secondary tuned. This coil is used as input to the first screen grid radio frequency tube. Secondary has moving coil.
Cat. No. BT3A for 00035 mfd. ..$1.35

Bernard Tuner BT5B for .0005 mfd for working out of a screen grid tube, tuned primary, untuned secondary. Primary has moving coil.
Cat. BT3B for .00035 mfd. ..$1.35



Cat. No. BT5B—$1.35
FOR .0005 MFD. CONDENSER

SG TRANSFORMER



Cat. No. SGS5—$0.60
FOR .0005 MFD. CONDENSER

Interstage radio frequency transformer, to work out of a screen grid tube, primary untuned.
Cat. No. SGS3 for .00035 mfd......... $0.65

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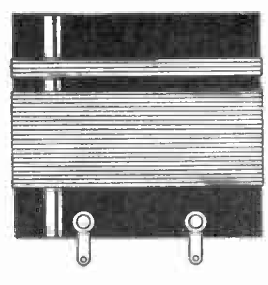


Cat. No. RF5—$0.60
FOR .0005 MFD. CONDENSER

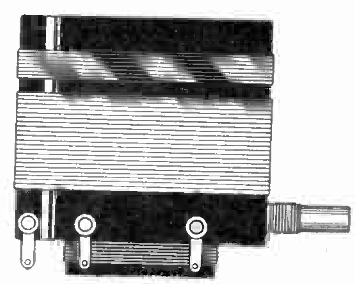
Cat. No. RF5—$0.60
FOR .0005 MFD. CONDENSER
Antenna coil for any standard circuit, and one of the two coils constituting the Diamond Pair.
Cat. No. RF3 for .00035 .$0.65

Cat. No. SGT5—$0.85
FOR .0005 MFD. CONDENSER
Interstage 3-circuit coil for any hookup where an untuned primary is in the plate circuit of a screen grid tube.
SGT3 for .00035 mfd...$0.90

Order the Diamond Pair, Cat. DP5 for .0005 mfd. at $1.45

Order the Diamond Pair, Cat. DP3 for .00035 mfd. at $1.55

[Note: These same coils are for AC or battery circuit.]



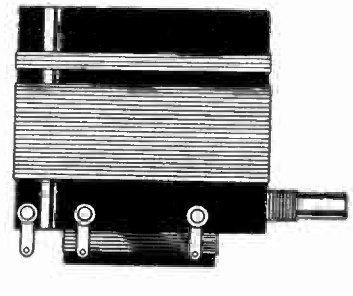
Cat. No. SGT5—$0.85
FOR .0005 MFD. CONDENSER

FL4 $0.30

Flexible insulated coupler for uniting coil or condenser shafts.
Order Cat. FL4 at $0.30

Equalizing condenser, 80 mmfd., for connection across any tuning condenser where ganging is resorted to, or for equalizing independently tuned circuits to make dials track.
Order Cat. EQ80 at $0.35

STANDARD TUNER



The standard three-circuit tuner is used with primary in the plate circuit of any RF tube, AC or battery type, excepting only screen grid tube.

For .0005 mfd. order T5 at $0.85

For .00035 order Cat. T3 at $0.90

All coils have 2⅛" diameter, except the shielded coil, which is wound on 1¾".

The coils are wound by machine on a bakelite form, and the tuned windings have identical inductance for a given capacity condenser, i. e., .0005 mfd. or .00035 mfd. Full coverage of the wave band is assured.

All coils with a moving coil have single hole panel mounting fixture. All others have base mounting provision. The coils should be used with connection lugs at bottom, to shorten leads.

Only the Bernard Tuners have a shaft extending from rear. This feature is necesary so that physical coupling to tuning condenser shaft may be accomplished by the insulated link.

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NINTH YEAR

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Superizing a TRF Set

Tuner Becomes Intermediate Filter by Simple Changes

By J. E. Anderson

Technical Editor

THE conversion into a superheterodyne of any broadcast receiver having a screen grid tube in the first radio frequency socket is easily accomplished without making any wiring changes except removing the grid clip from the control grid of the tube and placing thereon another grid clip from the output of the adapter circuit. There are many different circuit arrangements by means of which the change may be made, some of which we proceed to describe.

The adapter is a frequency changer consisting of a modulator and an oscillator similar to the first part of an ordinary superheterodyne. The frequency changer converts the desired signal carrier to a lower frequency lying within the tuning range of the broadcast receiver, preferably below the 550 kc limit of the broadcast band. The radio frequency amplifier in the broadcast receiver becomes the intermediate frequency amplifier of the entire system and the frequency remains fixed for all carriers that may be desired, unless for some reason it becomes desirable to change the setting of the tuner to another frequency, which may be done as quickly as tuning from one station to another.

A typical frequency changer is shown in Fig. 1. This contains a screen grid tube modulator and a 227 type oscillator, and the voltage vibrations generated by the oscillator are introduced into the modulator by means of a small coil L1 coupled inductively to the oscillator circuit and connected in series with the screen grid.

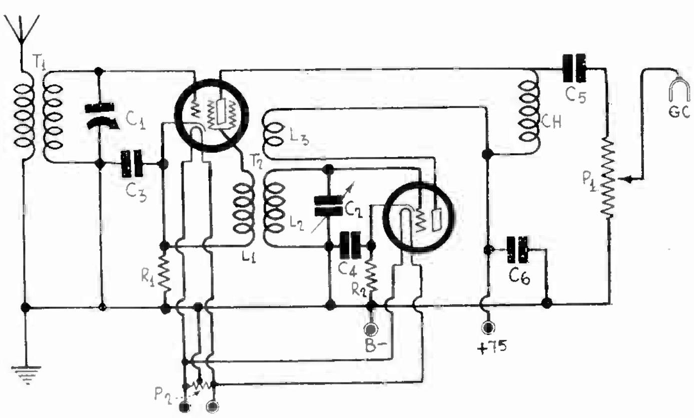


Fig. 1
THE CIRCUIT OF AN ADAPTER WHICH CHANGES ANY SCREEN GRID TUBE BROADCAST RECEIVER INTO A SUPERHETERODYNE. THE PICK-UP COILS ARE CONNECTED IN THE SCREEN GRID CIRCUIT.

Details of the Circuit

T1 is an ordinary antenna coupler such as is used in all radio frequency type receivers, its design depending on the space that is available for the coil and the size of the condenser C1 with which it is to be tuned. A .0005 mfd. condenser is preferred because it covers the broadcast band better than a smaller condenser.

The oscillator coil system T2 consists of three windings, L1, the pick-up, L2, the oscillation coil, and L3, the tickler. In form this system is similar to the three circuit tuner used in regenerative receivers but it differs in respect to the number of turns and also the size of the tuning condenser. Both the inductance of L2 and the capacity of C2 should be smaller than the corresponding values in the first tuning system because the range of the oscillator is smaller than the range of the radio frequency tuner and the mean frequency is higher.

In order to show the difference between the ranges of the two let us assume typical examples. Let the broadcast receiver be set at 540 kc. It is assumed that this can be done. Then the intermediate frequency will be 540 kc. To produce this frequency by beating between a 550 kc carrier and the oscillation frequency, the oscillator must be set at 1,090 kc. And to produce the required beat frequency between the 1,500 kc carrier and the oscillation frequency, the oscillator must be set at 2,040 kc. Thus the range of the oscillator must be from 1,090 to 2,040 kilocycles. The range of the radio frequency tuner must be from 550 to 1,500 kilocycles.

Inductance Required

We might well use a value of 250 mmfd. for C2. If this is done we need a value of 84.25 microhenries for L2, which is about one-half as much as the value of the inductance of the secondary of T1 when a value of .0005 mfd. is used for C1. An inductance of 84.25 microhenries is obtained by winding 49 turns of No. 30 enameled wire on a 1.25-inch diameter. The tickler L3 may consist of 33 turns of the same wire on the same form, beginning one winding where the other leaves off. The pick-up coil L1 may consist of 20 turns of the same wire, put on the same form on the grid end of L2, but separated from it by about one-quarter inch.

If the inductance value of L2 should prove to be too high for the condenser used, a few turns may be removed, one at a time, until the 550 kc carrier comes in near the 98 point on the oscillator dial. Likewise, if the pick-up winding should be too high for satisfactory operation a few turns may be removed from that winding. The larger the number of turns on this winding the greater the sensitivity but the stronger will be the squeals from harmonics. The selectivity will also be better the smaller the number of turns on the pick-up coil.

The Volume Control

It is advisable that two separate dials be used for the two tuning condensers in the frequency changer because the frequency characteristics of the two circuits are quite different. This does not complicate the tuning of the receiver greatly because after the broadcast receiver has been set there are only two controls with which to tune, and only one of these, the oscillator, is critical.

The choke coil Ch in the plate circuit of the modulator may be one of 65 millihenries, but the value is not at all critical.

The intermediate frequency signal is taken off by means of a

AC and Battery Type Mi

Regular Receiver is Used at Low Intermedi

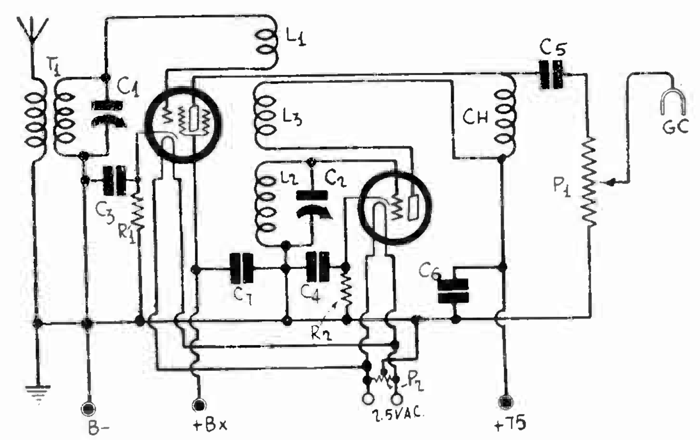


FIG 2
THE SAME CIRCUIT AS IN FIG. 1 WITH THE EXCEPTON THAT THE PICK-UP IS CONNECTED IN SERIES WITH THE CONTROL GRID OF THE MODULATOR TUBE.

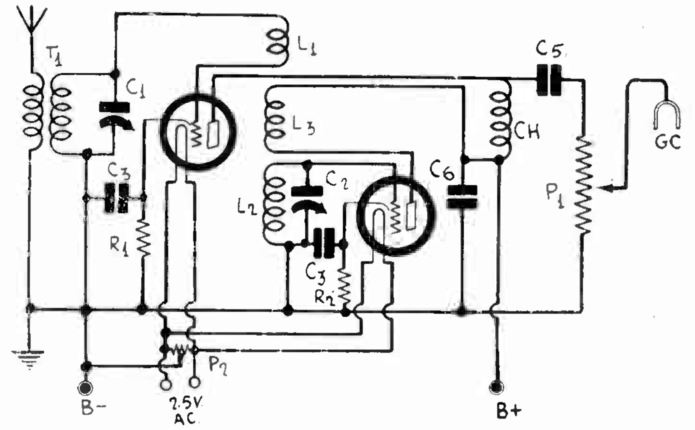


FIG. 3
THIS ADAPTER OR FREQUENCY CHANGER CIRCUIT IS LIKE THAT IN FIG. 2 EXCEPT THAT A THREE-ELEMENT HEATER TUBE IS USED FOR MODULATOR.

500,000-ohm potentiometer P1, connected in series with a stopping condenser C5, which may have a value of about .01 mfd. The slider of the potentiometer is connected to a lead of suitable length, terminating in a clip that fits over the cap of the first screen grid tube in the broadcast receiver. The range of volume that may be covered with this potentiometer is from zero to the maximum that is put out by the frequency changer.

The two resistors R1 and R2 may have a value of 300 ohms each and each of the by-pass condensers C3, C4 and C5 may have a capacity of .01 mfd. or more. The center-tapped resistor P2 is used for the purpose of connecting the center of the heater winding to ground. If the filament winding is center-tapped this tap may be grounded and the resistor omitted. If the resistor is used it should have a value of about 30 ohms.

In Fig. 2 is the same circuit as in Fig. 1 with the exception that lator tube. All the values are the same in both circuits, but in Fig. 2 is an extra by-pass condenser C7, which may have a value of .01 mfd. or more. When the pick-up coils is connected in the grid circuit it is more effective than when it is put in the screen circuit, and therefore for a given degree of coupling between the two tubes L1 should have fewer turns in Fig. 2 than in Fig. 1.

Three-element Modulator

In Fig. 1 the screen return is made to the cathode. Since the modulating efficiency depends largely on the voltages applied it is well to try making the return to different positive voltages. This applies also to the second circuit, and for that reason the screen return in that circuit has been terminated by plus Bx, indicating that different positive voltages should be tried to find that which gives greatest modulating, or detecting efficiency. Since the applied plate voltage in each case is low, the optimum value of screen voltage is rather low also. It should always be considerably less than the applied plate voltage.

In most superheterodynes the modulator, or so-called first detector, is usually a three-element tube. In Fig. 3 is shown the same frequency changer with a 227 tube as modulator. The various constants in this circuit are the same as those in Fig. 2 except that R1 may have a higher value. It is recommended, in fact, that R1 be made a 5,000 ohm variable resistor so that it may be set at that value which gives best operation.

AC Circuits

The circuits in Figs. 1, 2 and 3 are designed for alternating-current tubes. In Figs. 4, 5 and 6 the same circuits are given for direct-current tubes. There is practically no difference between the corresponding circuits in respect to coils and condensers, but there are slight differences in the grid bias resistors. In Figs. 4 and 5 R1 should be 20 ohms and in Fig. 6 R1 should be 4 ohms or an equivalent filament ballast resistor. R2 in all the battery circuits in a 4-ohm resistor.

Since the ballast resistor R1 in Fig. 6 does not give the grid enough bias for effective detection a grid battery Eg is connected between ground and the grid return of the first tube. Voltages of 1.5, 3.0. and 4.5 volts should be tried and that one used which gives the highest detecting efficiency.

On the DC circuits it is not necessary to use more than 45 volts on the plates of any of the tubes. This applies to the circuits using screen grid tubes as well as to the circuit using a three-element tube as detector. While the screen grid tubes ordinarily require high plate voltages for amplification, lower voltages may be used for detection, and if the plate voltage is too low for a given value of screen grid voltage it is only necessary to reduce the voltage on the screen.

Behavior of Oscillator

In giving the design for the oscillator coil the number of turns on the tickler winding was specified at two-thirds as many as on the tuned winding. It frequently happens that this will cause oscillation on the low frequency end of the tuning range but not on the high end. That is, the oscillator may work from 550 to 1,000 kc and fail from 1,000 to 1,500 kc. When that happens it is best to remove a few turns from the tickler, just enough to cause oscillation at all settings of the condenser. It may also happen that the circuit will oscillate at the high frequency end but not at the low end. In such cases it is best to add a few turns to the tickler. Oscillation can usually be induced by increasing the voltage on the plate of the oscillator but it is preferable to adjust the tickler turns to achieve the desired result.

In each of the six adapter circuits described is a choke coil Ch of 65 millihenries used for coupling the modulator to the first tube in the receiver. If this choke is replaced by a tuner adjusted to the intermediate frequency, that is, a tuning coil with a suitable condenser across it, considerably better operation will result. The modulator will be more efficient and the circuit will be more selective as well as more sensitive. However, unless this tuned circuit be provided with a variable condenser it is not possible to select more than one intermediate frequency. And if a condenser is provided for tuning this coupling coil the circuit becomes complicated. If the receiver used with the adapter is of the modern, sensitive type it is best to arrange the circuit just as is given in the diagrams.

One-spot super

The lowest frequency that can be selected for the intermediate frequency is so high that the circuit is essentially a one-spot. Only the higher oscillator setting can be selected. This, however, does not mean that certain stations cannot be received on harmonics. But no trouble should be experienced from this source since the intermediate frequency is so high that the first tuner in the adapter will effectively suppress any interference.

In building any one of these adapters it is advisable to shield the circuit as a whole as well as to shield the first tuner T1C1 from the rest of the circuit. The oscillator system, however, should not be shielded separately because the shielding will change the characteristics of the oscillator and may stop the oscillations entirely.

It is scarcely necessary to describe the antenna input transformer T1 since there are hundreds of suitable "antenna coils" on the market, any one of which may be used, provided that it fits the tuning condenser with which it is to be used. But there are those who prefer to wind their own coils and who do not have winding data available, and for their benefit we give a design for each of the standard tuning capacities.

Since compactness is a desirable feature of an adapter of this sort we select a small form for the coil, a piece of bakelite tubing 1.5 inches in diameter. If the tuning condenser has a maximum capacity of .0005 mfd. the inductance of the secondary of the coils should be 160 microhenries. This assumes that the distributed capacity in the circuit is 25 mmfd. This inductance will be obtained with 68 turns of No. 28 enameled wire wound on the 1.5-inch tubing. Fifteen turns of the same kind of wire

xers for Broadcast Waves

ate Frequency in Superheterodyne Adaption

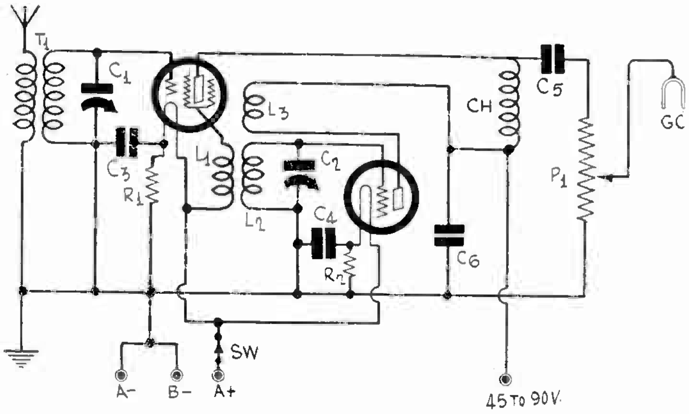


FIG. 4
THE DIRECT-CURRENT COUNTERPART OF THE ADAPTER SHOWN IN FIG. 1.

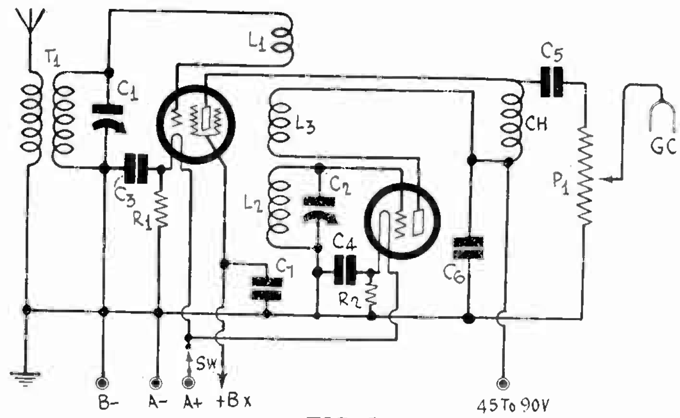


FIG. 5
THIS CIRCUIT IS THE SAME AS THAT IN FIG. 2 BUT ARRANGED FOR BATTERY OPERATION.

on the same form at one end of the secondary will be enough for the primary winding.

If the condenser has a capacity of .00035 mfd. the required inductance is 224 microhenries, again allowing 25 mmfd. for distributed capacity. This inductance is obtained with 79 turns of No. 30 enameled wire on a 1.5-inch form. The primary may contain 16 turns of the same wire.

Recommended Tubes

The direct-current tube circuits are designed for 222 screen grid tubes and 201A three-element tubes, with a filament battery voltage of 6 volts. While the circuits could be assembled with 199s in the three-element sockets and a voltage source of 4.5 volts, this is not recommended because these small tubes do not give nearly as satisfactory results as the larger tubes.

Whenever it is practical the plate voltage for all six circuits should be provided by batteries because they will not introduce any hum. However, if the filtering in a B supply is very good this may be used with good results.

In connecting one of these adapters it is necessary that the same ground be used for both the adapter and the radio receiver. It is also necessary that the grid clip on the first tube in the receiver be removed and that the grid clip in the adapter be substituted for it. When the grid clip in the set is removed from the cap the first tuner and any volume control which may be used ahead of the tube are disconnected and the adapter substituted. The change amounts to the same thing as to rebuild the receiver and to make a superheterodyne out of it.

Use of Low Intermediate

When the broadcast receiver is converted to a superheterodyne by means of one of these adapters it should be tuned to the lowest possible frequency so that the intermediate frequency does not become impractically large. As a rule, every broadcast receiver can be tuned to a frequency somewhat below 550 kc. We previously assumed a frequency of 540 kc, but it is quite probable that on many receivers a lower frequency can be obtained. Once the intermediate frequency has been selected it should be kept at that value, because any changes in the frequency by readjusting the tuning control in the broadcast receiver will change the dial settings of the oscillator condenser. If it is left fixed it is possible to calibrate the oscillator dial so that the station tuned in may be known by the position on the dial.

There may be times, however, when it is desirable to select a different intermediate frequency. For example, there may be harmonic interference on a certain station. This can be avoided by changing the intermediate frequency, that is, by setting the tuning control of the broadcast receiver at a different point.

Again, when short wave stations in the vicinity of 200 meters are being tuned in it may also be desirable to select a higher intermediate frequency. Since the higher oscillator setting is selected in all instances, the intermediate frequency may be as high as 1,500 kc without any undsirable effects, provided that the broadcast receiver is sensitive at this frequency.

In each of these six adapters the output voltage is developed across a choke Ch. If it is desired to tune the output, a tuning coil having the same inductance as the secondary of T1 may be substituted for the choke and another .0005 or .00035 mfd. tuning condenser connected across this coil. This will transform the output to the tuned impedance type. Somewhat higher detection, or modulation, efficiency can be obtained in this manner, but it complicates the circuit by adding another tuner that must be adjusted whenever the tuning of the broadcast receiver is readjusted. This tuned output impedance must be tuned to exactly the same frequency as the broadcast receiver, since the coupler becomes a part of the intermediate tuner. It will make the circuit both more sensitive and more selective. The added complication, however, is not justified by the improved results. This is especially true when the broadcast receiver itself is sensitive and selective.

Short Wave Reception

Those who have followed the articles on short wave adapters in previous issues of RADIO WORLD will note that the six adapters here described are of the same form as the short wave adapters. The only essential differences between the circuits here given and the short wave circuits lie in the values of the coils and the condensers in the tuned circuits. In the present circuits they are essentially of broadcast dimensions, while in the previous circuits they were smaller electrically. Those who are interested in adapting broadcast receivers to short wave reception, using the superheterodyne principle, are referred to the articles previously published on this subject.

An adapter like any one of those described here may be built into a compact box, placed on top of or inside the cabinet of the broadcast receiver. It is advisable that this box as a whole be shielded so that there will be no energy pick-up other than that intended from the antenna and also so that there will be no coupling between the adapter and the receiver other than that provided by the potentiometer P1 and the grid clip GC.

In connecting up the adapter, the antenna lead which is connected to the broadcast receiver should be transferred to the antenna binding post on the adapter, and the two ground posts, as has been stated, should be connected together and grounded.

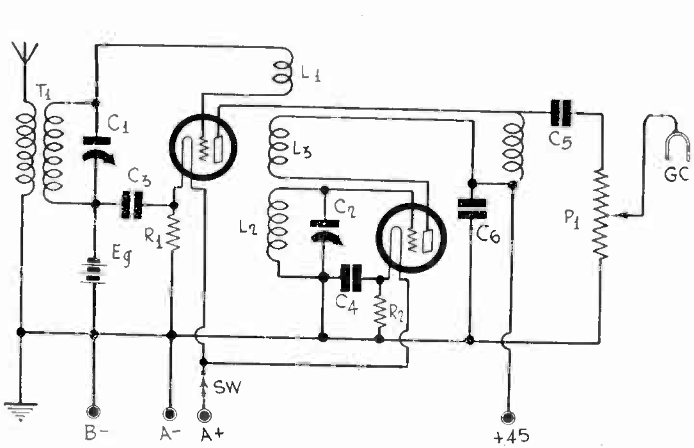


FIG. 6
THE DIRECT-CURRENT VERSION OF THE CIRCUIT DIAGRAMMED IN FIG. 3. A GRID BATTERY IS USED IN THIS HOOK-UP TO PROVIDE THE PROPER BIAS.

Why Coils Have Lag

Diverse Action is Due to Atomic Struc

By John C.

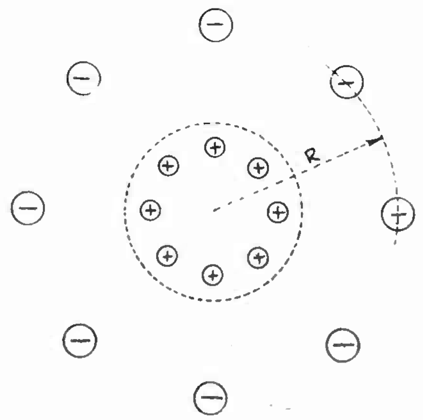


FIG. 1
THE RELATIVE ARRANGEMENT OF CHARGES IN AN ATOM.

[The following article is the fifth of a series on dynamic speakers. The series began in the March 15th issue with the article on "Design of Dynamic Speakers." The pot magnet, voice coil and baffle were discussed. The second article, "A comparative Test of Dynamic Results," appeared in the March 22nd issue, in which acoustic comparisons were made between magnetic and dynamic speakers. In the March 29th issue, "Hum Reduction in Dynamic Speakers" was discussed. Reverse wound coils and condenser choke systems were included. In the April 5th issue "Wave Forms of Hum Reducers" was the topic. The use of the bucking coil and some remedies for hum were discussed. Follow this series on dynamic speakers from week to week—EDITOR.]

INDUCTANCE (or electrical inertia) has the effect in AC, DC and pulsating DC circuits, of delaying the arrival of the current at maximum value, and this delay, or lag, also depends directly on the amount of inductance present. Now, condensers have the opposite effect in electrical circuits, and create leading effects instead of lagging ones.

Later on we will examine typical curves of effects relative to each other and the applied emf.

We must first understand how a condenser condenses, and why, before we can intelligently apply its effects.

The Atom Under Consideration

The electrical constitution of matter rests upon some concepts of great importance. The atom, and its constituents, the electron (negative charge) and the proton (the associated positive charge). How they are associated in atomic structure and their relation to the explanation of condenser action are important facts for getting at the root of the subject in a simple and readily understandable manner.

The atom in its simplest form consists of electrical charges grouped around a nucleus of positive charges (protons) and is represented for convenience as not being in motion, and can be shown to have a very direct bearing on the action of a condenser.

The materials of which a condenser is made have a definite electrical structure and although the capacity of a condenser is mainly dependent upon the distance between the two plates or electrodes; the atomic structure of the material that separates the plates influences the value of the capacity by the extent of the material's tenacity, or rather its tendency to retain its normal condition of aggregation.

Voltage Applied to Condenser

When the terminals of a condenser are connected to a source of difference of uniform direct voltage a corresponding difference of potential is set up across the terminals of the condenser a short fraction of time after the contact with the charging source is completed. During the lapse of time between the contact with the charging source and the final arrival of the condenser terminal voltage at similarity with that of the charging source a current flowed and this current is called the charging current.

Fig. 1 shows the arrangement of protons and electrons in an atom.

As can be seen from Fig. 1, the atom is made up of a positive nucleus marked A and contains eight positive charges, each of such strength electrically that it holds within the radius R the eight negative charges. Now, the number of electrons that, a positive nucleus can hold is exactly similar to the *quantity* of electric current that *can* flow in a given electrical circuit. The radius R about which the eight negative charges are grouped is a direct comparison to the expression *voltage,* which means electrical pressure. The difference of potential expression means the work done on the electron to locate it where it is.

Now although we began at the outset by stating that this atom was not moving we were purposely not telling the full story. Now the rest can be told.

Electrons Shifted

Fig. 1 shows an atom that is under electric stress and although the electric field that is actually responsible for molding the electrons in the position shown is *acting* it is not shown so, but may be regarded as a mutual repelling force acting between the eight electrons and exactly counterbalanced by the attractive force between the positive nucleus and the ring of eight electrons (the negative charges).

If the position of one of the negative charges in Fig. 1 is altered by the application of an external force, the resulting dislocation automatically will result in the seven remaining electrons (negative charges) being shifted to a new position of equilibrium. To accomplish this, work must be done on the atom, and since this is the case we find that due to the electrons having been re-located from their former positions the atom *now* can do work for us. The atom having stored some energy, because the atom is elastic, has permitted some of its constituent parts to be dislodged temporarily from a position of rest. Later on when the effect of the dislodgement is removed the electrons will assume their former relative positions and in doing so return a *part* of the work that has been done on them.

Condenser's Condition

Fig 2 shows a condenser of two plates, with air between them. The two plates are of the same material and the same size. Also each bears in the natural electrical state the same number of atoms as the distribution of electrical charges on each plate shows.

Now, this condenser is said to be not charged or discharged depending upon its previous electrical condition, but I will assume a new condenser and therefore an uncharged one. Furthermore, the uncharged state assumes that the atoms of each plate are exactly alike and contain the same number of constituent parts, viz.—positive nuclei and electrons.

In Fig 3 the same condenser is shown ready to be charged by battery M when the key is closed, but before I close the key I want to explain that there is no premeditated idea in arranging the battery connections as shown. The battery could have been hooked up the other way around, with the result that the very same effect that is about to be shown would have occurred. So, having noted this, and once again that there is the same number of positive and negative charges on each of the two plates.

Action Resulting from Closing Key

I close the key, with the result that one plate is charged positively by the battery and the other becomes charged negatively. The plate that is now positive is so because it has drawn off (by virtue of its positive charge imparted by the battery M), the negative charges which existed previously on the opposite plate. See Fig. 3. If the key is opened, and the terminals of an electro-static voltmeter are touched to the two plates, the condenser will be found to have a potential difference between the plates, approximately equal to the battery emf of the battery M, and thus potential will remain unchanged provided there is no way for the excess of electrons on the positive plate to reach the "negative" plate, from whence the original supply was withdrawn. But in a commercial condenser of not very high grade this leakage current, or tendency of the charged condenser gradually to or otherwise assume its uncharged state, is due to the excess electrons on the positively charged plate finding their way back to the negatively charged side.

From the foregoing it can be seen that a positive charge on a condenser plate is in reality a deficiency of electrons and a negatively charged plate represents an excess of electrons.

Where Reverse Current Arises

I have stated previously that if work (electrically speaking) be done on a condenser, that the condenser can do work in return. The circuit of Fig. 3 can be imagined to contain a high resistance connected in series with the key and a milliammeter in any part of the external circuit. On closing the key the condenser charges more slowly, of course, but we can see by the milliammeter reading that there IS a current and if the time

and Condensers Lead

ture Affected by Charge Due to Pontential

Williams

rate of flow be observed this quantity when multiplied by the potential of the battery M will give a measure of the energy done *on* the condenser. And similarly if we connect the high resistance across a charged condenser we will observe a current, but in the reverse direction, and the emf across the resistance furnishes the voltage drop which when multiplied by the indication of the milliammeter gives the energy in fractions of a watt. I have purposely not taken up the fact that the charging emf in an experimental or actual case is not constant but varies with the state of charge and the resistance of the external circuit, as this will be brought out later.

In the simple condensers shown the work done in charging the condenser, and in discharging, is very small, and to make the effect large enough to be visually demonstrated a condenser of high capacity is substituted for the two-plate types depicted.

Changes in Voltage

Fig. 5 shows a graph of the voltage variation of a sine wave alternating source of voltage. The voltage is seen to begin at zero and rise and attain its highest value of 120 volts in seventeen-tenths of a cycle unit, and after this point has been reached the voltage is seen to fall. At thirty-four tenths of a cycle unit after having begun its upward excursion the voltage is zero again. Then it starts off again in the opposite direction and another seventeen-tenths of a cycle unit later it is seen to have reached its negative value of 120 volts, whence it recedes back to zero again, completing the cycle.

Now, when the condenser of Fig. 3 was connected to battery M the current started to flow BEFORE the full voltage of the battery M was measurable across its plates, and as the electrons pile up on one of the condenser plates the voltage across the condenser increases until, when no more electrons are transferred, the voltage reaches its highest value.

Same Effect on AC

Now, as has been explained, the fact that the condenser current flows before the voltage drop reaches its maximum value gives rise to the expression of "leading current" in connection with the effect of a condenser connected to an alternating source of exciting power.

This is also true of condenser effect in pulsating circuits but I will refer to that later, in further discussion on the phase relationships of hum voltage components, this subject is extensive and must therefore have special treatment in a subsequent article.

Fig. 6 shows the voltage curve of Fig. 5 with the accompanying condenser current curve and this shows that the condenser current leads the applied emf by 45 degrees, and is a representation of an observed effect. The amount of each is proportional to the capacity of the condenser. The final value of the emf of the condenser depends generally on the resistance in series with it and the charging source. This interesting property of a condenser is therefore seen to be due to natural causes and is not a secondary effect as some electrical manifestations are.

Now it will be remembered that the effect of self-induction was discussed and shown in last week's article and it will be remembered also that this effect produced reverse emfs that tended to oppose the building up of the applied emf in a coil of many turns (containing an iron core.)

Reason for Lag

Since the emf of self-induction opposes the applied emf and is therefore said to lag behind the applied emf, the two devices, namely the inductance coil and the condenser, will be found to have opposite effects when combined on an alternating current circuit, and these opposing effects are utilized in varying degrees, in electrical apparatus of all kinds, and especially in radio receiving and power circuits.

Fig. 6 shows the manner in which inductance and capacity will vary on an alternating current circuit in which there is no resistance. They are shown equal and opposite and therefore in the case shown if the inductance and condenser that reproduce these curves are connected in parallel or series the net current through both would be zero.

In an actual case this condition would be very closely approximated, though never attained.

Now, as previously stated, the condenser has some very definite applications to rid dynamic speakers of objectionable hum. Of course there is associated with the condenser used an inductance, in the form of the pot coil, but in some cases there is an extra inductance also, which is not linked magnetically with the speaker pot.

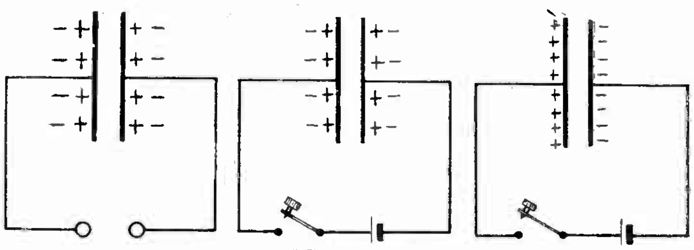


FIG. 2 (Left)
THE ARRANGEMENT OF CHARGES ON THE PLATES OF AN UNCHARGED CONDENSER.

FIG. 3 (Center)
A CONDENSER READY TO BE CHARGED

FIG. 4 (Right)
A CHARGED CONDENSER—AND ALSO THE RE-DISTRIBUTION OF POSITIVE AND NEGATIVE CHARGES.

Ripple Smoothed Out

Whether the speaker be dry rectifier operated or not, a condenser often is used to smooth out the ripple in the pulsating DC supply, and advantage is taken of precisely the same effects, except that as the voltage fluctuation on pulsating DC circuits is considerably less than it is on alternating current circuits of the same voltage, a larger condenser is necessary to obtain the same effect. In high voltage pulsating DC circuits, though, the magnetizing coil is usually of high inductance, and where a speaker coil forms part of a B voltage source network there is usually a condenser associated with the pot coil circuit or some adjacent circuit.

Rectifiers of all kinds depend for their action on the displacement of electrons, essentially, although in the wet types where chemical action is incidental the terminology is somewhat different. Yet the fact that ions and molecules are referred to need not confuse in the least as the idea involved is still the previously recorded description.

Circuit Traced

In a simple circuit consisting of a dry cell in series with a copper and zinc plate immersed in water you can trace a circuit from the positive terminal of the dry cell to the zinc plate, then through the water to the copper plate and back to the negative terminal of the dry cell. If you connect an indicating instrument in series in this circuit and add a pinch of salt to the water in which the copper and zinc plates are inserted, a current will flow.

This current flow results from the zinc plate being charged positively by the dry cell, thus attracting from combination with the water molecules the electrons they normally contain and these are deposited on the zinc plate, resulting in the establishment of a current and consequently at a brief time later a potential difference builds up. Notice how this compares with the previous statement about the condenser.

Now let the connection to the dry cell be reversed. We now trace a circuit from the positive terminal of the dry cell to the copper plate, and thence to the zinc plate and return to the negative terminal of the dry cell. But the indicating meter shows little or no current. If we investigate we find that the electrons are tending to move through the solution in the same way as they formerly did and the emf of the dry cell is trying to make them move oppositely and the result is that there is no net current in the external circuit.

AC is Substituted

Now if we substitute a source of alternating emf of the same magnitude as the dry cell, and contrive to make the reversals slow enough so that we can observe the effect as it will be indicated by the series indicating device we will see that we get a deflection where the current flows one way and no deflection where it reverses its emf, we have in effect an elementary rectifier and the series indicating device is showing us a pulsating direct current, or a uni-lateral current as it is some times called.

Fig. 8 shows the usual diagrammatic sketch of a dry rectifier and it consists essentially of two dissimilar metals which when

Condensers Affect Hum

Rectifier Action Analagous to Capacity Effect

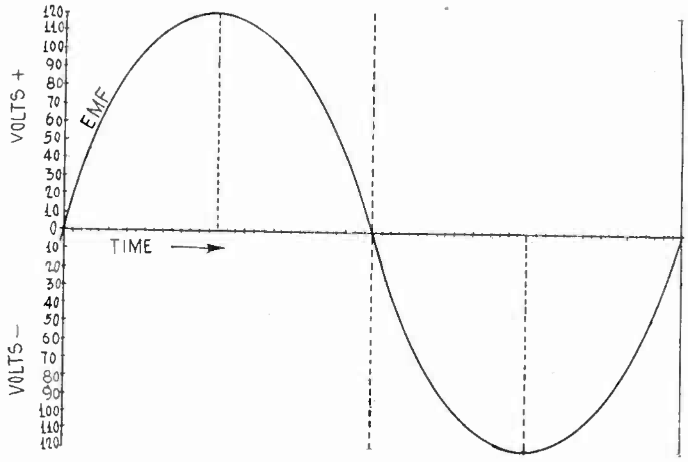


FIG. 5
A SINE WAVE ALTERNATING VOLTAGE CURVE.

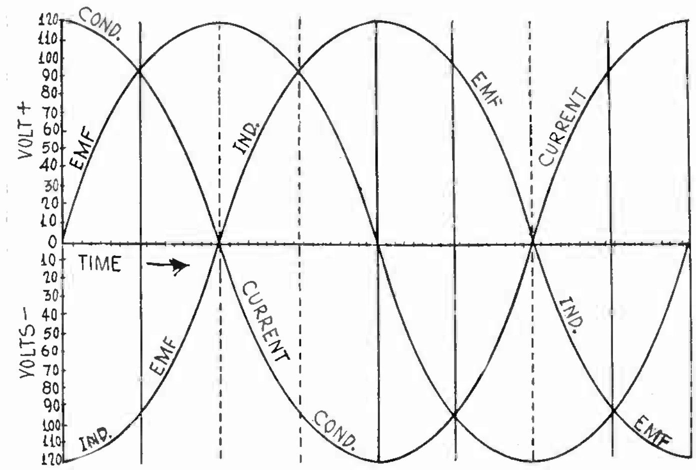


FIG. 7
HOW INDUCTANCE AND CAPACITY EFFECTS OPPOSE EACH OTHER IN AN AC CIRCUIT.

combined in very close proximity constitute a combination which has the property of conducting a current of electricity in one direction very much better than in another, and a series combination of several such cells forms a very efficient rectifier.

A form of condenser operative on this principle but consisting of suitable electrodes immersed in a conducting paste—and having a very thin insulating film built up on one of the electrodes so that the device has very large capacity is successfully used on low voltage circuits to remove ripples.

Fig. 9 shows a rectifying tube for the production of high voltage pulsating DC, its rectifying action is also dependent upon the flow of electrons from the cathode C to the anode A

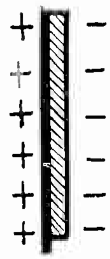


FIG. 8 (Left)
SHOWS ARRANGEMENT OF PARTS OF A DRY RECTIFIER

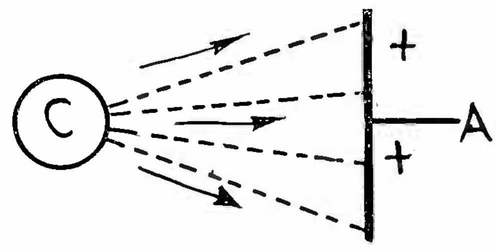


FIG. 9 (Right)
SHOWS DIRECTION OF ELECTRON-FLOW IN A RECTIFYING TUBE.

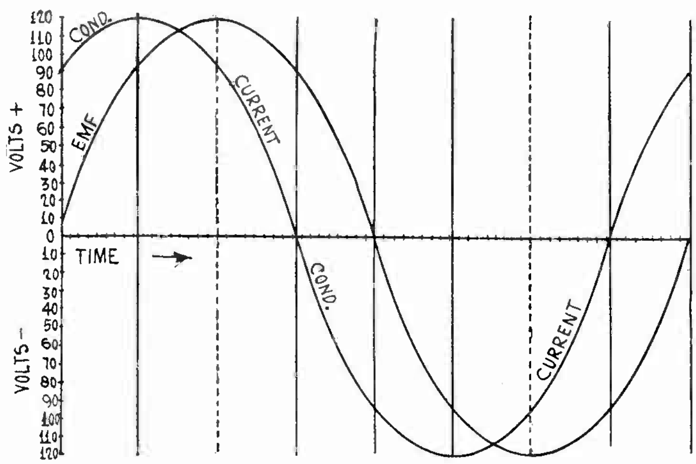


FIG. 6
HOW CONDENSER CURRENT LEADS THE APPLIED VOLTAGE.

(or plate) and it is doubtless known that the current is proportional to the difference of potential between the cathode and the anode.

Service of a Receiver is Something to be Considered

In discussing the relative merits of receivers one must not forget the service that any receiver may require. It is clear that the troubles which may develop in a receiver is directly proportional to the number of tubes in the circuit. It is proportionately more difficult to locate the source of any trouble that may develop. It is, therefore, clear also that the cost of servicing will be proportional to the number of tubes. The cost of this service must be added to the cost of upkeep, and on this score the modest receiver wins by a wide margin.

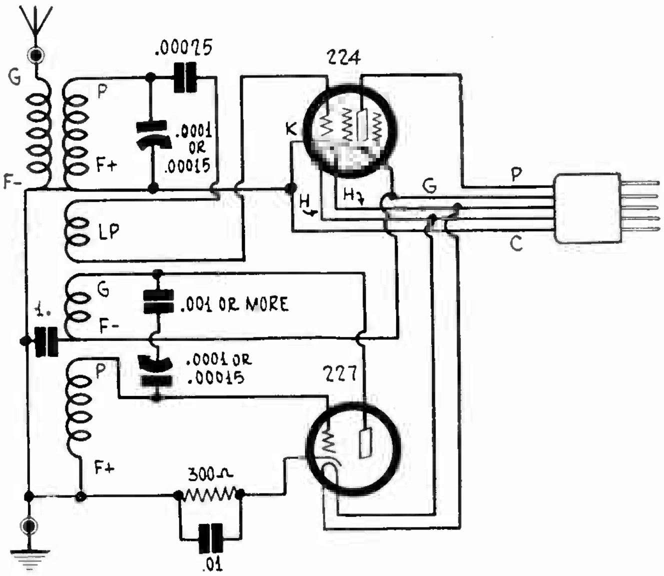
Furthermore, if troubles requiring the attention of a service man develop at a rate proportional to the number of tubes it is obvious that the receiver will be inoperative a larger percentage of the time. Difficulties may develop late in the afternoon on a day when a special program is scheduled. The service man is called in, but he may be too busy to attend to that particular difficulty the same day. He may not be able to come around until the next morning. Obviously, the special program will be missed.

The owner of the receiver may become desperate as the time for the special program approaches, and he may attempt to fix the set himself. He switches the tubes around in a random manner. He short-circuits a coil here, a resistor there. He tries out his spare tubes. The result may be a receiver requiring a thorough overhauling by an expert. This is not a fantastic assumption, for such things happen every day.

Is Grid Blocking Real?

Positive Grid Never Below Zero, or Stops Plate Current

By Henry Field Farrow



IN THIS SHORT-WAVE ADAPTER NO GRID LEAK IS PROVIDED AND THE GRID CONDENSER IS SUBJECT TO CHARGE ACCUMULATON AS EXPLAINED IN THIS ARTICLE. STRAY LEAKAGE KEEPS THIS CIRCUIT OPERATIVE.

AS everybody knows, there are two types of detection by means of a vacuum tube, namely, grid condenser-leak and grid bias detection. A satisfactory explanation of the grid bias process of detection has been given, but not so of grid condenser-leak detection. It is true that an explanation has been given, and a simple one, but not a satisfactory explanation. Indeed, not even a sensible explanation has been propounded that is intelligible to anyone who is not well versed in mathematics.

The usual simple explanation is nothing short of ridiculous. It violates the so-called "uniqueness theorem" in mathematics, which in its simplest terms is nothing but a statement of common sense. The explanation goes about as follows:

A signal voltage is impressed on the grid, making it alternately positive and negative. A leak-proof condenser is placed in series with the grid lead. When the signal voltage is such as to make the grid positive, electrons flow from the cathode to the grid, partially neutralizing the charge impressed by the signal. These electrons cannot escape from the grid because the condenser is leak-proof. When the signal withdraws the grid remains negative by an amount depending on the number of electrons that were trapped. Shortly the second cycle making the grid positive comes along and more electrons are attracted to the grid, and when the signal voltage recedes, the grid is left still more negative. This process goes on until the grid is so much negative that no plate current can flow. That is the explanation of grid blocking, which is part of the explanation for detection by grid condenser and leak.

The Fallacy

This explanation depends on the fact that grid current can flow only when the grid is positive. But this very condition makes the explanation fallacious. How can a weak signal voltage, which is negligible in comparison with the grid voltage required to cut off the plate current, continue to force the grid positive against the accumulating negative charge on the grid? Obviously, it cannot continue to force it positive to the point where the plate current is cut off, but only until the charge on the grid makes the potential of the grid equal to the peak of the signal voltage that is impressed. This peak voltage may be of the order of one-tenth of a volt whereas the bias necessary to stop the plate current may be of the order of 25 volts.

The absurdity of the contention can be illustrated simply by means of an analogy. Let there be a dam between a dry dock and the open ocean. It is desired to keep the dock dry. Waves of a given height begin to roll in, and at every crest a little water goes over the dam. After every crest the dam is raised a little to prevent any overflow at the next crest. Clearly, it is not necessary to raise the dam any higher than the height of the peak of the crests. It is only necessary to raise the dam in case the waves should become higher.

In this analogy the waves represent the signal voltage and the height of the dam the accumulated charge on the grid. The fact that the electrical charge on the grid increases automatically and the water dam has to be raised does not vitiate the analogy.

It is true, however, that if a sudden surge of voltage, the peak of which is higher than the bias necessary to stop the plate current, should be impressed on the grid, then the grid would be completely blocked. This may be tested very easily with a battery. When the signal voltage is weak and the grid blocks some other explanation must be found for the blocking.

Since the explanation for the action of the grid condenser-leak detector depends on the absurd condition that the grid goes negative and positive simultaneously, the explanation must necessarily be absurd. It is not enough to call it fallacious.

A simpler explanation can be given in terms of an analogy. The grid condenser can be likened to a vessel into which air may be forced with a pump. The grid leak can be likened to a very tiny hole in this vessel through which air may escape at a very slow rate. The air pressure in the vessel would then be the electric pressure on the condenser, or the potential, which determines not only the flow of current through the leak but also in the plate circuit. The signal voltage will find its counterpart in an air pump forcing air into the vessel. The pump may work regularly with equal strokes, which would compare with an unmodulated voltage, or it may work with unequal strokes, the lengths of the strokes going through regular variations. This compares with a modulated radio wave.

What will happen to the air pressure as the pump works with periodic strokes of irregular lengths. It will increase to a value depending on the amount of leakage through the hole and the force back of the pump. At a certain time as much will leak out as is forced in. For each stroke the current through the hole will increase, but only a little, because the increased pressure due to the stroke will be small compared with the steady pressure inside. This small variation in the air draught through the hole corresponds with the radio frequency component of the current through the grid leak.

Wide Fluctuations

The regular fluctuations in the length of the strokes will result in a pressure variation, and hence a variation in the current through the hole, which will have a much greater amplitude. This slow-period fluctuation corresponds with the audio frequency variations in the potential of the grid, or the audio frequency variations in the current through the grid leak. The grid condenser, like the air vessel, acts like a storage tank which levels out the amplitude of the small input variations and brings out the long-period variations in the amplitude of the signal, or the length of the strokes.

In the electrical case there is no appreciable inductance to help smooth out the rapid variations. Neither is there any appreciable mass in the hydraulic case. There is a slight inductance in the wiring, and there is also a little mass in the air. Hence the two cases are closely analogous. Anyone who can visualize the rate of flow of air through the little hole in the tank as it varies with the rate of pumping in air can visualize the rate of flow of electric current through the grid leak when a modulated signal is impressed on the grid.

But how is the plate current of the tube affected by the rate of flow of current through the grid leak? There is no counterpart to the plate current in the hydraulic case. Well, the plate current is determined by the voltage on the grid (the pressure in the tank) and the current through the leak is directly proportional to the voltage. In fact, the current times the resistance of the leak is numerically equal to the voltage. Hence the plate current may be said to depend directly on the current through the grid leak. It is simply a magnified copy of it.

It is admitted that the usual simple explanation of grid condenser-leak detection amounts to the same thing as that one just given. The only difference is that the untenable idea that the charge on the grid accumulates until the plate current is cut off has been rejected, not in its entirety but to the extent of about 99 per cent. The periodic charges which have been likened to the strokes of an air pump are just the groups of electrons from the cathode to the grid which are used in the other explanation.

When there is no leakage from the grid to the filament in the external circuit the electrons that are trapped will make the grid negative to the extent of the peak signal voltage. If the carrier is unmodulated this is equal to the amplitude of the carrier wave as impressed on the grid circuit. If the grid is modulated, it is the greatest amplitude of the wave. It is clear that if the wave is greatly modulated, say for a low frequency, the grid may be charged so highly negative that the tube will be dead to all other signals. In effect it would be as if the plate current had been shut off by an excessive negative charge, but a steady plate current flows just the same. The trouble is that it is perfectly steady. This cannot happen when there is a grid leak.

Turns Off Primaries

Simply Reduce Amplification to Give Deceptive "Gain"

By Herman

Managing

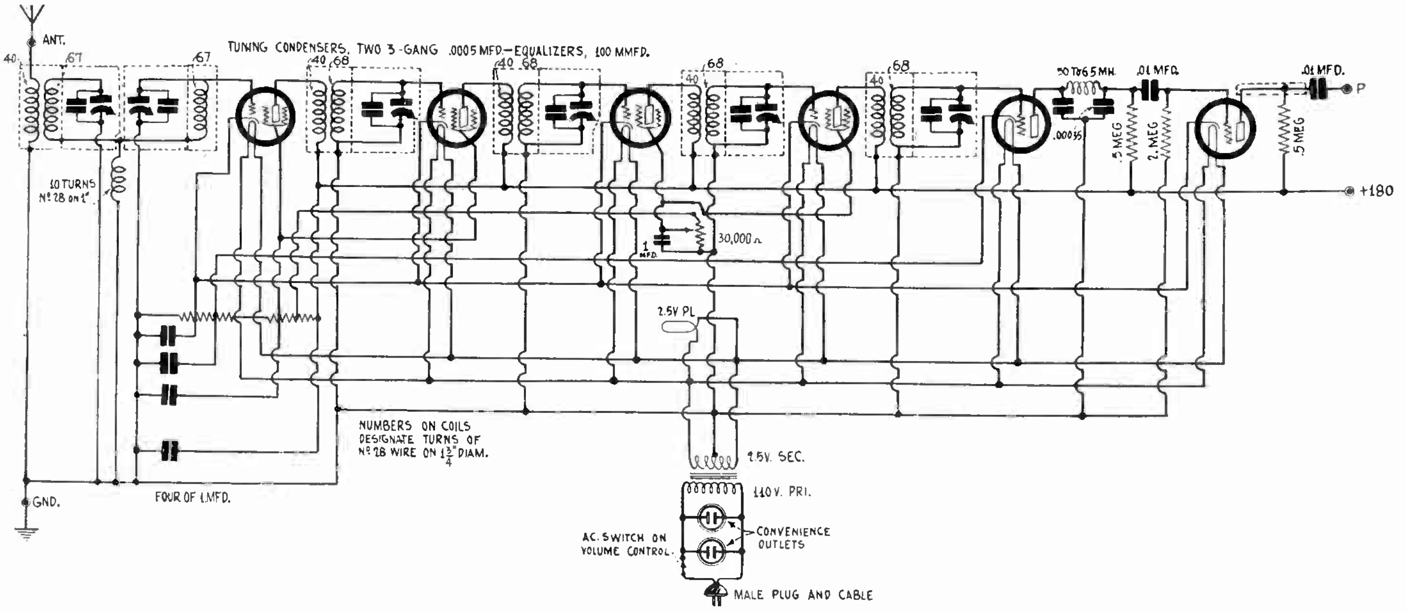


FIG. 1
REVISED DIAGRAM OF THE SIX-CIRCUIT TUNER, WITH COIL CONSTANTS GIVEN.

[*In the March 29th issue was shown a theoretical circuit, using six tuned circuits, comprising a band pass filter, four stages of TRF and a power detector, for AC operation as a tuner in conjunction with a power amplifier. It was promised this would be built, and a report rendered. This report, published last week, issue of April 5th, hailed the extreme sensitivity of the circuit, but found fault with the selectivity and some of the tentative mechanical arrangement. Some critical voltage aspects were found, also. The experiment was proposed of reducing the number of primary turns on some of the coils to cure the selectivity trouble, and the critical voltage aspect was to be relieved in the same way. The following article deals with the results of the application of these and other suggested remedies.*—EDITOR.]

HAVING started with a tuner that was pretty good, in that the sensitivity was very high, but the selectivity fell short of what one would expect from six tuned circuits, we applied some theoretical remedies. In the beginning there were forty turns on the primaries of all six coils used. Well, we reduced the number of turns to twenty in the instances of the first three RF transformers. It is indeed true that the apparent selectivity was increased thereby. But what happened to that exceedingly high sensitivity that had been developed? Obsequies are in order.

If any one were to suggest that the set builder be invited to follow the design as it now stands, he would be rash indeed, for the immediate reaction from constructors would be that about the same results could be obtained from a stage of tuned RF and a regenerative detector. And that criticism would be correct.

No Mere Compromise

It is obvious, therefore, that with multiple stages of tuned radio frequency amplification that enormous sensitivity can be attained. There is nothing left to do but to retain that sensitivity and insure selectivity by other means, for if it is not for sensitivity, then for what are all those tubes used? For selectivity? No. Adequate selectivity could be developed with three or four tuned circuits, so six ought to provide abundantly more.

At the present writing six are affording very little more, but with disappointingly low sensitivity. Radio science challenges us to solve the problem adequately. No mere compromise, that gives three-circuit selectivity from a six-circuit assembly, will do. We want all the sensitivity that's to be had, down to just above the noise level, and selectivity enough to give us 10 kc separation between two frequencies of equal power at the antenna, say, 50,000 microvolts per meter apiece.

As was suggested in a previous instalment, besides reducing the number of primary turns, to improve the apparent selectivity (although not the actual selectivity), other remedies, and ones that affect the actual selectivity, include the use of shielded wire for the antenna lead from the post of the tuner to the coil, shielded wire for the plate, and grid leads and also for any long leads. It so happens there is only one long lead, and it carries audio frequency, since the design has been changed from the first presentation, March 29th, to include a stage of audio, as shown last week, April 5th. The lead being long, we are resolved to use shielded wire, whether the frequencies be audio or radio.

How Condensers Pick Up

Another remedy suggested was to use a cover over the bottom of the subpanel. Thus all the wiring would be shielded as a unit, because the subpanel is metal, and the bottom cover is metal, and between the two they bottle up the works of the tuner and force any pickup to be exclusively of antenna origin, with one exception, the tuning condensers.

No suggestion has been made until now that the tuning condensers be shielded. But when one considers (after experimental stimulus) that there are two three-gang condensers, and that each condenser has, say 23 plates, and there are thus 138 plates, only half of which are at ground potential, we can rest assured that we have a pretty good capacity antenna right in the tuning capacities, no matter what other precautions may be taken to insure no pickup save from the intended aerial itself.

The cover has not been put on the bottom of the receiver yet, as there was some delay on the part of the machine shop in getting it ready. Moreover, the tuner, as it stands now, must be torn down and rebuilt, because we want to introduce all intended changes, except primary turns reduction, and then we will be ready for a more optimistic report, let's hope.

Must Be No Stray Pickup

In last week's issue the statement was made that a receiver that picks up distant stations without antenna attached as this did, up to 1,000 miles, needs some remedial attention. Some may ask whether this is really so, since all that a receiver is intended to do is to pick up stations, and if it does that well without an intended antenna, why decide arbitrarily that such antenna is needed?

There is no point whatsoever to the question, as put, and no argument that represents good engineering practice or highest possible results, since the object of using tuned circuits is to obtain the full benefit of tuning, and stray pickup tends to spoil the advantage of tuning. The selectivity is not as high as it would be were the antenna actually used, and the remedies applied that would make such use practical.

Only a very sensitive receiver is affected by stray pick-up. The amplification is high, hence any small pickup ahead of the detector becomes large enough to produce a substantial result on the detector. Whatever stray pickup takes place in the

Condenser Characteristics

Determined by Zero Beat Oscillator Test

By Benson Burroughs

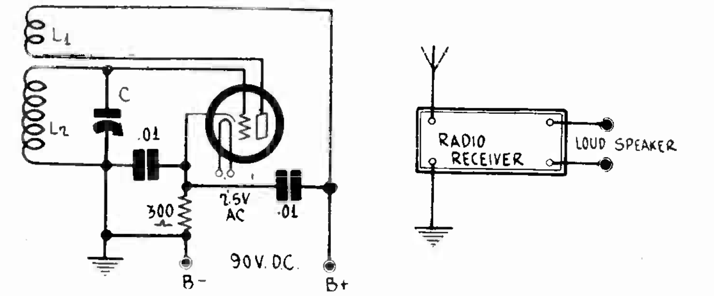


FIG. 1
AN ARRANGEMENT OF AN OSCILLATOR AND A BROADCAST RECEIVER FOR TAKING THE RATE OF CHANGE OF CAPACITY OF A CONDENSER, USING THE ZERO BEAT METHOD.

SOMETIMES an occasion arises for taking the tuning characteristic of a variable condenser, that is, for determining its rate of capacity change with degrees of rotation of the shaft. For example, is the condenser of the straight line frequency, the straight line wavelength, the straight line capacity, or some other type? In laboratories it is customary to determine the characteristic by comparing the condenser with a calibrated standard condenser, but few experimenters have access to standard condensers and therefore they need some other method which does not require any special equipment.

There is a very simple method which requires nothing more than an ordinary broadcast receiver and an oscillator such as is used in Superheterodynes in which the condenser under test is used for controlling the frequency of oscillation. This oscillator and the broadcast receiver are placed close together but are not directly connected, except that both are grounded. The rotor plates of the condenser under test are connected to ground in order to stabilize the frequency of oscillation.

The circuit diagram of a suitable oscillator is shown in Fig. 1 to the left of the receiver. In this oscillator C is the condenser under test and L1L2 is an oscillation coil, the secondary L2 of which is adjusted so that the frequency range of the oscillator is the same as the range of the receiver. The number of turns, of course, depends on the capacity of the condenser and on the size of the coil form. If the condenser is designed for tuning a broadcast receiver the coil might be a three-circuit tuner designed for the particular capacity of the condenser used, the smallest winding of the coil being left open.

Principle of Test

The object of the broadcast receiver is to tune in stations of known frequencies, or wavelengths, and the object of the oscillator is to produce a frequency which may be adjusted to equality with the known frequency, using the zero beat method. When the frequency of the oscillator is the same as that of the station tuned in, the signals disappear from the loudspeaker, the oscillator tuned circuit acting as a wave trap. The exact setting of the oscillator dial is sharply indicated by the zero beat.

Before a run is made on the condenser a number of broadcast stations covering the entire tuning range should be selected spaced as nearly as practical at equal intervals and the exact frequency of each station should be obtained from a list. These frequencies should be entered in a table. This done, the run on the condenser may be started.

First set the broadcast receiver on the lowest broadcast frequency selected, for example, 550 kc. Turn the oscillator condenser until the zero beat position is found accurately. This is characterized not only by the characteristic squeal on the approach to the point from either direction, but also, as was stated, by the disappearance of the signal or a marked diminution in its strength. Read the oscillator carefully when set at zero beat with the first frequency and enter the reading in the table opposite the frequency previously entered.

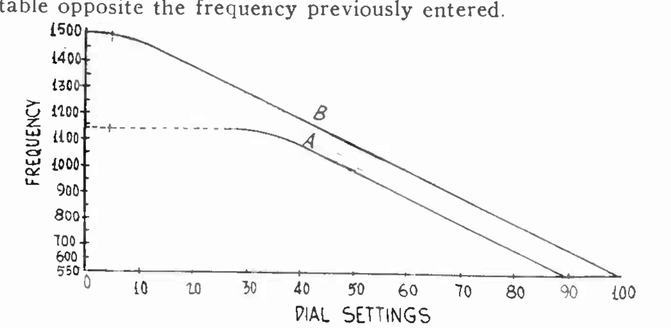


FIG. 2
TWO CURVES SHOWING THE TUNING CHARACTERISTIC OF A STRAIGHT LINE FREQUENCY CONDENSER, OBTAINED BY THE ZERO BEAT METHOD. THE LOWER CURVE INDICATES TOO MUCH INDUCTANCE IN THE COIL.

Now turn the receiver to the next station selected and repeat the operation on the oscillator condenser and again enter the zero beat position in the table opposite the second frequency. Continue this process until all the selected stations have been covered and a zero beat position found for each.

Many Squeal Points

In turning the oscillator dial from minimum to maximum, or vice versa, it will be found that there are many zero beat positions for every broadcast frequency. Some of these will be very weak and others will be strong. Usually, however, there is only one at which the signal disappears. That is the setting for which the fundamental frequency of the oscillator is equal to the fundamental of the broadcast carrier. The other squeals heard may be due to beating between harmonics of the two frequencies intentionally involved, or between the fundamental of the oscillator with broadcast carriers not tuned in with the receiver. All these weak squeals should be disregarded.

It should be remembered that the squealing produced will cause a certain amount of interference with other receivers close to the experimental hook-up. Because of this it is well to do the work when this will be a minimum, for example, early in the morning or late at night. It should not be supposed, however, that the intensity of the squeals heard in the test receiver is indicative of the intensity of the interference in receivers nearby. The oscillator causing the squeals will be not over twelve inches from the test receiver while it may be 100 feet from the nearest receiver used for entertainment at the time. The squeals may be intensely loud in the test receiver yet not be audible in another receiver located in apartment one flight higher or lower. This point was tested experimentally.

Sample Characteristic

Two sample curves obtained by this method are shown in Fig. 2. Curve A was obtained first on a straight line frequency condenser. At the right this curve follows nearly a straight line but bends downward toward the left. No squeals could be obtained below about 28 on the dial. To the left of this point of the curve continues as a broken line. The failure was due to the high zero setting capacity in the circuit, which greatly limited the tuning range of the circuit.

Curve B was obtained on the same circuit after the turns on the coil L2 had been reduced until the 550 kc carrier came in at approximately 98 on the 100 division dial. This change not only reduced the zero setting capacity somewhat but it also reduced the inductance so that oscillation, as indicated by the squeals, could be obtained all the way up to 1,500 kilocycles. The influence of the zero setting capacity is clearly discernible as the curve approaches the 1,500 kc carrier, but the bending over is not great.

The curves in Fig. 2 are idealized. The actual observation points did not fall exactly on the curve drawn, some falling below, others above, but no point deviated more than one division. These inaccuracies, which must be expected, are due to errors in setting for zero beat, slight lost motion of the condenser, deviations of the carrier frequencies from the nominal frequencies, and to other causes.

If it is suspected that the condenser under test is of the straight line wavelength type, wavelengths should be used instead of frequencies. The curves obtained in this case should be straight, if the condenser is correctly designed, but they will run in the opposite direction, using the same dial. That is, they should start in the lower left corner of the graph and run upward toward the right. Fig. 3A shows the type of curve obtained with a straight line wavelength condenser.

If the condenser is of the straight line capacity type the curve obtained when wavelengths are plotted against dial settings is about as shown in Fig. 3B. This curve, too, will be straight if the wavelengths squared is plotted against dial settings.

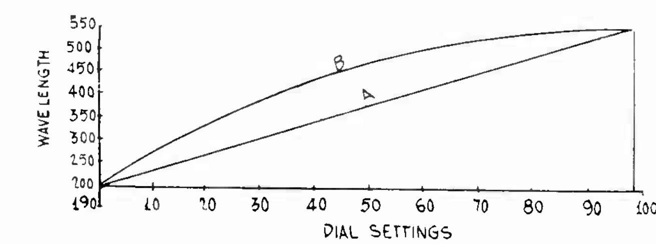


FIG. 3
TWO CURVES FOR A STRAIGHT LINE WAVELENGTH (A) AND A STRAIGHT LINE CAPACITY (B) CONDENSER, TAKEN WITH THE ZERO BEAT METHOD.

Type of Dial

It is assumed that the dial, whether it is on a drum or on a disc, is divided into 100 equal divisions. It is also possible to use a dial which is divided into 180 equal divisions. The equality of the divisions is essential. Since the zero beat position may be found very accurately it is preferable to use a dial which is provided with a real vernier so that it may be read to one-tenth of the smallest division. If it is not provided with a real vernier, the readings should be estimated to the nearest tenth of a division. Since the zero beat settings are quite critical it is also desirable that the dial be provided with a slow motion device, popularly called "vernier" in connection with radio tuners.

It is important that the voltage sources on the oscillator remain constant during a run on the condenser because changes in the voltages will change the frequency even if there is no change in the condenser or the inductance coil. It is also important that the oscillator remain in a fixed position during an experiment and that nothing close to it be moved around while the test is in progress. This applies to the hand that turns the dial, which should be held in the same relative position at every adjustment. If the oscillator were surrounded by a ground metal shield there would be no appreciable change in the frequency when external objects are moved, but in this case it would be necessary to introduce some coupling arrangement between the oscillator and the receiver. This complication is not necessary if the few simple precautions are observed.

An oscillating coil suitable for a .0005 mfd. condenser can be made by winding 60 turns of No. 24 enameled wire on a 2-inch diameter. This is the secondary winding. The tickler winding may consist of 40 turns of the same wire and on the same diameter. If the condenser has a capacity of .00035 mfd. the number of turns should be 78, the size of coil and kind of wire being the same as before. The tickler in this case might be 52 turns.

ELEVEN SEEK NEW STATIONS

Washington.

The following new station applications were received by the Federal Radio Commission on new stations:

Floyd G. Carr, Lancaster, New Hampshire, construction permit to erect a new station using 100 watts, at 1,000 kilocycles. Unlimited time.

J. Milton Guyton, Swan Hotel, Uniontown, Pa.—construction permit to erect a new station using 250 watts at 1190 kilocycles, and unlimited time.

V. F. Hutchens, of Huntsville, Alabama,—construction permit to erect a new station using 250 watts, at 1190 kilocycles, and unlimited time.

Frank P. Wernali, Hazen, North Dakota—construction permit to erect a new station using 5 watts on 1100 kilocycles, one night a week.

Sewell B. Jackson, Memphis, Tenn. C P to build new station using 50 watts on 1210 kc on unlimited time.

D. V. Piggott, doing business as Broach Sales Co., Susanville, California, C. P. To erect new station on 1420 kc 100 watts, unlimited time.

Kay Kawachi, Los Angeles, California, CP. To erect new station on 1450 kc, 50 watts. Unlimited time.

Porter Hardy Jr., Salisbury, Ind. C. P. to erect new station on 1220 kc—250 watts. Unlimited time.

Pierce E. Lackey and Fred W. Olcott, doing business as Paducah Broadcasting Co., Paducah, Kentucky—CP to erect new station on 1370 kc, 250 watts day and 100 watts night unlimited time.

Huntington Broadcast Company Inc., Huntington, Ind—C. P. to erect new station on 1240 kc—500 watts for four hours daytime, and two hours night.

F. L. Elliott, M. S. Finley, E. L. Edwards doing business as Hoosier Broadcasting Co., Indianapolis, Indiana, C.P. to erect new station on 920 kc, 500 watts. Unlimited time.

Frequency and power changes include:

WSIX—Springfield Tenn.—C. P. to use day power of 200 or 500 watts. (now using 100 watts).

WWAE—Hammond, Ind.—C. P. to install new equipment with automatic frequency control, and change frequency from 1200 to 920 kc and increase power from 100 watts to 5 kw. Also change hours from dividing time with WRAF to unlimited.

KGAR—Tucson, Ariz. License to cover C. P. to move studio and transmitter locally, and install new equipment with automatic frequency control, also change power from 100 to 250 watts day and 100 watts night on 1370 kc.

KGER—Yuma, Colo. License to cover C. P. for 50 watts on 1200 kc. Divides time with KGEW.

KXA—Seattle, Washington. Installation of automatic frequency control.

BOOK REVIEW

RADIO TROUBLE-SHOOTING, second edition, by Enno R. Haan, E.E., Associate Editor of Popular Mechanics Magazine, published by The Goodheart-Wilcox Co., Inc., Chicago. ($3.00).

Those who are contemplating going into radio servicing as a profession should procure this splendid volume, for it contains a wealth of servicing information from the tools required and how to use them to the theory on which radio receivers and accessories work. The book not only tells how to repair radio receivers but it shows how by drawings and half-tones. It is the kind of book that answers all questions that arise in the course of service work, and that answers them in a practical and explicit manner. It is surprising how many practical suggestions have been crowded into a single volume of 361 pages.

The book is bound in flexible imitation leather and is 6x9 inches. It is well indexed so that anyone looking for information on radio servicing can find it in a moment.

WORTH THINKING OVER

ONE solid hour of the oratorio, "Elijah," over the air, and, according to reports from Station WJZ, the listeners-in liked it. Who shall say now that jazz has the American public by the ear and that we are a nation of loose thoughts and looser musical tastes?

The Spelling Bee

WJZ carried a spelling bee the other night that proved highly interesting. Members of the Senate and the House, and representatives of the press, under the auspices of the National Press Club competed. Heavy casualties took place early, so Ray T. Tucker, Washington correspondent for the New York "Telegram," and Representative Luce, of Massachusetts, were left to fight it out for first honors.

It looked for a while as if Mr. Tucker was tripped up on the word referable, which he spelt r-e-f-e-r-r-i-b-l-e. Senator Fess, of Ohio, a former schoolmaster, who played the roll of schoolmaster in the contest, reading the words for his "pupils" to spell, rang the bell on the quaint spelling, indicating failure. But Mr. Tucker protested that there were two ways of spelling the word, and that he was familiar with both ways, and at liberty to choose either. The question, being referrible was referred to Representative Luce, and he acquiesced politely, although it is not certain he was really convinced. Yet Mr. Tucker was right. The spelling he gave is strictly correct, and is not even in the dubious realm of the archaic, being simply the second choice way of spelling the word. Mr. Tucker's way is classed as a variant.

Finally Representative Luce was stumped by the spelling of the word kimono. He used the letters k-i-m-o-n-a. Perhaps the defeat was not entirely his fault, for the former schoolmaster pronounced the word kimonah. This is utterly incorrect, although a popular error, and perhaps for psychological if not for spellological reasons, Representative Luce was trapped into the error, with no intended injustice flowing from Senator Fess, but with an unhappy twist at best.

The Senator did some excellent mispronouncing in the course of the broadcast, although some of it was sectionalism creeping into a national event, for the pronunciations sometimes fell into the category of local sanction.

One of the rules of the contest was that the "pupil" was not to be permitted to spell a word any differently than the way in which he started to spell it, although he might repeat the letters already uttered, came the word "stalactite." The Representative spelt this without the "a" after the first "t," and when asked to repeat the spelling, repeated the error. But it was thought by Senator Fess that the omission was a slip of the tongue, and Mr. Tucker, consulted, courteously agreed and the inviolate rule really didn't prove so at all inviolate. The Representative should have been counted out then, so after all, if he tripped up on Senator Fess's suggested "kimonah" there wasn't any injustice involved in the final result. Mr. Tucker won twice, once clearly, once by unwitting outside help, and two victories ought to be enough to win any one prize any night.

Is 10 KC Selectivit Badly Hurt Sensitivity

Ratio of Signal Strengths at Rec in Separation, So New Tack is Taken in Six-Circuit Tuner

By Knollys Bernard
Editor

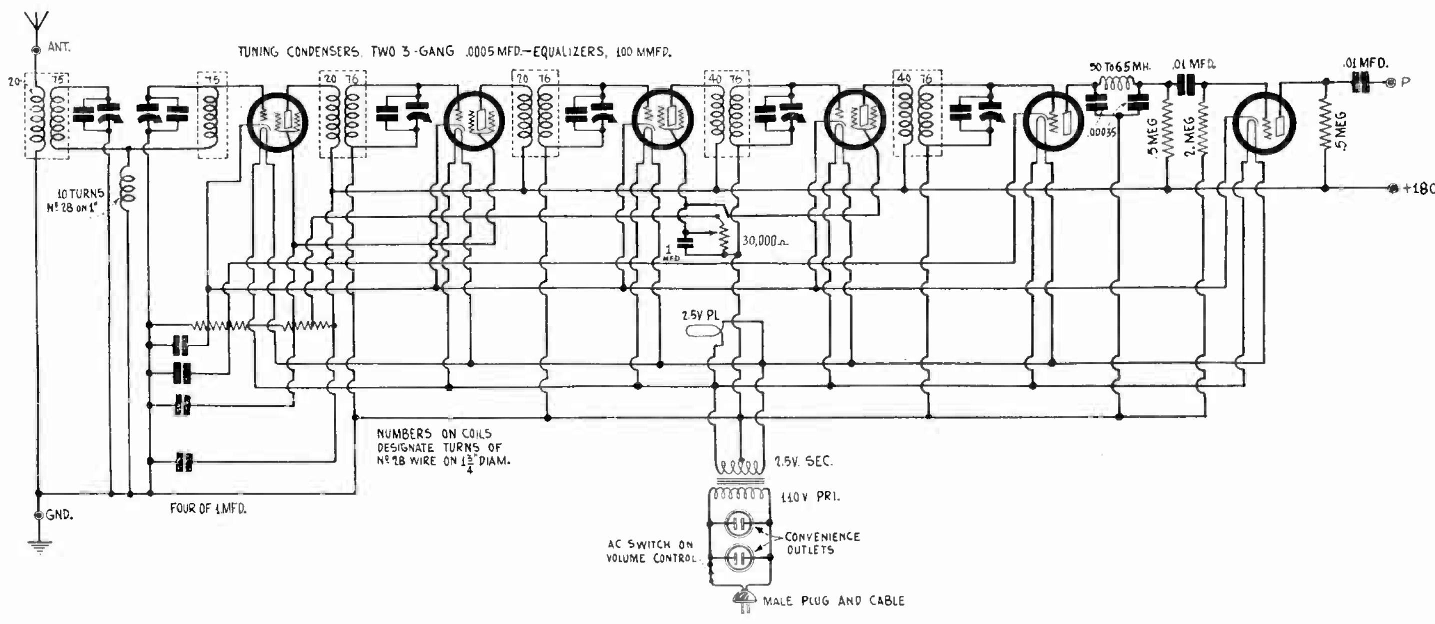


FIG. 1

THIS MULTI-TUBE AND MULTI-TUNER RECEIVER IS CAPABLE OF A HIGH DEGREE OF SELECTIVITY, BUT IT CANNOT BE SAID THAT IT HAS 10-KC SELECTIVITY SINCE THIS EXPRESSION HAS NO SIGNIFICANCE.

ONE hears a great deal about receivers having 10 kc selectivity. Any radio fan who is planning to build a receiver that is to be ne plus ultra always puts this as one of the first conditions that must be satisfied. The receiver must also be so sensitive that it will bring in any station this side of antipodes with loudspeaker volume at any time of the day and year. And withal it must be absolutely free from all kinds of distortion. It must rate 100 per cent in the three cardinal virtues selectivity, sensitivity, and quality.

One fan with undamped enthusiasm demanded a receiver which would tune out the signals from a high power broadcast station located within half a mile of his antenna and tune in the signals from the same station after they had gone once around the earth, less the half mile that separated the station and the receiver.

"My receiver must have absolute 10 kc selectivity," is the usual demand. "I am interested in the Decadyne receiver, but before buying it I want to know whether it really has 10 kc selectivity."

One does not have to tell a deliberate falsehood to say that the Decadyne has 10 kc selectivity. But neither can one say without reservation that it has. The difficulty in the matter is that the fan does not define what he means by 10 kc selectivity. Since there is no accepted definition of the expression it must necessarily be defined by the one who uses it.

Meaningless Expression

The expression "10 kc selectivity" is quite meaningless unless it is accompanied by clearly stated limitations. The expression itself suggests only that the tuning accuity of the receiver should be such that it should separate two stations operating on frequencies 10 kilocycles apart. It says nothing of the relative intensities of the signals of the two stations at the receiver antenna. And that omission makes the expression meaningless.

Suppose there is a station on the Pacific Coast and another on the Atlantic Coast operating with the same antenna power on frequencies 10 kc apart. Can a modern receiver located in Chicago or Omaha pick up either of these stations to the complete exclusion of the other? Quite likely it could. Then that receiver would have a 10 kc selectivity in the Middle West. But suppose the same receiver were set up in exactly the same way within a mile of either station. Could it then tune in the distant station to the complete exclusion of the local? Quite likely it could not. If it could tune in the distant station audibly at all the background noise from the local station would undoubtedly be stronger than the signals from the distant station. Hence that receiver would not have a 10 kc selectivity in the vicinity of either station.

Undoubtedly, if the receiver were really selective there would be a wide swath of country between the two transmitting stations in which either station could be tuned in with it to the practical exclusion of the other station, but there would also be large sections in the West and in the East where there would be plenty interference. Now, has that particular receiver a 10 kc selectivity? Remember that we considered an exceptionally good receiver in respect to selectivity and sensitivity.

Field Strength Important

The relative field strength about the receiving antenna of the two stations is just as important as the intrinsic selectivity of the receiver. The term "10 kc selectivity" does not have any meaning in the case, for it simply indicates a lack of the proper conception of tuned circuits on the part of the man who uses it without definite qualifications.

The relative field strength of two stations does not depend on the distance alone but also on the original power of the transmitting stations, and on degrees of absorption of the radio wave in the space intervening between the transmitter and the receiver. Suppose a selective receiver is located half way between two transmitting stations, one using 50,000 watts and the other 500 watts, and operating on frequencies 10 kc apart. Can the receiver pick up the smaller of the two stations to the exclusion of the high power station? If the distance is large it may be possible but if the distance is small it is quite probable that the signals from the high power station will override those of the smaller, even when the receiver is adjusted accurately to the weaker station.

Again, if the signals of the two equidistant stations have the same strength when transmitted and the intervening terrain in one case is poor for wave propagation and the other is good, the signals which must traverse the poor terrain will be weak compared with those of the other station, and it is quite likely that the receiver will not receive uniquely the signals coming over the poor terrain.

Good terrain for wave propagation are water, moist earth and level country. Poor terrain are sand, dry earth, hilly country, and ground covered by steel structures such as city sky-

detector input circuit, though without amplification, is also without tuning benefit of any preceding tuned circuit.

Good Test of Sensitive Circuit

So if there are two stages of RF, the detector's stray pickup and the second RF stage's pickup are both deprived of the tuning benefit of the first stage, as to this sum pickup, and the effect is cumulative. It is therefore a good test of a sensitive receiver, as to the expertness and care of its design, to test it for stray pickup. Disconnect the antenna and determine if stations can be brought in. It should be virtually impossible to hear any stations. The more you hear, and the louder they are, the greater the stray pickup and the greater the desirability of eliminating this defect. So many very sensitive receivers have no means of shielding the wiring against such pickup that the result is inevitable: stations come in without aerial or ground attached.

This is not to say receivers that are affected by stray pick-up are no good, but that they would be better if, at the same amplification, the nuisance could be cured. Much more DX could be picked up.

On this score it is well to inquire somewhat into what selectivity is. A definition is that selectivity is the ability of a tuner to respond to a given frequency at a time, bringing in that frequency to the exclusion of all other frequencies. The selectivity differences between receivers is shown by means of superimposed curves so that the greater sharpness of the peak discloses the greater selectivity.

It must be obvious that the selectivity of a tuner is an inherent characteristic of the tuner. Practically, it is the relatively low level of resistance of the tuned circuit to a resonant frequency.

When Selectivity Seems to Be Improved

Suppose we put a series condenser in the antenna lead, say, .00025 mfd. This remedy is often suggested for "improving the selectivity." But the condenser remedy does not accomplish this. It simply reduces the coupling between antenna and the receiver. The volume is lower on all stations, because the coupling is looser. The selectivity seems to be greater, but the receiver itself, which alone creates its own selectivity, hasn't been changed, so you can rest assured the actual selectivity hasn't been increased, either.

Now, the same holds true as to reduction of the number of primary turns. It seems that the tuner becomes more selective, because a station is blotted out three divisions of the dial off resonance that formerly came in over ten divisions. But notice the difference in volume.

The station still comes in over ten divisions, only you do not hear it as plainly, or may not hear it at all, due to the constitution of the ear as a non-delicate instrument. But accurate meters measure the voltage ten divisions off resonance. Hence, while the remedy of looser coupling, one way or another, may have some practical value, by causing the operating indications of the receiver to be as desired, this gain is at the expense of volume by reduced coupling or sacrifice of amplification, and while we want selectivity, we don't want it at this price.

Our experiment has merely verified the fact that while apparent selectivity, as observed visually on a dial by the number of divisions off resonance that tunes a station out of the sensitivity level of the ear, has some practical advantages, it is not that kind of a makeshift that will satisfy the discriminating and radio-wise experimenter. He wants all the promised amplification, plus all the necessary selectivity. And he is going to get both.

High Plate Impedance Necessary

It must not be assumed that all required selectivity has never been achieved in a highly sensitive receiver. The only assumption justifiable just now, on the basis of experiments, is that the screen grid tubes must have their generous impedance in the plate circuits or they will not perform as well as general purpose tubes, and that extraordinary sensitivity makes triply necessary the severest precautions as to total shielding. So in the model that is now in the works the primaries will have their forty turns, the shield wire will be used as needed, as an extra precaution, the bottom piece will be put on the subpanel, and the tuning condensers will be shielded as well. Then, we feel confident, we will get somewhere If we do or if we don't, the story will be told in RADIO WORLD next week, issue of April 19th.

It must not be supposed that lack of selectivity is due only to pick-up by the various leads after the antenna coupler. Some of it must be ascribed to the lack of matching of the several tuned circuits. It is next to impossible to adjust two tuners on the same control and have them track nicely throughout the tuning range, let alone six of them. However, when good condensers are used, like those used in the present undertaking, it is possible to get them to track with sufficient accuracy to get a high degree of selectivity. To achieve this goal it is imperative that all the tuning coils be made alike, as well as to make certain that all the condensers and the coils are put in similar settings. The experimental work on the circuit now in progress will clear up this difficulty.

While at first it would seem to be three times as difficult to line up six tuned circuits to track satisfactorily as to line up two of them, this is not the case. A little deviation can be tolerated when there are six tuned circuits and as many amplifiers, because the gain will be enormous and the six tuners will average up so that the selectivity will be good, not as good, to be sure, as if each circuit were tuned independently, but it will be satisfactory. It is really a blessing that exact line-up cannot be achieved for if it could, the selectivity would be so enormous that the quality of the receiver would not be tolerable. The object of the experimentation is to get the highest possible sensitivity and selectivity consistent with excellent quality.

Precautions taken in getting all the coils and the condensers exactly alike, both in construction and in location, would be wasted if the shielding were not thoroughly done, permitting the wiring to act as miniature antennas. If the signal is not forced to go through the entire tuner, it is of no help to have a highly selective one. It would be like using a fine-mesh sieve to separate gravel from sand and then allowing large holes in the sieve, or shaking part of the unsifted material over the top of the sieve. A tuner is nothing but a fine-mesh sieve which sifts out one frequency to the exclusion of other frequencies.

Shield Experiment Made

Some experiments have been conducted with the shields that house the coils. The thickness of the walls has been reduced, and it was found that while the shielding remained as effective, for the purpose intended, the inductance of the coils due to energy absorption was reduced less, so that fewer secondary turns were necessary. The diagram this week therefore shows the new windings, left to right: 40-67, 0-67, 40-68, 40-68, 40-68, 40-68. These windings are for tubing 1¾ inches in diameter. The wire is No. 28 enamel. The primary is wound outside the secondary, and a piece of Empire cloth, 21/10,000 of an inch thick separates the two. The band pass filter coil has 10 turns of No. 28 wire on under diameter.

Even though the tuner design is far from completed, some thought is being given to the power amplifier. The design calls for a 250 output tube, preceded by a resistance-coupled stage of non-reactive audio, and that preceded by a direct-coupled impedance stage. The two preliminary tubes are 227s. The rectifier is a 281.

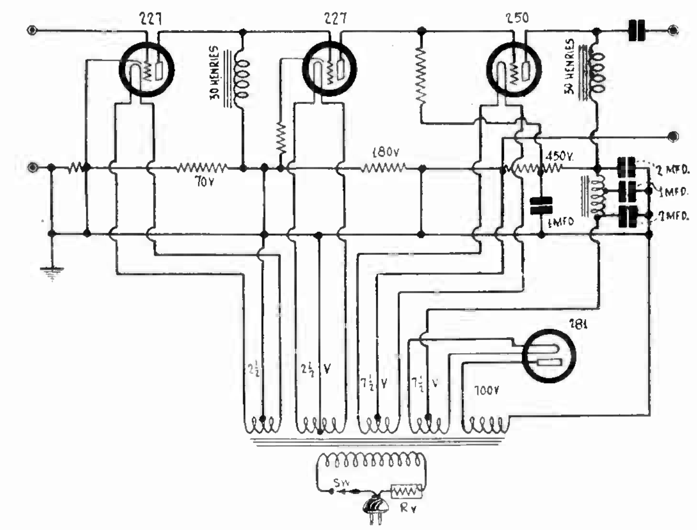


FIG. 2

DIRECT-COUPLED POWER AMPLIFIER, PARTLY NON-REACTIVE, PARTLY REACTIVE, UNDER CONSIDERATION FOR USE IN CONJUNCTION WITH THE SIX-CIRCUIT TUNER

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in Separation, So New Tack is Taken in Six-Circuit Tuner

Bernard

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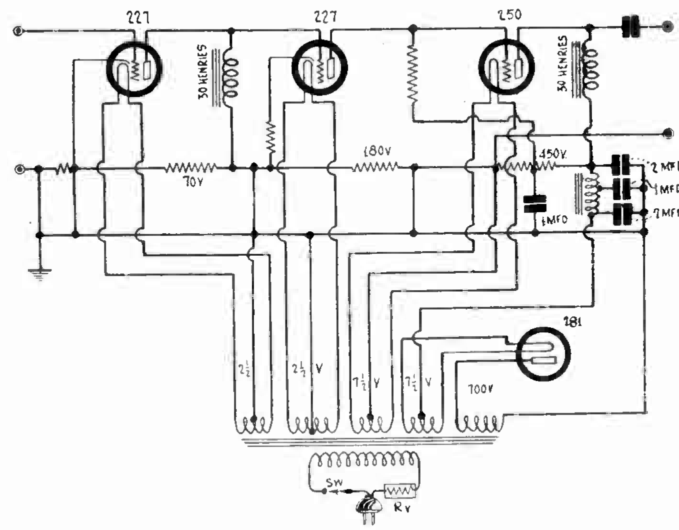

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Condenser C

Determined by Zero

By Benso

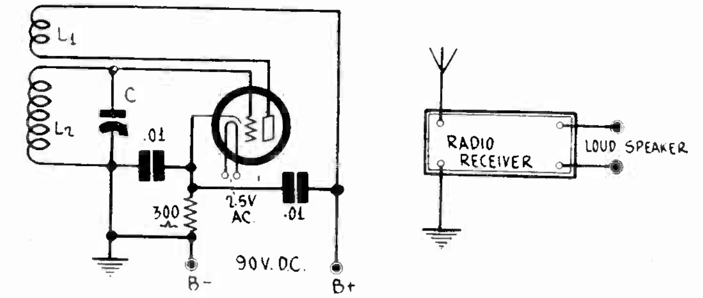

FIG. 1
AN ARRANGEMENT OF AN OSCILLATOR AND A BROADCAST RECEIVER FOR TAKING THE RATE OF CHANGE OF CAPACITY OF A CONDENSER, USING THE ZERO BEAT METHOD.

SOMETIMES an occasion arises for taking the tuning characteristic of a variable condenser, that is, for determining its rate of capacity change with degrees of rotation of the shaft. For example, is the condenser of the straight line frequency, the straight line wavelength, the straight line capacity, or some other type? In laboratories it is customary to determine the characteristic by comparing the condenser with a calibrated standard condenser, but few experimenters have access to standard condensers and therefore they need some other method which does not require any special equipment.

There is a very simple method which requires nothing more than an ordinary broadcast receiver and an oscillator such as is used in Superheterodynes in which the condenser under test is used for controlling the frequency of oscillation. This oscillator and the broadcast receiver are placed close together but are not directly connected, except that both are grounded. The rotor plates of the condenser under test are connected to ground in order to stabilize the frequency of oscillation.

The circuit diagram of a suitable oscillator is shown in Fig. 1 to the left of the receiver. In this oscillator C is the condenser under test and L1L2 is an oscillation coil, the secondary L2 of which is adjusted so that the frequency range of the oscillator is the same as the range of the receiver. The number of turns, of course, depends on the capacity of the condenser and on the size of the coil form. If the condenser is designed for tuning a broadcast receiver the coil might be a three-circuit tuner designed for the particular capacity of the condenser used, the smallest winding of the coil being left open.

Principle of Test

The object of the broadcast receiver is to tune in stations of known frequencies, or wavelengths, and the object of the oscillator is to produce a frequency which may be adjusted to equality with the known frequency, using the zero beat method. When the frequency of the oscillator is the same as that of the station tuned in, the signals disappear from the loudspeaker, the oscillator tuned circuit acting as a wave trap. The exact setting of the oscillator dial is sharply indicated by the zero beat.

Before a run is made on the condenser a number of broadcast stations covering the entire tuning range should be selected spaced as nearly as practical at equal intervals and the exact frequency of each station should be obtained from a list. These frequencies should be entered in a table. This done, the run on the condenser may be started.

First set the broadcast receiver on the lowest broadcast frequency selected, for example, 550 kc. Turn the oscillator condenser until the zero beat position is found accurately. This is characterized not only by the characteristic squeal on the approach to the point from either direction, but also, as was stated, by the disappearance of the signal or a marked diminution in its strength. Read the oscillator carefully when set at zero beat with the first frequency and enter the reading in the table opposite the frequency previously entered.

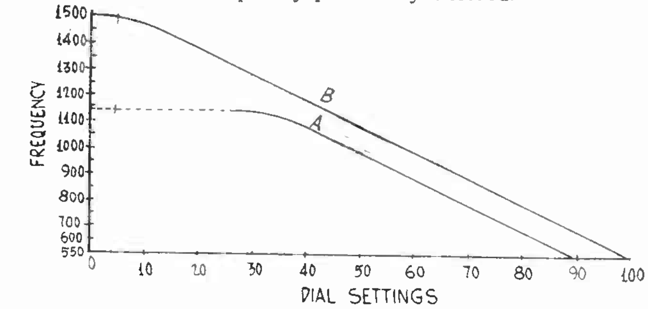

FIG. 2
TWO CURVES SHOWING THE TUNING CHARACTERISTIC OF A STRAIGHT LINE FREQUENCY CONDENSER, OBTAINED BY THE ZERO BEAT METHOD. THE LOWER CURVE INDICATES TOO MUCH INDUCTANCE IN THE COIL.

Now turn the receiver to the next station selected and repeat the operation on the oscillator condenser and again enter the zero beat position in the table opposite the second frequency. Continue this process until all the selected stations have been covered and a zero beat position found for each.

Many Squeal Points

In turning the oscillator dial from minimum to maximum, or vice versa, it will be found that there are many zero beat posi tions for every broadcast frequency. Some of these will be ver weak and others will be strong. Usually, however, there is only one at which the signal disappears. That is the setting for which the fundamental frequency of the oscillator is equal to the fundamental of the broadcast carrier. The other squeals heard may

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Washington.

The following new station applications were received by the Federal Radio Commission on new stations:

Floyd G. Carr, Lancaster, New Hampshire, construction permit to erect a new station using 100 watts, at 1,000 kilocycles. Unlimited time.

J. Milton Guyton, Swan Hotel, Uniontown, Pa.—construction permit to erect a new station using 250 watts at 1190 kilocycles, and unlimited **time.**

V. F. Hutchens, of Huntsville, Alabama. —construction permit to erect a new station using 250 watts, at 1190 kilocycles, and unlimited time.

Frank P. Wernali, Hazen, North Dakota—construction permit to erect a new station using 5 watts on 1100 kilocycles, one night a week.

Sewell B. Jackson, Memphis, Tenn. C P to build new station using 50 watts on 1210 kc on unlimited time.

D. V. Piggott, doing business as Broach Sales Co., Susanville, California, C. P. To erect new station on 1420 kc 100 watts, unlimited time.

Kay Kawachi, Los Angeles, California, CP. To erect new station on 1450 kc, 50 watts. Unlimited time.

Porter Hardy Jr., Salisbury, Ind. C. P. to erect new station on 1220 kc—250 watts. Unlimited titme.

Pierce E. Lackey and Fred W. Olcott, doing business as Paducah Broadcasting Co., Paducah, Kentucky—CP to erect new station on 1370 kc, 250 watts day and 100 watts night unlimited time.

Huntington Broadcast Company Inc.,

ELEVEN

NEW S

Huntington, Ind—C tion on 1240 kc—50 daytime, and two l

F. L. Elliott, M. wards doing busine casting Co., Indiana erect new station Unlimited time.

Frequency and p WSIX—Springfiel day power of 200 using 100 watts).

WWAE—Hammo stall new equipmen quency control, a from 1200 to 920 k from 100 watts to hours from dividin to unlimited.

KGAR—Tucson, C. P. to move st locally, and install automatic frequenc power from 100 to watts night on 137

KGER—Yuma, C C. P. for 50 watts time with KGEW.

WJZ carried a spelling bee the other night that proved highly interesting. Members of the Senate and the House, and representatives of the press, under the auspices of the National Press Club competed. Heavy casualties took place early, so Ray T. Tucker, Washington correspondent for the New York "Telegram," and Representative Luce, of Massachusetts, were left to fight it out for first honors.

It looked for a while as if Mr. Tucker was tripped up on the word referable, which he spelt r-e-f-e-r-r-i-b-l-e. Senator Fess, of Ohio, a former schoolmaster, who played the roll of schoolmaster in the contest, reading the words for his "pupils" to spell, rang the bell on the quaint spelling, indicating failure. But Mr. Tucker protested that there were two ways of spelling the word, and that he was familiar with both ways, and at liberty to choose either. The question, being referrible was referred to Representative Luce, and he acquiesced politely, although it is not cer-

The Spe

tain he was really Tucker was right. is strictly correct, a dubious realm of the the second choice word. Mr. Tucker's variant.

Finally Represen stumped by the sp kimono. He used the Perhaps the defeat w fault, for the former nounced the word ki terly incorrect, althou and perhaps for psych spellological reasons, R was trapped into the e tended injustice flowing Fess, but with an unhapp

The Senator did some pronouncing in the course cast, although some of it w

'haracteristics

Beat Oscillator Test

n Burroughs

be due to beating between harmonics of the two frequencies intentionally involved, or between the fundamental of the oscillator with broadcast carriers not tuned in with the receiver. All these weak squeals should be disregarded.

It should be remembered that the squealing produced will cause a certain amount of interference with other receivers close to the experimental hook-up. Because of this it is well to do the work when this will be a minimum, for example, early in the morning or late at night. It should not be supposed, however, that the intensity of the squeals heard in the test receiver is indicative of the intensity of the interference in receivers nearby. The oscillator causing the squeals will be not over twelve inches from the test receiver while it may be 100 feet from the nearest receiver used for entertainment at the time. The squeals may

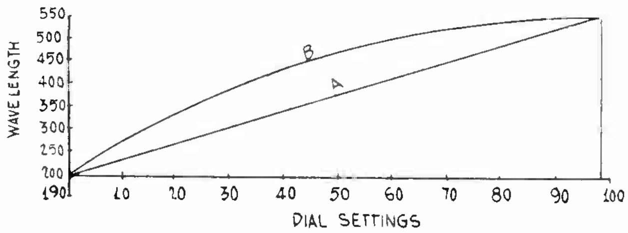

FIG. 3
TWO CURVES FOR A STRAIGHT LINE WAVELENGTH (A) AND A STRAIGHT LINE CAPACITY (B) CONDENSER, TAKEN WITH THE ZERO BEAT METHOD.

be intensely loud in the test receiver yet not be audible in another receiver located in apartment one flight higher or lower. This point was tested experimentally.

Sample Characteristic

Two sample curves obtained by this method are shown in Fig. 2. Curve A was obtained first on a straight line frequency condenser. At the right this curve follows nearly a straight line but bends downward toward the left. No squeals could be obtained below about 28 on the dial. To the left of this point of the curve continues as a broken line. The failure was due to the high zero setting capacity in the circuit, which greatly limited the tuning range of the circuit.

Curve B was obtained on the same circuit after the turns on the coil L2 had been reduced until the 550 kc carrier came in at approximately 98 on the 100 division dial. This change not only reduced the zero setting capacity somewhat but it also reduced the inductance so that oscillation, as indicated by the squeals, could be obtained all the way up to 1,500 kilocycles. The influence of the zero setting capacity is clearly discernible as the curve approaches the 1,500 kc carrier, but the bending over is not great.

The curves in Fig. 2 are idealized. The actual observation points did not fall exactly on the curve drawn, some falling below, others above, but no point deviated more than one division. These inaccuracies, which must be expected, are due to errors in setting for zero beat, slight lost motion of the condenser, deviations of the carrier frequencies from the nominal frequencies, and to other causes.

If it is suspected that the condenser under test is of the straight line wavelength type, wavelengths should be used instead of frequencies. The curves obtained in this case should be straight, if the condenser is correctly designed, but they will run in the opposite direction, using the same dial. That is, they should start in the lower left corner of the graph and run upward toward the right. Fig. 3A shows the type of curve obtained with a straight line wavelength condenser.

If the condenser is of the straight line capacity type the curve obtained when wavelengths are plotted against dial settings is about as shown in Fig. 3B. This curve, too, will be straight if the wavelengths squared is plotted against dial settings.

Type of Dial

It is assumed that the dial, whether it is on a drum or on a disc, is divided into 100 equal divisions. It is also possible to use a dial which is divided into 180 equal divisions. The equality of the divisions is essential. Since the zero beat position may be found very accurately it is preferable to use a dial which is provided with a real vernier so that it may be read to one-tenth of the smallest division. If it is not provided with a real vernier, the readings should be estimated to the nearest tenth of a division. Since the zero beat settings are quite critical it is also desirable that the dial be provided with a slow motion device, popularly called "vernier" in connection with radio tuners.

It is important that the voltage sources on the oscillator remain constant during a run on the condenser because changes in the voltages will change the frequency even if there is no change in the condenser or the inductance coil. It is also important that the oscillator remain in a fixed position during an experiment and that nothing close to it be moved around while the test is in progress. This applies to the hand that turns the dial, which should be held in the same relative position at every adjustment. If the oscillator were surrounded by a ground metal shield there would be no appreciable change in the frequency when external objects are moved, but in this case it would be necessary to introduce some coupling arrangement between the oscillator and the receiver. This complication is not necessary if the few simple precautions are observed.

An oscillating coil suitable for a .0005 mfd. condenser can be made by winding 60 turns of No. 24 enameled wire on a 2-inch diameter. This is the secondary winding. The tickler winding may consist of 40 turns of the same wire and on the same diameter. If the condenser has a capacity of .00035 mfd. the number of turns should be 78, the size of coil and kind of wire being the same as before. The tickler in this case might be 52 turns.

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KXA—Seattle, Washington. Installation of automatic frequency control.

BOOK REVIEW

RADIO TROUBLE-SHOOTING, second edition, by Enno R. Haan, E.E., Associate Editor of Popular Mechanics Magazine, published by The Goodheart-Wilcox Co., Inc., Chicago. ($3.00).

Those who are contemplating going into radio servicing as a profession should procure this splendid volume, for it contains a wealth of servicing information from the tools required and how to use them to the theory on which radio receivers and accessories work. The book not only tells how to repair radio receivers but it shows how by drawings and half-tones. It is the kind of book that answers all questions that arise in the course of service work, and that answers them in a practical and explicit manner. It is surprising how many practical suggestions have been crowded into a single volume of 361 pages.

The book is bound in flexible imitation leather and is 6x9 inches. It is well indexed so that anyone looking for information on radio servicing can find it in a moment.

WORTH THINKING OVER

ONE solid hour of the oratorio, "Elijah," over the air, and, according to reports from Station WJZ, the listeners-in liked it. Who shall say now that jazz has the American public by the ear and that we are a nation of loose thoughts and looser musical tastes?

lling Bee

convinced. Yet Mr.
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creeping into a national event, for the pronunciations sometimes fell into the category of local sanction.

One of the rules of the contest was that the "pupil" was not to be permitted to spell a word any differently than the way in which he started to spell it, although he might repeat the letters already uttered, came the word "stalactite." The Representative spelt this without the "a" after the first "t," and when asked to repeat the spelling, repeated the error. But it was thought by Senator Fess that the omission was a slip of the tongue, and Mr. Tucker, consulted, courteously agreed and the inviolate rule really didn't prove so at all inviolate. The Representative should have been counted out then, so after all, if he tripped up on Senator Fess's suggested "kimonah" there wasn't any injustice involved in the final result. Mr. Tucker won twice, once clearly, once by unwitting outside help, and two victories ought to be enough to win any one prize any night.

Is 10 KC Selectivit

Ratio of Signal Strengths at Rec

By Knollys

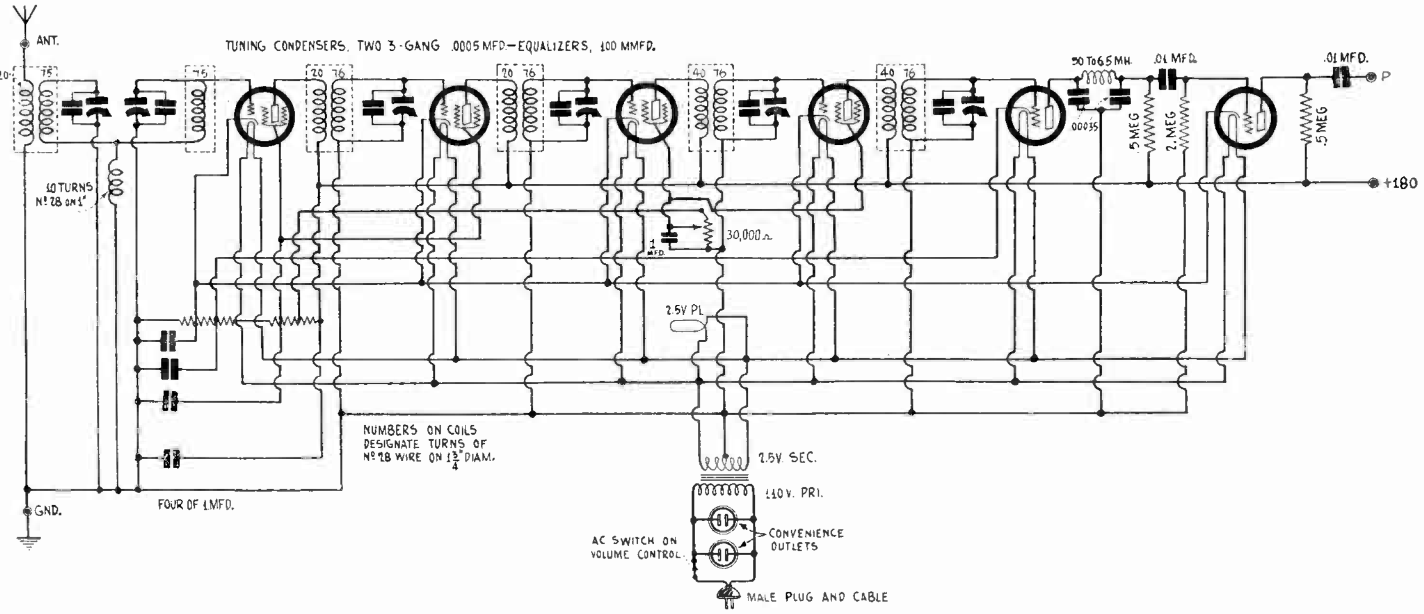

FIG. 1

THIS MULTI-TUBE AND MULTI-TUNER RECEIVER IS CAPABLE OF A HIGH DEGREE OF SELECTIVITY, BUT IT CANNOT BE SAID THAT IT HAS 10-KC SELECTIVITY SINCE THIS EXPRESSION HAS NO SIGNIFICANCE.

ONE hears a great deal about receivers having 10 kc selectivity. Any radio fan who is planning to build a receiver that is to be ne plus ultra always puts this as one of the first conditions that must be satisfied. The receiver must also be so sensitive that it will bring in any station this side of antipodes with loudspeaker volume at any time of the day and year. And withal it must be absolutely free from all kinds of distortion. It must rate 100 per cent in the three cardinal virtues selectivity, sensitivity, and quality.

One fan with undamped enthusiasm demanded a receiver which would tune out the signals from a high power broadcast station located within half a mile of his antenna and tune in the signals from the same station after they had gone once around the earth, less the half mile that separated the station and the receiver.

"My receiver must have absolute 10 kc selectivity," is the usual demand. "I am interested in the Decadyne receiver, but before buying it I want to know whether it really has 10 kc selectivity."

One does not have to tell a deliberate falsehood to say that the Decadyne has 10 kc selectivity. But neither can one say without reservation that it has. The difficulty in the matter is that the fan does not define what he means by 10 kc selectivity. Since there is no accepted definition of the expression it must necessarily be defined by the one who uses it.

Meaningless Expression

The expression "10 kc selectivity" is quite meaningless unless it is accompanied by clearly stated limitations. The expression itself suggests only that the tuning accuity of the receiver should be such that it should separate two stations operating on frequencies 10 kilocycles apart. It says nothing of the relative intensities of the signals of the two stations at the receiver antenna. And that omission makes the expression meaningless.

Suppose there is a station on the Pacific Coast and another on the Atlantic Coast operating with the same antenna power on frequencies 10 kc apart. Can a modern receiver located in Chicago or Omaha pick up either of these stations to the complete exclusion of the other? Quite likely it could. Then that receiver would have a 10 kc selectivity in the Middle West. But suppose the same receiver were set up in exactly the same way within a mile of either station. Could it then tune in the distant station to the complete exclusion of the local? Quite likely it could not. If it could tune in the distant station audibly at all the background noise from the local station would undoubtedly be stronger than the signals from the distant station. Hence that receiver would not have a 10 kc selectivity in the vicinity of either station.

Undoubtedly, if the receiver were really selective there would be a wide swath of country between the two transmitting stations in which either station could be tuned in with it to the practical exclusion of the other station, but there would also be large sections in the West and in the East where there would be plenty interference. Now, has that particular receiver a 10 kc selectivity? Remember that we considered an exceptionally good receiver in respect to selectivity and sensitivity.

Field Strength Important

The relative field strength about the receiving antenna of the two stations is just as important as the intrinsic selectivity of the receiver. The term "10 kc selectivity" does not have any meaning in the case, for it simply indicates a lack of the proper conception of tuned circuits on the part of the man who uses it without definite qualifications.

The relative field strength of two stations does not depend on the distance alone but also on the original power of the transmitting stations, and on degrees of absorption of the radio wave in the space intervening between the transmitter and the receiver. Suppose a selective receiver is located half way between two transmitting stations, one using 50,000 watts and the other 500 watts, and operating on frequencies 10 kc apart. Can the receiver pick up the smaller of the two stations to the exclusion of the high power station? If the distance is large it may be possible but if the distance is small it is quite probable that the signals from the high power station will override those of the smaller, even when the receiver is adjusted accurately to the weaker station.

Again, if the signals of the two equidistant stations have the same strength when transmitted and the intervening terrain in one case is poor for wave propagation and the other is good, the signals which must traverse the poor terrain will be weak compared with those of the other station, and it is quite likely that the receiver will not receive uniquely the signals coming over the poor terrain.

Good terrain for wave propagation are water, moist earth and level country. Poor terrain are sand, dry earth, hilly country, and ground covered by steel structures such as city sky-

y Fact or Fiction?

eiving Antenna Important Factor

Satterwhite

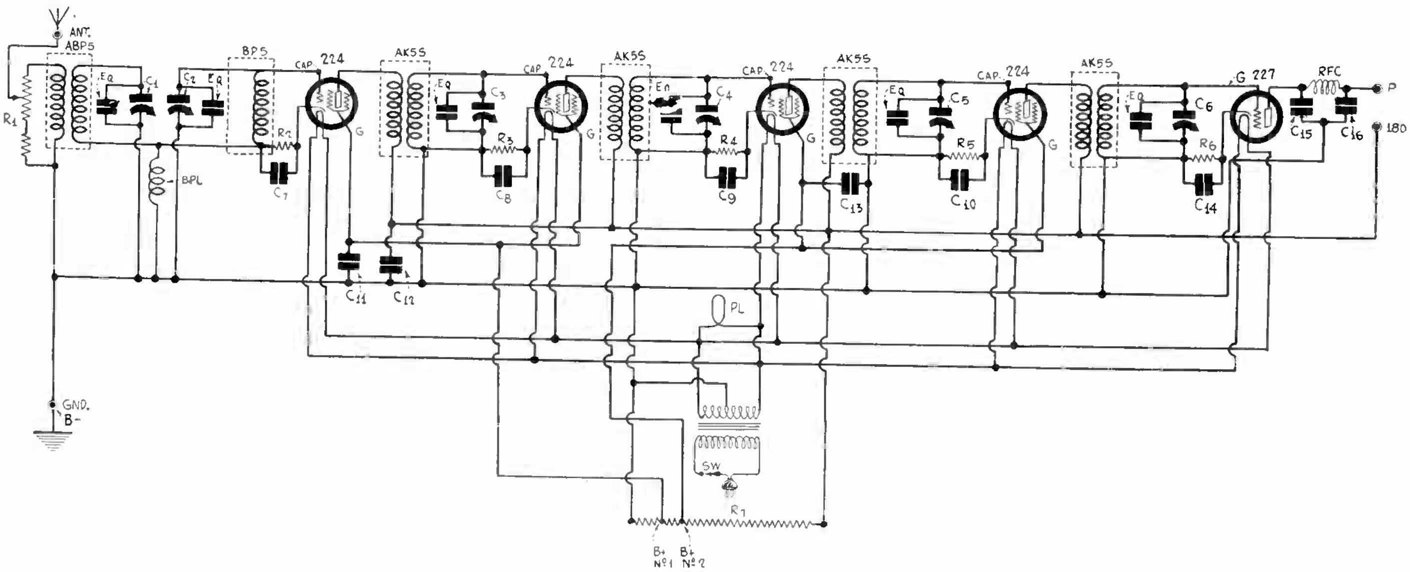

FIG. 2

THE CIRCUIT DIAGRAM OF ANOTHER HIGHLY SENSITIVE AND SELECTIVE RECEIVER WHICH HAS BEEN SAID, ERRONEOUSLY, TO HAVE 10-KC SELECTIVITY. A REAL RECEIVER CANNOT HAVE A FICTIONAL PROPERTY.

scrapers. It may happen that when two stations of unequal transmitted power are located at equal distances from a receiver the nature of the intervening terrain will equalize the two signal strengths, or it may even make the weaker station stronger at the receiver.

Relative Selectivity

The selectivity of receivers should be rated on the basis of relative field strengths at the antenna. For example, if the relative signal srength of two stations 10 kc apart is 100 to 1 will it tune in the weaker of the two stations to the complete exclusion of the stronger? If it does, it is fairly selective. But it is not selective enough for all reception conditions. The signal strength of one station, may for instance be 2 microvolts per meter and that of another 200,000 microvolts per meter, a ratio of 100,000 to 1. It requires an exceptionally selective receiver to tune in the weaker station to the complete exclusion of the stronger if they are separated by only 10 kc. Indeed, very few receivers can do it. Moreover, those that do are so selective that the quality of sound produced by them is scarcely worth listening to.

Those who must have receivers with ultra-selectivity must necessarily sacrifice some of the quality, at least while the set is adjusted to distant stations requiring the very high selectivity. To be sure, there is the possibility of using band pass filters for sharpening the selectivity without at the same time ruining the quality, but such filters have to be adjusted right or it is better to leave them out of the circuit.

The reason no definite meaning can be attached to "10 kc selectivity" is evident when it is recalled how the intensity of the received signal varies when the dial is turned. Suppose we start with the signal tuned in accurately and adjusted to maximum. Then when the dial is turned in either direction the intensity decreases, not suddenly but gradually. It is true that the rate of decrease is most rapid next to the exact tuning point, but it is gradual just the same. When the dial has been turned so far that the signals are inaudible they still persist. They would still be audible if the ear were a little more sensitive, or they could be made audible by adding more audio frequency amplification. This is true no matter how far from the exact tuning point the dial is set. There is no abrupt cut-off anywhere.

Powerful Signals Force In

The strongest signals force themselves in without any encouragement from the tuners, and they often reach the detector with sufficient intensity to produce audible signals in the loudspeaker. The weak signals require a great deal of nursing and encouragement from the tuner before they are built up to sufficient strength to produce an audible signal.

Suppose the ratio of the field strengths of two stations 10 kc apart is 100,000 to 1 and it is desired to receive the weaker of the two without interference from the other. If the selectivity of the receiver is such that when the dial is set 10 kc off resonance the signal is reduced in intensity to 1/100,000 of its maximum value, the two signals will come in with equal intensity when the tuner is set for the weaker station. This is an exceedingly high selectivity. Yet it must be higher, for it will not do to have two signals of equal intensity coming out of the loudspeaker simultaneously.

Just how much weaker should the interfering signal be in order that it may not be objectionable. Let us say that the desired signal should be 100 times stronger. In order to satisfy that requirement it is necessary that when the tuner is 10 kc off resonance the signal should be reduced in the ratio of 10,000,000 to 1, a ratio 100 times greater than the ratio of the field strengths of the two signals in question. There is no practical receiver having such high selectivity.

An Extreme Condition

Of course, it is not necessary that the ratio of the two sounds be 100 to one. This can be demonstrated readily from everyday experience. Suppose a person talks in a low voice one foot from the ear of another person. Ten feet away is a third person with the same hearing accuity as the second. Can he hear the voice of the first person? If he hears the voice does it interfere with the second person's hearing? The intensity of the sound from the first person is only 1/100 as strong ten feet away as at one foot. Common experience tells that there will be practically no interference. It makes no difference whether the voice comes from a human or a mechanical speaker. Just the same it is well to have as much suppression of the one as possible. A background of extraneous noise, whether it be signals from another station or static, does not enhance the enjoyment of the program tuned in.

The expression "10 kc selectivity" is never used in radio engineering circles because engineers know the meaninglessness of it. When engineers use the term selectivity they always employ it qualitatively, or they give a set of curves representing the selectivity of a given receiver. They recognize that only by a set of curves can a quantitative expression of this important property be given. A set of resonance curves, not a single such curve, is required, because the selectivity of any receiver varies with the frequency.

And do these curves show the so-called 10 kc selectivity? No, not if they are real experimental curves on a real receiver. Sometimes ideal curves are given which show that inside a 10 kc band every frequency comes through with equal strength and outside that band nothing gets through. But these curves represent nothing but an unattainable goal.

A THOUGHT FOR THE WEEK

IN former years we were told of the salaries paid grand opera singers and were supposed to grow excited and envious when the figures were mentioned. Then came the motion picture stars with salaries that made the stipend of a bank president look silly. Now we have Will Rogers with his contract calling for $72,000 for fourteen appearances before the mike. Next!

RADIO WORLD

The First and Only National Radio Weekly
Eighth Year

Owned and published by Hennessy Radio Publications Corporation, 145 West 45th Street, New York, N. Y. Roland Burke Hennessy, president and treasurer, 145 West 45th Street, New York, N. Y.; M. B. Hennessy, vice-president, 145 West 45th Street, New York, N. Y.; Herman Bernard, secretary, 145 West 45th Street, New York, N. Y.
Roland Burke Hennessy, editor; Herman Bernard, business manager and managing editor; J. E. Anderson, technical editor.

A Governor Gets Brave

WHETHER a legal right exists is plainly a legal question, and you would not expect any substantial person to assume it was a whimsical question, to be decided on the flip of a coin, the throw of a pair of dice or by the fury of a hot-tempered executive.

Nevertheless, the Governor of the State or Michigan, Fred W. Green, desiring to erect a 5,000-watt short-wave station at East Lansing, to aid the State police in crime prevention and the tracking down of suspects and criminals, has to decide whether he has the legal right to erect such a station. This decision he makes at first, in the right way, by applying to the Federal Radio Commission for a permit to erect the station, for that indeed indicates a realization that the Commission has something to do with the subject.

But a decision is not reached by the commission speedily enough to suit him, the final hearing being set for May 15th, so what does he say he will do but erect the station, permit or no permit. From sources close to the Commission comes the counter-comment that the radio law has a punitive clause, and that the Commission is ready to ask the Department of Justice to proceed fully under that clause. The people's remedy includes a fine of $5,000 and five years' imprisonment.

The Governor himself started the spectacle and perhaps the Federal Government will treat the country to the further spectacle of the Governor of a State accused of lawlessness.

It so happens that it is a Governor who is the center of the spotlight, and in his behalf a softer reaction may be expected to take place. When some ordinary person conducts a station without legal authority, the Federal Radio Commission and the Department of Justice combine to inform the press in careful statements that the "outlaw" station has been dismantled by the Federal Government, and offender indicted.

At this writing the Governor has done nothing more than issue a threat. If we know Governors who have rashly threatening habits, they have the politically easy faculty of backing down, and we expect Governor Green to back down.

Maybe the Federal Radio Commission can advance the date of the hearing, and grant the petition for a wavelength, if deserved, thus avoiding an ugly difficulty, but if this does not come to pass, and the Governor goes ahead with his attempt to erect a bootleg station in the name of the State of Michigan, it is hoped that the Federal Government will do as is intimated, proceed against him with the same just vigor that would characterize the prosecution of an obscure offender.

This business of defying the Federal Government—Congress that passed the law, the courts that affirmed it and the administrative offices that prosecute it—is particularly bad when conducted by a person of standing, for the higher he stands, the better he is supposed to be able to appreciate his responsibilities.

If Governor Green thinks that he can elevate himself from the sphere of local attention to a favorable national spotlight by making this "brave" stand, he may be right, but it would be better if he could gain national position by doing some legal act, some constructive work, rendering some public service, instead of uttering defiance of a Federal law. We shall see presently whether he has uttered "weasel words," as Roosevelt might have said, or whether he really means what he says.

It may be true that there is some feeling in and around Michigan corridors that the station is needed quickly by the State police, but the radio law is the law of all the people of the United States, and East Lansing is not the only city that has applied for a police wavelength and hasn't received it yet. East Lansing's bootleg broadcasts on 2,416 kilocycles might interfere seriously with police broadcasts from half a dozen other cities, and thus the other cities might interfere with East Lansing, and if criminals would not reap some benefit from this confusion, then radio has no use or value in trailing criminals.

Yet it should not be necessary yet to go into the facts to determine a question of law.

The Governor mutters something about State's rights, which somehow doesn't sound so sincere when coming from North of the Mason and Dixon line. Does the governor claim the right of the state to do wrong?

The Governor says he will not back down. We say he will, providing the problem is not solved by granting of the wavelength. He ought to know what he will do, and we ought not to know. But we expect to print soon a complete news article on his forsaken bravery!

The Musical Level

SOME few efforts are being made to bring symphonic music to the gates of popularity. The idea is to make this type of music pass the gates and stay inside the fence of popular favor. For purely historical and experience reasons, and not pessimistically we are afraid the effort is doomed to failure. Assuming it is so doomed, the question will be raised whether that's too bad. We don't think it is.

It requires considerable musical familiarity, if not musical education, to enable one to enjoy a full half hour uninterruptedly devoted to Beethoven's Fifth Symphony. Walter Damrosch essayed to hold his radio audience for that length of time with that rendition, but we have a sneaking suspicion there was much exercising of the wrist among listeners who are the family dial engineers.

Symphonic music is heavy. It has been true all along that if you do not select your audience, and there is no such selection in radio, you can not get far along with symphonic music before your listeners start fidgeting in their seats. Often persons who have no liking for such music find themselves trapped by social conventions. Not being able to duck, they brave it out as best they can, which is often none too well.

This is no indictment of symphonic music or its kindred compositions of the opera, concert and chamber stages. Nor is it any indictment of popular taste. What is in symphonic music can be appreciated only after study, and the problem thus acquires an educational aspect. Now, the popular acceptance of music is as entertainment, rather than as edification or education, and the enjoyment must be such as to require no preparation by the listener to make it complete. In that respect jazz comes through easily, and so do other forms of music, including some of the melodic pieces from the operas and much semi-classical music.

Mr. Damrosch frequently gives an exposition of the "plot" of the music, with the technicalities explained, but many people must fail to coincide all such expositions with the music that follows. Interpretation of such music is not easy. You cannot take any musical piece, dissect it, analyze it, and say with finality just what each passage symbolizes. So some system of interpretation must be followed, just as the courts, not being able to discern just what the legislature meant in every section of every statute, follow rules of statutory construction. Now, these rules, like those of musical construction, may lead to a goal other than that intended by the enactors, but when otherwise impossible to decide what's what, the only resort is to make the best interpretation possible.

So with musical compositions. Being often wordless, they require some verbal equivalents for the thoughts intended to be stirred by the score. The composer actually may state his aim, whch is supposed to close all argument, or, too proud to admit that his music needs the help of any such statement, he leaves the understanding to those who understand. Then the possibility arises for conflicting interpretations and constructions. Even if the composer has disclosed in words the purpose of his composition, who knows he isn't spoofing? Although the serious composers have not been noted for their humor (but too often by their ill humor), a joke in the second power would be a possibility for an expert in mathematical music.

Musical compositions are much like radio circuits. A slight change makes a world of difference. In radio, a condenser from plate to ground will help make a detector stable. Connected from plate to grid, it produces unholy oscillation. So a change in tempo, as we know from sportive musical tricks we've heard so often, makes a fox-trot out of an erstwhile funeral march. Fortunately, with words, whether spoken fast or slow, the meaning is always the same, if otherwise what a perplexing world this would be.

The public can't be bothered to make special preparation for the understanding of any music, but is mainly concerned with sitting back and enjoying the program.

The so-called popular music and semi-classical pieces have a wider "circulation" for the same reason that "Liberty" has a wider circulation than "The Atlantic Monthly."

Granite and Iron Core Called Wave Absorbers

Washington.

Deposits of granite and iron ore in New England absorb radio signals with consequent deterioration of broadcasting reception, the Federal Radio Commission was told by Howard Booth, who operated WBRL, at Tilton, N. H.

Seeking renewal of the broadcasting license of the station, Mr. Booth said the channel on which it had operated was not well suited for reception because of these conditions. WBRL has not been operating since December 1st, having been ordered off the air because of failure to apply for renewal. The station formerly operated with 500 watts power on the 1,430-kilocycle channel with unlimited time.

Forum

Likes the Debates

YOUR magazine certainly is appreciated for the manner in which it is handled, both as to outstanding facts and truth. No deadly germs of deceit are between the lines.

EDWARD J. BROCKWAY,
Wildwood, Annex, N. J.

* * *

Favors Simple Battery Sets

MULTI-TUBE receivers do not perform any better than sets with one-third or one-half the number of tubes. Mr. Cramer, one of your readers, believes he is getting something good when he gets KDKA from Iowa. Well, I am living in Washington Heights, New York City, with WOR only a few miles away from me, and am listening to WLW, Cincinnati, O., with not the faintest whisper from WOR, with a 5 tube—four 112 and one 171.

The simple receivers will cut through locals and bring in distance regularly if assembled and operated properly.

Furthermore, multi-tubers are always out of tune. The balancing condensers are good only for one and only one setting of the dial and there is no set made yet which is an exception, because it is impossible to make two things exactly alike. There will always be points on the dial where a station could be brought in louder, if one or two condensers could be moved just a little bit.

As for power noise in electric sets, Mr. Cramer is all wrong. There is today not a single electric set on the market which does not reproduce plenty or such noise, so battery sets have it all over the others in this respect. Ask any experimenter or serviceman. I have been servicing radios for four years and I know where most of my complaints come in. Noise, noise and noise again. God bless the good old battery sets!

Why, Mr. Cramer, do manufacturers build multi-tube sets today? Because the public wants them. And if a producer does not make what the public wants, he has to close up. That does not mean that fewer tubes could not do the same work if the set is made properly. The manufacturers have to introduce losses to cut down the tremendous gain so, why not be content with fewer tubes and save all around, using them to full efficiency?

A 5-tuber can be made to tune just as easily as a 10-tuber. Oscillation can always be controlled but sensitivity is much better because of the oscillation minus one little movement, which gives you those extra 100 miles distance.

My circuit consists of:

(1)—R. F.: plain tuned stage with 112 tube.

(2)—R. F.: regenerative tuned stage with 112 tube.

(3)—Detective, regenerative tuned stage with 112 tube.

(4)—Transformer coupled first audio unit.

(5)—Transformer coupled second AF. 112 tube.

For coils I am using plain R F and 3-circuit tuners, as advertised in RADIO WORLD.

Now a little advice:

Read RADIO WORLD carefully. If you see a big article don't skip over it. Read it. What counts is not only pictures but everything that is printed. RADIO WORLD is good, otherwise I would not be reading this paper today, after five years.

WALTER STRUDEMAN,
513 W. 176th Street, N. Y. City.

* * *

No Sidebands, Says He

IN your argument about sidebands, both sides confuse very simple and easily explained phenomena regarding compound waves, heterodyne waves and modulated waves. They are all mixed up and thrown in a jumble of facts, reminding one of the blind men and the elephant; each was wrong, but altogether there is a lot of truth in their opinions about the elephant. In some respects the elephant is like a wall, and in others like a snake etc. etc. It is all so simple that one feels foolish to offer even an explanation, Fleming and Morecroft at loggerheads notwithstanding:

(1)—A simple or fundamental wave has a single frequency.

(2)—A complex wave is the resultant wave train of several wave trains of differing frequencies acting concurrently.

(3)—A heterodyne wave train is the sum or difference wave train of two wave trains having different frequencies.

(4)—A modulated wave train, simple or complex, (in radio it is simple) is one that has its amplitude varied in accordance with some controlling frequency but is in no wise combined with this control frequency.

In case (2) of a complex wave we may tune in on and single out pure and unadulterated any one of the elemental wave trains no matter how many miles such a wave is broadcast. But our receiver must tune them all in if we wish to receive the full wave in all its complexity, and sideband cutting will surely result if the receiver will not tune in the full range of frequencies which make up the wave.

In case (4) of a modulated simple wave of carrier frequency 1 cycle wide or 10,000 cycles wide, the amplitude is varied periodically. The detector knows no difference—it will rectify either and deliver pulsing DC which varies at the same period as the variation in amplitude of the carrier wave, no matter what the rate of variation. In case (2) of a complex wave, the tuner must pass the audible band of frequencies but in the case (4) of a modulated wave it need pass only the modulated wave. Try to imagine a selective tuner that will pass frequencies of both 1,000,000 cycles and from 30 to 5,000 cycles, and put it on the air in our congested broadcast band and see what happens. There is no other frequency to which you can tune a modulated simple wave (excluding harmonics), for, however it is modulated, it is still a simple wave train. Varying the ampltitude alone does not change its wave form, and does not make it complex, any more than does changing the volume of a sound.

Furthermore, if sidebands were present in a modulated simple wave, these sidebands would heterodyne with carrier waves of other stations and we would have audio frequency heterodyning as well as radio frequency heterodyning. Where stations sometimes stray from their assigned frequencies the sidebands of a broadcasting station would autodyne against the carrier of the next station during its silent interval; its program would heterodyne, with the result that along with the whistle or even before the whistle we would hear the program at some different frequency without need of detection as is done in C W telegraphy. Thus Superheterodynes would need no detectors if carrier waves carried sidebands. It would only be necessary to heterodyne the oscillator against the sideband, and we could vary the pitch of the program at will.

It may be true that Morecroft found that passing a wave train through a tuner decreased its modulation,—and it may not be true. Of course if he used a complex wave, as the negative side states, that is something vastly different than a simple modulated wave. Modulation affects only the volume of the radio frequency and surely tuners cannot discriminate between volume changes varying from 30 to 10,000 cycles if they cannot discriminate between volume changes in the carrier wave's zero to peak values. That is, the rapidity of volume change in the carrier wave itself in rising from zero to peak is so great in comparison that it should make no difference at what rate the peak is varied since the carrier frequency is the same in any case.

If a modulated wave train loses some degree of modulation, but I do not see how it can, then it will favor the high frequencies more than the lower ones simply because the tuner has a resonance peak above the audible band. However, it is so far above it that modulation in all frequencies must be affected alike and this again affects only a change in audio volume, the same as if the per cent. modulation were changed at the station and can have no effect on quality whatsoever.

It may be repeated that in complex waves, sidebands are present and tuners for such waves must pass all the different frequencies present to avoid sideband cutting. In the case of modulated waves, however, the tuner may have any desired degree of selectivity, since a band 1 cycle wide may be varied in volume at the same rate and degree as a band of any desired width; 10 kc or more.

When two frequencies are combined into a complex wave, the low frequency follows a straight line zero abcissa and the higher frequency follows, and has for a zero line, the wave form of the lower frequency, and this is true regardless of what the relative amplitude.

One reason some Superheterodynes lose the high frequencies is because the intermediate frequency is chosen so low (around 45 kc) that the second, third and fourth harmonics of audio tones are already up into the region of the intermediate frequencies. When a second detector plate by-pass condenser is chosen large enough to effectively filter out the radio frequency of 45 kc, unless care is used, it also begins to lop off the quality in the high audio register. The condenser should be replaced by a tuned wave trap which will just block 45 kc from getting into the audio system.

I might simplify the entire discussion by merely stating that if the carrier wave were varied in carrier frequency between 5 kc below and 5 kc above normal, that is within a 10 kc band, the receiver would cut sidebands if its selectivity band were less than 10 kc.

However, stations do not send out a carrier modulated in frequency. The frequency is constant, and only the volume is varied at a rate corresponding to the modulation frequency. In this case the tuner need not respond to variations in frequency, for there is none. It need respond only to variations in signal strength caused by modulation, and this it can easily do, on a narrow band equally as well as on a wide band. Thus complex waves which are modulated in frequency have sidebands equal in width to the modulation band, but simple carrier waves modulated only in volume have no side bands.

V. V. GUNSOLLEY
116 So. 4th Street
Minneapolis, Minn.

* * *

Doubtful on Selectivity

A GOOD topic for debate was given in your magazine, "Resolved, That Sidebands Are Mere Fiction." Well you've given out a lot of valuable reading matter. Here is a topic to debate:

"Resolved, That High Selectivity Reduces Interference."

No! it's not always so!

Well, how about it?

FRANK DE MARCO.

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Of Radio World published weekly at New York, N. Y., for April 1, 1930.

State of New York }
County of New York } ss:

Before me, a Notary Public in and for the State and county aforesaid, personally appeared Roland Burke Hennessy, who, having been duly sworn according to law, deposes and says that he is the Editor of the Radio World, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 411, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor and business managers are: Publisher, Hennessy Radio Publications Corp., 145 West 45th St., N. Y. C. Editor Roland Burke Hennessy, 145 West 45th St., N. Y. C. Managing Editor Herman Bernard, 145 West 45th St., N. Y. C. Business Manager Herman Bernard, 145 West 45th St., N. Y. C.

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ROLAND BURKE HENNESSY
(Signature of Editor.)

Sworn to and subscribed before me this 31st day of March, 1930.

HARRY GERSTEN.
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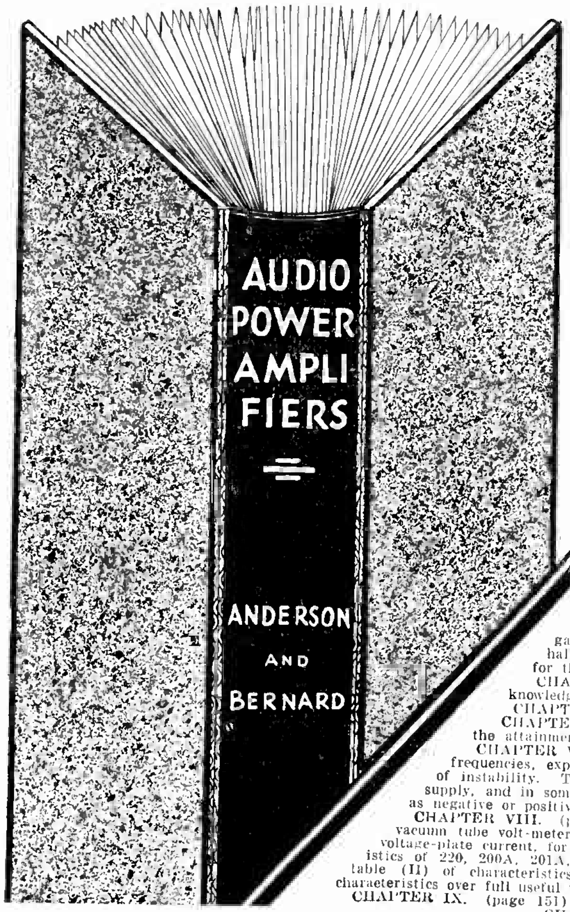

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J. E. Anderson, M.A., former instructor in physics, University of Wisconsin, former Western Electric engineer, and for the last three years technical editor of "Radio World."

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

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

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

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

Details of Chapter Contents

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

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

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

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

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

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

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

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

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

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

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

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

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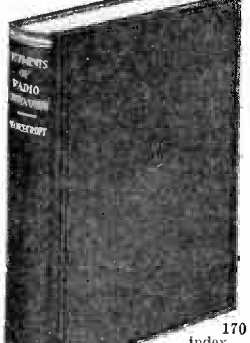

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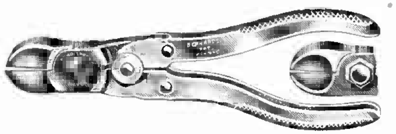
Spring Action Diagonal Nipper



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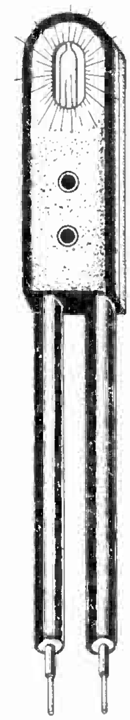
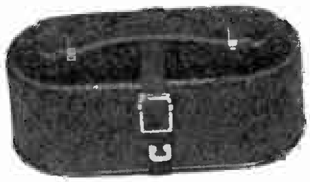


Illumination Tester, Vest Pocket Size, Shows Shorts and Opens Visually, also polarity of DC line. A Neon lamp is built in.



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

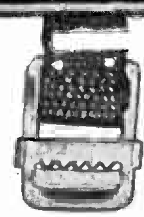
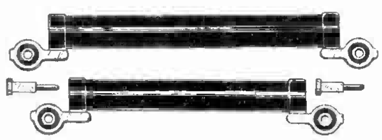
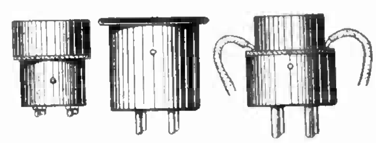


Illustration above is 2/3 scale.





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

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

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

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

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

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

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

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

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

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5-DAY MONEY-BACK GUARANTY

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

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

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

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

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

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

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

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