AUGUST 17th, 1929 15 CENTS

RADIO WORLD

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The First and Only National Radio Weekly

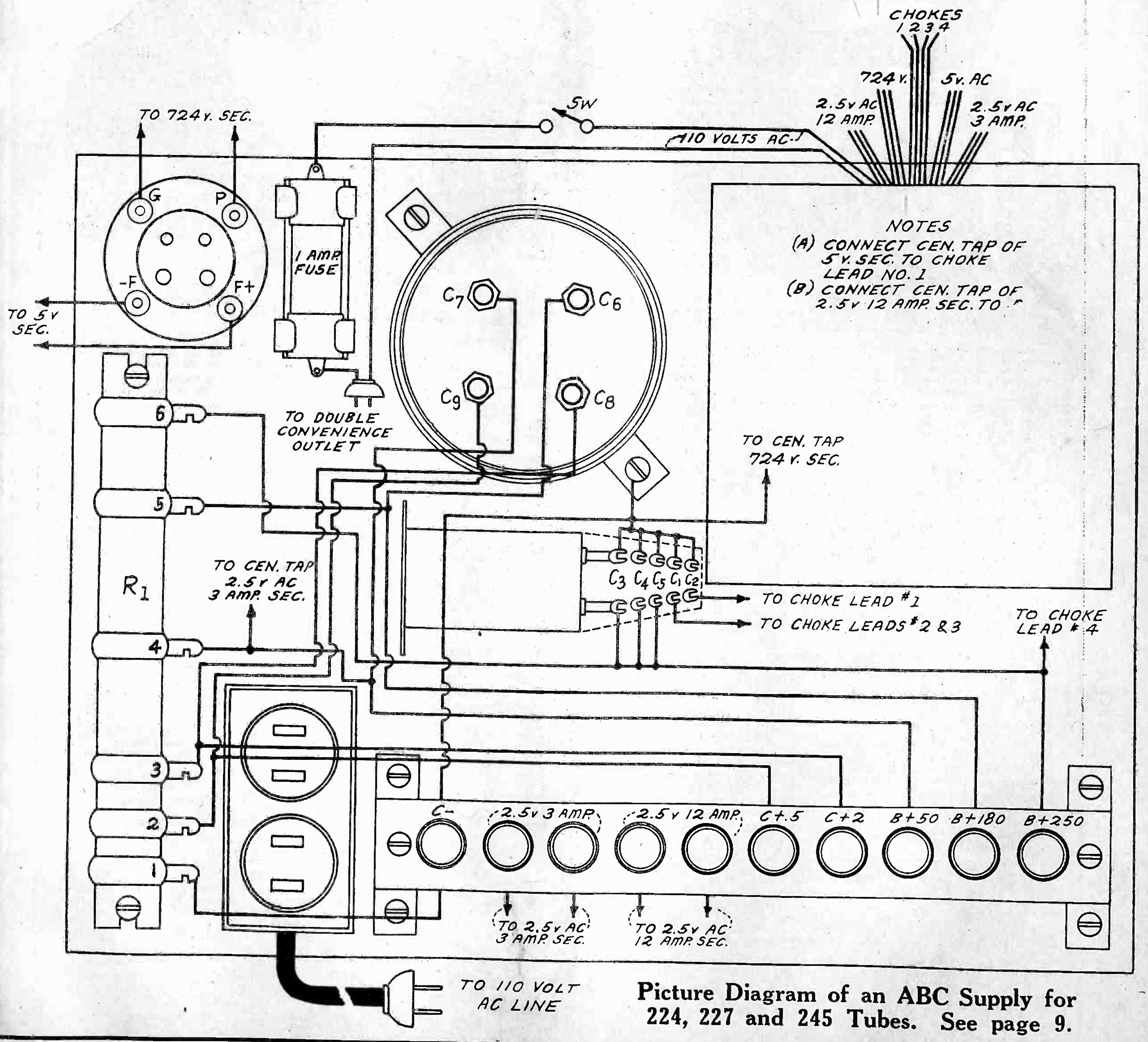
386th Consecutive Issue—EIGHTH YEAR

SIMPLE WAY TO MEASURE THE MU OF A TUBE

CHARACTERISTICS OF 220, 240, 201A, 112 and 171A

AMAZINGLY SENSITIVE 4-TUBE AC CIRCUIT

WIRING OF 224-227-245 ABC SUPPLY

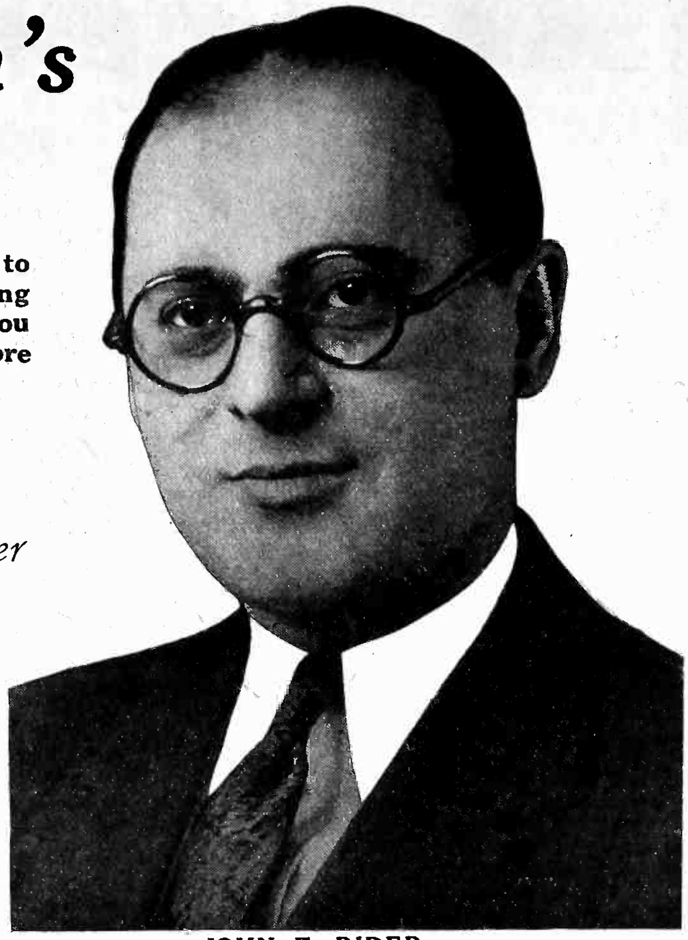


Picture Diagram of an ABC Supply for 224, 227 and 245 Tubes. See page 9.

RADIO WORLD, 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, N. Y.; Herman Bernard, Secretary, 145 West 45th Street, New York, N. Y.

Rider Lifts a BIG Load Off the Service Man's Chest!

In New Book Noted Radio Engineer Devotes 240 Pages to Trouble Shooting in All Receivers and Gives the Wiring Diagrams of Factory-Made Sets in 200 Illustrations—You Can Carry This Book Around With You—No More Torture Tracing Out Circuits.



JOHN F. RIDER
Member, Institute of Radio Engineers

"Trouble Shooter's Manual" *By John F. Rider*

JUST OUT!

The first comprehensive volume devoted exclusively to the topic uppermost in every service man's mind is "Trouble Shooter's Manual," just published. It is not only a treatise for service men, telling them how to overcome their most serious problems, and fully diagramming the solutions, but it is a course in how to become a service man. It gives all the details of servicing as they have never been given before. Finding the right mode of attack, applying the remedy promptly and obtaining the actual factory-drawn diagrams of receivers always have been a load on the service man's chest. But no more. Rider, expert on trouble shooting, has produced the outstanding volume on servicing, and has taken the load off the service man's chest!

This book is worth hundreds of dollars to any one who shoots trouble in receivers—whether they be factory-made, custom-built or home-made receivers. The home experimenter, the radio engineer, the custom set-builder, the teacher, the student,—all will find this new book immensely informative and absolutely authoritative.

Wiring Diagrams of *All* These Receivers!

Besides 22 chapters covering thoroughly the field of trouble shooting, this volume contains the wiring diagrams of models, as obtained direct from the factory, a wealth of hitherto confidential wiring information released for the first time in the interest of producing better results from receivers. You will find these diagrams alone well worth the price of the book. The wiring diagrams are of new and old models, of receivers and accessories, and as to some of the set manufacturers, all the models they ever produced are shown in wiring diagrams! Here is the list of receivers, etc., diagrams of which are published in this most important and valuable book:

R. C. A.
60, 62, 20, 64, 30, 105, 51, 16, 32, 50, 25 A.C., 28 A.C., 41, Receptor S.P.U., 17, 18, 33.

FEDERAL
Type F series filament, type E series filament, type D series filament, Model K, Model H.

ATWATER-KENT
10B, 12, 20, 30, 35, 48, 32, 33, 49, 38, 36, 37, 40 42, 52, 50, 44, 43, 41 power units for 37, 38, 44, 43, 41.

CROSLEY
XJ, Trirdyn 3R3, 601, 401, 401A, 608, 704, B and C supply for 704, 704A, 704B, 705, 706.

ZENITH
39, 39A, 392, 392A, 40A, 35PX, 35APX, 352PX, 352APX, 37A, 35P, 35AP, 352P, 352AP, 34P, 342P, 33, 34, 35, 35A, 342, 352, 352A, 362, 31, 32, 333, 353A, power supply ZE17, power supply ZE12.

MAJESTIC
70, 70B, 180, power pack 7BP3, 7P6, 7P3 (old wiring) 8P3, 8P6, 7BP6.

FRESHMAN
Masterpiece, equaphase, G, G-60-S power supply, L and LS, Q15, K, K-60-S power supply.

FADA
50/80A receivers, 460A Fada 10, 11, 30, 31, 10Z, 11Z, 30Z, 31Z, 16, 17, 32, 16Z, 32Z, 18, special, 192A-192S and 192BS units, R80A, 480A, and SF 50/80A receivers, 460A receiver and R60 unit, 7 A.C. receiver, 475 UA or CA and SF45-75 UA or CA, 50, 70, 71, 72, C electric unit for special and 7 A.C. receivers, ABC 6 volt tube supply, 86V and 82W, E180Z power plant and E 420 power plant.

FREED-EISEMANN
NR5, FE18, NR70, 470, N R 5 7, 457, NR11, NR80 DC.

STEWART-WARNER
300, 305, 310, 315, 320, 325, 500, 520, 525, 700, 705, 710, 715, 720, 530, 535, 750, 801, 802, 806.

GREBE
MU1, MU2, synchrophase 5, synchrophase A C 6, synchrophase AC7, Deluxe 428.

PHILCO
Philco-electric, 82, 86.

KOLSTER
4-tube chassis used in 6 tube sets, tuning chassis for 7 tube sets, power amplifier, 7 tube power pack and amplifier, 6 tube power pack and amplifier, rectifier unit K23.

STROMBERG-CARLSON
1A, 2B, 501, 502, 523, 524, 635, 636, 403AA power plant, 404 RA power plant.

ALL-AMERICAN
6 tube electric, 8 tube 80, 83, 84, 85, 86, 88, 6 tube 60, 61, 62, 65, 66, 6 and 8 tube A.C. power pack.

DAY FAN
OEM7, 4 tube, 5-5 tube 1925 model, Day Fan 8 A.C., power supply for 6 tube A.C., B power supply 5524 and 5525, motor generator and filter, 6 tube motor generator set, 6 tube 110 volt D.C. set, 6 tube 32 volt D.C. set.

COLONIAL
26, 31 A.C., 31 D.C.

WORKRITE
8 tube chassis, 6 tube chassis.

AMRAD
70, 7100, 7191 power unit.

SPARTON
A.C. 89.

MISCELLANEOUS
DeForest F5, D10, D17, Super Zenith Magnavox dial, Thermyodyne, Grimes 4DL inverse duplex, Garod neutrodyne, Garod EA, Ware 7 tube, Ware type T. Federal 102 special, Federal 59, Kennedy 220, Operadio portable, Sleeper RX1, Armad inductrol.

Here are the 22 chapter headings:

- SERVICE PROCEDURE
- PRACTICAL APPLICATION OF ANALYSIS
- VACUUM TUBES
- OPERATING SYSTEMS
- AERIAL SYSTEMS
- "A" BATTERY ELIMINATORS
- TROUBLES IN "A" ELIMINATORS
- TROUBLE SHOOTING IN "A" ELIMINATORS
- "B" BATTERY ELIMINATORS
- TROUBLES IN "B" BATTERY ELIMINATORS
- TROUBLE SHOOTING IN "B" BATTERY ELIMINATORS
- SPEAKERS AND TYPES
- AUDIO AMPLIFIERS
- TROUBLE SHOOTING IN AUDIO AMPLIFIERS
- TROUBLES IN DETECTOR SYSTEMS
- RADIO FREQUENCY AMPLIFIERS
- TROUBLE SHOOTING IN RF AMPLIFIERS
- SERIES FILAMENT RECEIVERS
- TESTING, AND TESTING DEVICES
- TROUBLES IN DC SETS
- TROUBLES IN AC SETS

Some of the Questions Settled in Book:

Securing information from the receiver owner, list of questions, practical chart system of repairs, circuits and operating conditions.

Repairs in the home, method of operation, spare tubes, the process of elimination, recognizing symptoms, examples of practical application, tracing distortion, tracing electrical disturbances; vacuum tube tests; neutralizing systems, filament circuits, grid circuits, methods of securing grid bias, plate circuits; long aerials, short aerials, selectivity, imperfect contact, directional qualities, grounds; "A" battery eliminator types, design, operating limitations, requirements for perfect operation, AC eliminators, DC eliminators; "A" elminator hum, reasons, voltage, reasons, noise; full wave, half wave, B battery eliminators, filament rectifiers, gaseous rectifier, dry disc rectifier, wiring, parts used, design, voltage regulation, operating limitations, requirements for perfect operation, combination filament and plate voltage eliminators, AC and DC types; B battery eliminator output current and voltage, excessive hum, dead eliminator, poor design, reasons for defects, motorboating, punctured condensers, shorted chokes, voltage regulator tubes, function of filter system, C bias voltages, voltage divider systems, filter condensers, by-pass condensers, voltages in the system; determining voltages in B eliminators, AC, DC, voltage drop, effect of shorted filter system, defective rectifiers, defective transformer, defective chokes, defective by-pass condenser, design of filter system, defective voltage divider network, relation between hum and output voltage, isolation of troubles, external filters, noise filters; cone, dynamic, exponential speakers, troubles, dead, weak output, distorted output, rattle, continuity testing, windings, magnets, frequency filters, testing, chokes, condensers, hum elimination;! audio amplifier types, transformer, resistance, impedance, auto-transformer, combinations, requirements for perfect operation, operating limitations, tubes, forms of coupling, plate voltage, grid voltage, filament voltage, isolating condensers, voltage reducing resistances, noises, analysis of trouble, plate current, grid current.

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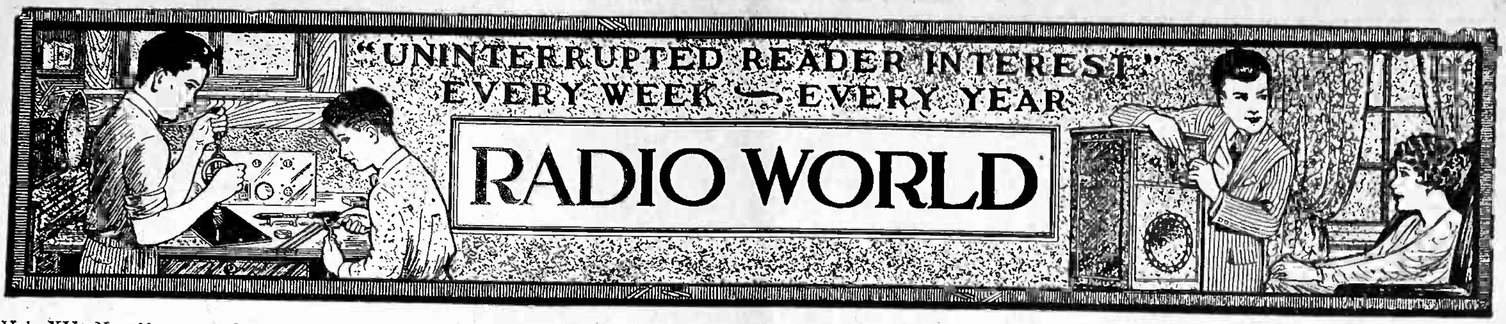

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SIMPLE MU METER

Grid and Plate Voltage Changes Are Key

By Lyon Brook Battle

THE only methods usually published for measuring the amplification constants of tubes involve the use of some kind of bridge, most of which are quite complex and made up of expensive parts. Such arrangements are not at all necessary except when the amplification factor is desired to a high degree of accuracy. A simple arrangement such as that shown in Fig. 1 herewith can be used for obtaining the constant quickly, with fair accuracy and with comparatively simple and inexpensive apparatus.

The principle of the circuit is to find what change in the grid bias is necessary to counteract a given change in the plate voltage so as to keep the plate current unchanged. The grid voltage is measured with the voltmeter V, which may be of a type which is available in every radio experimenter's work shop. A meter used for measuring the voltage of a storage battery is entirely suitable.

The indicating meter A is a milliammeter which has a range which will cover the plate current which will occur for the tube, plate voltage, and grid bias in question. A 0-10 meter is suitable for most tubes, while for some tubes it would be better to use one having a range of 0-50 milliamperes.

The grid bias battery is divided into two parts, one of about 3 volts across which a suitable voltage divided P is connected, and a second part outside the voltage divider. The voltage of the second part depends on the amount of change in the plate voltage and the grid bias used on the tube at the point of measurement, as well as on the amplification constant of the tube. The second part of Eg should be variable in steps less than 3 volts, or in steps smaller than the voltage across P. The voltage divider may well be a 400-ohm potentiometer, but preferably one of 2,000 ohms. The only object of using the higher resistance is to reduce the current drain on the battery across it while the experiment is in progress.

Divided into Three Parts

The plate battery is divided into three parts, E1, E2, and E3. The voltage of E2 and E3 combined is the plate voltage at which the amplification factor is to be taken. E1 and E2 should be exactly equal. The object of using two equal voltages is to permit the measurement of the amplification constant when the plate voltage is reduced by a given amount as well as when it is increased by the same amount. The mean between the two results is taken as the amplification factor at the mean plate voltage.

The first measurement is to ascertain that the voltage of E1 and E2 are equal. Each battery may be a 7.5-volt grid bias battery. Then set the plate return lead on point (2) and adjust the grid voltage, that is, Eg, until the voltmeter reads the bias at which it is desired to measure the amplification factor. Read very carefully, and record, the indications on V and A.

Next connect the plate return to point (1) and readjust the value of Eg until the milliammeter A reads exactly the same as it did before. The voltage of E1 divided by the voltage change in the grid circuit is then the amplification factor of the tube when the plate voltage was increased. Next connect the plate return to point (3). Readjust Eg as before until the milliammeter reads the same as when the plate return was made to (2). The value of E2 divided by the voltage change in the grid circuit is then the amplification factor when the plate voltage is decreased. The average of the two values is the amplification constant of the tube when the voltage on the plate is equal to the sum of the voltages of E2 and E3. If the amplification factor is a constant, there will be no difference between the two values, so that the average is simply the value of either one.

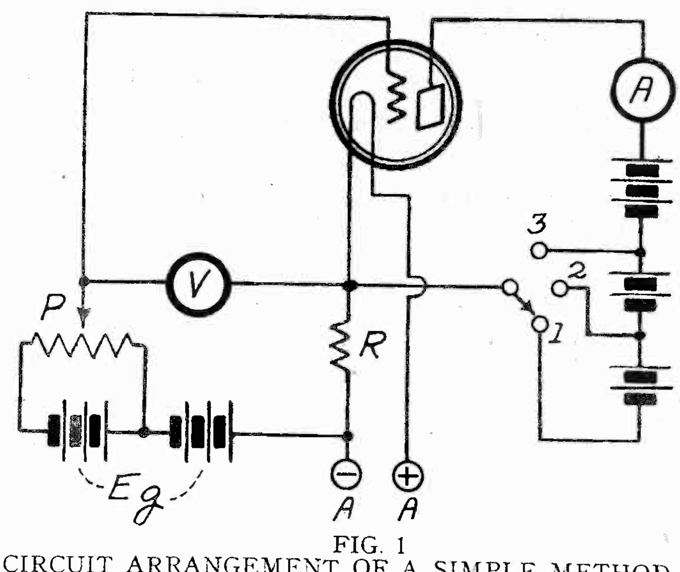

FIG. 1
CIRCUIT ARRANGEMENT OF A SIMPLE METHOD FOR MEASURING THE AMPLIFICATION FACTOR.

Formulation of Method

The method can be formulated simply to help in remembering it as well as to apply it. Suppose the voltage of each of E1 and E2 is E. Let the average plate voltage be Eb. When the plate return is set on (2), the milliammeter reads Ao, say. Let the grid voltage, read on V, be Vo at this adjustment. When the plate return is on (3) the plate voltage is Eb—E. Let the corresponding reading on V, when A has been brought back to Ao, be V3. Then the amplification factor is E/(Vo—V3).

When the plate return is on (1), the plate voltage is Eb + E. Let the corresponding reading on V, when the reading on A has been brought back to Ao, be V1. Then the amplification is E/(V1—Vo). The amplification at the plate voltage Eb is one-half of the sum of these two values.

Applied to a 171A tube the method in one instance worked out as follows: The value of Eb was 97.5 volts. The value of E selected was 7.5 volts. The grid bias Vo was 6 volts. When the plate return was set at (1), the grid bias necessary to bring the current back to the reference value was 8.54 volts, and when the plate was returned to (3), the necessary bias was 3.46 volts. Hence the amplification was 7.5/(8.54—6) or 7.5/(6—3.46), both of which have the same value of 7.5/2.54, or 2.95. The rated amplification factor of this tube is 3, but ordinarily it measures slightly less than this.

This method of measuring the amplification factor is probably the simplest of all, and it is sufficiently accurate for all practical purposes.

When using this method for measuring the amplification factor of a tube such as the 240, which has a mu of 30, it is necessary to measure the grid voltage change very accurately because the change for a given change in the plate voltage is small

WHY SG T[...]
FAR GREATER VOLU[...]

Ten Times as Great Amplificatio[...]

By Jam[...]

Contribut[...]

THE AC screen grid tube has an amplification factor of 420, which means that a change of one volt in the grid voltage will produce a change of 420 volts in the plate circuit. Or, putting it the other way, it requires only 1/420 of a volt in the grid circuit to produce a change of one volt in the plate circuit. If the plate voltage be decreased or increased by one volt, it requires only an increase or a decrease of 1/420 of a volt to bring the plate current back to the value it had before the plate voltage was changed.

The significance of this high amplification factor is that the highest possible voltage amplification that can be obtained from a tube of this kind is 420. Suppose the signal strength at the antenna of a receiver is one millivolt per meter, not a very strong signal. Also suppose that the effective height of the antenna is 10 meters, which is not an unusual height. Then the signal will be 10 millivolts. If this is impressed directly on the grid of the screen grid tube, and if the tube is operated so that the maximum possible amplification is obtained, the signal voltage in the plate circuit of the tube will be 4.2 volts. This is enough to overload many detectors operating with grid leak and condenser.

Full Amplification Not Obtained

This sounds very well and tempts one to throw out all other tubes in the RF amplifier except the screen grid tube. But the voltage gain is not quite so high as indicated by the amplification factor. The tube has an internal plate resistance of 400,000 ohms. As soon as plate current flows there will be a considerable voltage drop in this resistance, and that drop is not available for impressing on the grid circuit of any other tube. It is only the signal voltage drop in the plate load impedance which is available.

Suppose the load impedance is just equal to the internal resistance, that is, 400,000 ohms. Half of the voltage drop will then occur in the resistance of the tube and the other half in the load impedance. The effective amplification is then one-half the amplification factor of the tube, or 210. That seems to be a very great loss, but after all it is only a loss of 3 decibels. There is so much left that there will be ample voltage on the grid of the following tube.

A load impedance of 400,000 ohms cannot be used successfully unless the applied plate voltage is exceedingly high. It is customary to use 100,000 ohms. When that is the case .8 of the signal voltage will be dropped in the internal resistance and .2 will be available for the grid of the next tube. The effective amplification is then only one-fifth of 420, or 84. That is still so much higher than the highest possible with a three-electrode tube that there is really no comparison. The screen grid tube is away ahead.

No Oscillation

Not only is the amplification of this tube far ahead of that of other tubes, but the amplification that can be used successfully is still farther ahead. A three-electrode tube will begin to oscillate because of feed-back through the plate to grid capacity. This capacity in a three-element tube is of the order of 10 mfd. whereas in the screen grid tube it is only .01 mfd. The ease with which a circuit will oscillate, speaking roughly, may be measured by the product of the amplification and the plate-to-grid capacity. In a three-electrode tube having a mu of eight this product is 8x10, or 80. In the screen grid tube it is 4.2. The screen grid tube, therefore, wins by a factor of 19.

The two principal advantages of the screen grid tube over the three element tube is that a much higher amplification per stage is possible and that this higher amplification can be used and still stability remains.

The advantage of the screen grid tube is not limited to radio frequency amplification, for the tube is equally effective as an audio frequency amplifier, especially in resistance coupled circuits. The gain per stage is so high that a general purpose tube can be

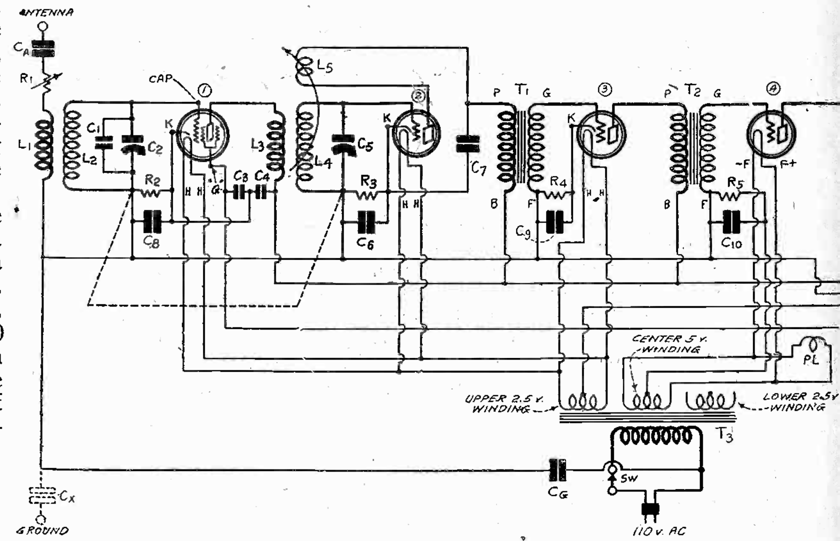

FIG. 1
THE CIRCUIT OF A RECEIVER IN WHICH AN [...] SCREEN GRID TUBE IS USED AS AN EFFECTI[...] RADIO FREQUENCY AMPLIFIER.

Right [...]

(1)—Radio broadcasting or telephony is impossible without transmitting the carrier frequency.

(2)—A resistance connected across a tuning coil or tuning condenser introduces a resistance in series with the tuned circuit and lowers the selectivity of that circuit.

(3)—When the relative power output are compared in transmission units or decibels, the zero level is zero power. That is, the number of decibels express the absolute value of the power in watts.

(4)—Two tuning coils geometrically similar but differing in size have the same inductance. The similarity must apply to every dimension of the coil, such a diameter of form, diameter of wire, length of coil and spacing of wire.

(5)—The heating of plates to a dull red color in rectifier and amplifier tubes indicates that the applied voltage is too high and that too much current is being drawn.

(6)—The amplification in a screen grid tube circuit is limited only by the size of the plate resistance used for coupling.

(7)—The most frequent hum in AC receivers is of a 60-cycle frequency.

(8)—The larger the time constant of the stopping condenser and grid leak resistance in a resistance-coupled amplifier the better the circuit amplifies on both high and low frequencies. The time constant is the product of the capacity of the condenser and the resistance, farads and ohms being the units.

(9)—The most stable transformer-coupled amplifier having two transformers and three tubes is that obtained when the transformers are connected so that the transformers as well as the tubes reverse the phase of the signal.

(10)—A full wave rectifier takes more power from the AC line than a half wave rectifier when both are delivering the same current and voltage into the same load.

(1)—Wrong. Both broadcasting and point-to-point telephony could be carried on by transmitting a single side band. Trans-

UBES PROVIDE ME AND BETTER TONE

asily Obtainable in Practice

I. Carroll

tor

eliminated from the circuit and still leave a greater signal gain when one SG tube replaces two others. This naturally reduces wave form distortion, for the more tubes in the audio amplifier the more distortion, as a rule.

In the radio frequency amplifier the low plate-to-grid capacity of the tube resulted in stability. In the audio amplifier it results in better frequency response when the tube is used in a resistance coupled amplifier. In the three-electrode tube the plate-to-grid capacity results in a lower amplification of the higher audio notes. In the screen grid tube this frequency distortion is much less. The practical effect of this is that the output from a resistance coupled screen grid amplifier will be more distinct than that from a similar circuit having three-electrode tubes. The consonants in speech will be more easily distinguishable, especially the sibilants. As far as music goes there will be no appreciable frequency difference.

Proper Voltage Necessary

So that best results may be obtained from a screen grid tube it is necessary that the proper voltages be used. This applies to the plate voltage, the screen grid voltage, and the grid bias. If the plate return lead be connected to a certain tap on the B supply unit there is no definite assurance that the voltage be correct, because there may be resistances in the circuit which will lower the voltage below that which the tube should have for the plate load and the screen voltage actually employed. Also, if the screen return be connected to another tap on the B supply, there is no assurance that the screen voltage will be correct. There should be no impedance at all in the screen circuit. If one is used for steadying the voltage applied, there must be an adequate by-pass condenser to reduce the impedance to zero with respect to the frequencies at which the tube is operating. This use of by-pass condensers is illustrated in Fig. 1 which shows an AC screen grid tube used as a radio frequency amplifier. The plate load on this tube is mainly the resistance reflected back into the primary from the tuned circuit. This may well be of the order of 100,000 ohms if the circuit is selective and if the primary and secondary are coupled closely.

rong?

oceanic telephony is carried on with such a scheme. Broadcasting is not because receivers are not suitable for the system.

(2)—Right. The higher the resistance connected across the tuned circuit the less is the equivalent series resistance in the tuned circuit. A small resistance across the tuned circuit introduces a very high series resistance.

(3)—Wrong. It is impossible to compare zero relatively to any finite quantity. The zero level of power is always some arbitrary power greater than zero.

(4)—Wrong. If two tuning coils are exactly similar geometrically, differing only in their dimensions, the inductances are proportional to the dimensions. For example, if every dimension of one of the coils is *n* times as great as the corresponding dimension of the other, then the inductance of one coil is *n* times as great as that of the other. This follows from the fact that the dimension of inductance is that of a length.

(5)—Right. The heating of the plate is due to the bombardment of electrons on the plate. Every electron contributes some heat. If enough electrons reach the plate every second, the plate will get red hot.

(6)—Wrong. Theoretically it is true provided that the applied plate voltage is high enough. Practically, the amplification is limited by the plate battery voltage used.

(7)—Wrong. The most frequent hum has a frequency of 120 cycles.

(8)—Right. There is nothing in the idea that the time constant should be small in order to amplify the high frequencies, because the condenser does not charge up.

(9)—Right. When both transformers as well as the tubes reverse the phase, the feed back through the common impedance is such as to decrease the amplification in every tube.

(10)—Wrong. The half wave rectifier takes more power under the conditions because its regulation is poorer. That is, its internal resistance is higher and power must be taken from the line to supply the losses. However, there is very little difference.

Hum Elimination

HUM is present in my AC receiver, which I built myself. It was not there before. Please give me some advice on elimination of hum.—H. E. R. Remove the detector tube, with the rest of the tubes in operation, as hum arising in the audio amplifier would persist under those circumstances. If the hum disappears when the detector tube is removed, then the hum may be ascribed to the detector or the radio frequency amplifier. If the hum seems to be in the radio frequency amplifier, make sure that self-oscillation is not present, and that the AC 110-volt cable does not run near the radio tubes. If grid bias detection is used, experiment with different values of bias, as the detector may be working inefficiently, and the hum component may be greater than the signal output. Test the bias on all tubes. If a voltage drop in a resistor furnishes the bias, use higher and lower values of resistance, or alter the plate current. If the hum seems to be in the audio amplifier it may be due to audio regenerative effects that produce overstressed amplification in the region of the hum frequency, which is normally strongest at 120 cycles, the second harmonic of the fundamental 60-cycle frequency. Ground the negative lead of the eliminator directly, not through a condenser, as the voltage drop in such a series condenser may produce hum. With the full set in operation, short one of the filter choke coils and listen to determine if hum increases. It is a good sign if the hum does increase. If it does not, the choke may be shorted. If you suspect a short circuit there, measure the voltage at the output of the rectifier tube and again at the point where the two chokes are joined. It should be less at the joint, due to the voltage drop in the first choke. If it is not less, and if the hum does not change in intensity when the first choke is shorted, then that choke is defective. Try the same test on the second choke. If more current is passed through the filter system than should be the case, remove the power tube and listen, with speaker or earphones, at the output of the first audio tube. The relative hum should be considered, not the absolute value, since the signal level is lower. A disproportionate reduction in hum would indicate the overloading has been corrected, since the heavy plate current drain of the power tube has been removed, so another small choke may be added to the series, not only for better filtration but also to reduce the voltage a little. One precaution to remeber is that some tubes produce hum when the plate current is lower than it should be, so increase the plate current on preliminary audio tubes as a test. In directly heated AC filament circuits of tubes the electrical center must be accurately established to avoid hum, so try a center-tapped resistor, or a fixed resistor with a movable center tap, across the filament of the last audio tube or tubes, with grid return to the center tap. Sometimes hum arises from acoustical coupling between speaker and audio amplifier or speaker and AC line or coupling of all three. If possible, move the speaker to some different angle or farther away from the set. See that the aerial does not run near telephone lines and the like, or, if it must be only a few feet away from them, that it runs at right angles to them. Put an AF choke coil in series with the B plus detector lead, between the B plus end of the audio transformer primary or other coil or resistor in the plate circuit, and put a 2 mfd. condenser from this end of the plate circuit to ground.

CHARACTERIS

Curves Predict Performance of 22

By J. E. Ander

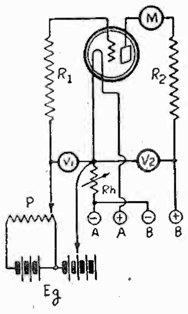

FIG. 62

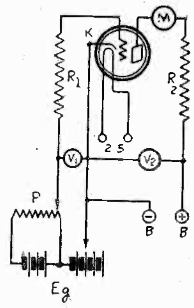

FIG. 63

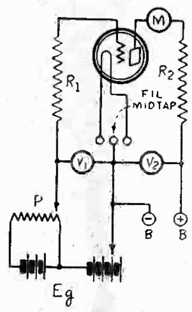

FIG. 64

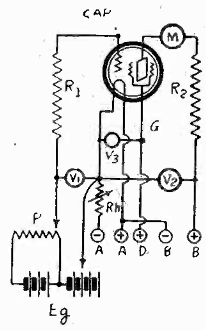

FIG. 65

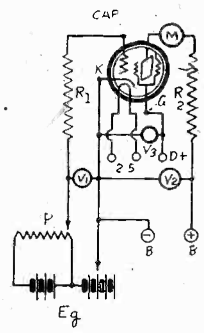

FIG. 66

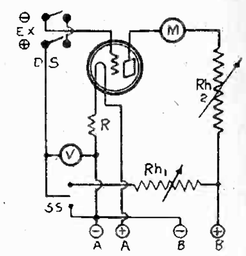

FIG. 67

FIG. 62—DIAGRAM OF CIRCUIT FOR TAKING GRID VOLTAGE, PLATE CURRENT CURVES ON A BATTERY HEATED TUBE OF THE THREE ELEMENT TYPE

FIG. 63—DIAGRAM OF A CIRCUIT FOR TAKING CHARACTERISTIC CURVES ON A HEATER TYPE TUBE HAVING THREE ELEMENTS

FIG. 64—CIRCUIT ARRANGEMENT FOR TAKING CHARACTERISTIC CURVES ON A THREE ELEMENT TUBE HEATED DIRECTLY WITH AC

FIG. 65—CIRCUIT FOR TAKING CHARACTERISTIC CURVES ON A BATTERY TYPE SCREEN GRID TUBE

FIG. 66—WHEN TAKING CHARACTERISTIC CURVES ON A HEATER TYPE SCREEN GRID TUBE A CIRCUIT OF THIS KIND IS SUITABLE

FIG. 67—CIRCUIT DIAGRAM OF A VACUUM TUBE VOLTMETER IN WHICH THE UNKNOWN VOLTAGE IS BALANCED AGAINST A KNOWN VOLTAGE. THIS CIRCUIT CAN BE USED FOR MEASURING THE VOLTAGE DROP IN HIGH RESISTANCES

[*The following article is the twelfth consecutive one in the series on "Power Amplifiers," by J. E. Anderson and Herman Bernard. The series was started in the June 1st issue. Next week the characteristics of other tubes will be discussed, completing the subject of characteristics, and comprising the remainder of the family of tubes in use today in audio amplifiers, including sound reproduction for theatres.—Editor.*]

* * *

This calculation does not take into account the losses in the transformer windings and the core. A loss of 20 per cent. may be assumed for ordinary transformers used in radio receivers and plate voltage supply units. Making this allowance the power becomes 26.25 watts.

The total power required by the plate circuits and the plate voltage supply unit, exclusive of the filament power, can be taken as equal to the effective AC voltage across one half of the high voltage winding on open cricuit, that is, rated voltage, and the total direct current flowing the B supply circuit. This current might be measured in the lead to the mid tap of the high voltage winding. The total current is used in order to take into account not only the plate currents but also the bleeder current. The rated voltage, or the voltage measured when no direct current flows, is used in order to take into account losses in the high voltage winding and the choke coils.

Suppose the total direct current is 80 milliamperes and that the voltage across each half of the high voltage winding is 350 volts. The power then is .08x350, or 28 watts. This does not take into account the core losses associated with the high voltage winding, but it does take into account the copper losses. Since iron and copper losses in a transformer are about equal, we add 10 per cent. to the 28 watts. Hence the total power required by the direct-current portion of the circuit is 30.8 watts.

Since the filament power was 26.25 watts and the plate power is 30.8 watts, the total power dissipation in the circuit is nearly 37 watts. This is the amount that is taken from the power line. From this it is possible to compute the cost per hour of operation. For example, if electrical energy costs 7.5 cents per kilowatt-hour, the cost per hour is 7.5x.037, or .2775 cent.

The alternating current in the primary, or the sum of the currents in the primaries if several transformers are used, is obtained approximately by dividing the power by the line voltage. Suppose the line voltage is 115 volts. Then the current is .322 ampere. This division assumes that the power factor of the transformer is unity. Actually it is slightly less than unity, so that the primary current would be slightly higher.

If a one ampere fuse be inserted in the line so that all the primary current, regardless of the number of transformers used in the amplifier, flows through fuse, there will be ample protection, for if any of the windings in the secondary becomes short-circuited the fuse will blow.

If the alternating current in the primary be measured with an AC ammeter and then multipled with the line voltage, an approximate value of the total power required will be obtained. This method is more direct than the other and gives the current directly. The power thus obtained neglects the power factor of the transformer, but even so the result may be more accurate than the indirect method.

Curves showing the relationship between the plate current and grid voltage are very useful for determining the proper operating grid bias and for estimating the performance of tubes and circuits under given conditions. Such curves are not available for all tubes, and those curves that are avaliable are for average tubes and so-called normal operating plate voltages. Therefore it is often necessary to take the curves.

For this purpose suitable circuit arrangements are required, and they differ somewhat according to the type of tube that is to be studied. In Figs. 62 to 66, inclusive, are given such circuits for five different types of tubes. While a resistance R1 is shown in each of these circuits, it is sometimes desirable to take curves when there is no resistance or other impedance in the grid circuit. R1 then is simply short circuited. R1 represents the grid leak resistance or the resistance of the secondary of the coupling transformer.

In each plate circuit is also shown a resistance R2, which may be a pure resistance or the resistance of the primary of a transformer or choke coil. Sometimes it is desirable to take a curve on the tube alone, without any load impedance. R2 is then short circuited.

The meter M in each of these circuits is a milliammeter of a range suitable to the type of tube studied, the plate battery voltage used, and the amount of resistance in the plate circuit. For a resistance-coupled circuit the range may be 0-1 milliampere and for a 250 power tube it may be 0-100 milliamperes. The plate current flowing when the grid bias is zero usually determines the range, since there is no particular reason for taking observations for positive grid voltages.

Before taking any observations on plate current with any of these arrangements, the filament terminal voltage should be adjusted to the normal value for the tube studied, using for this purpose a suitable low range voltmeter. For battery-heated tubes the filament terminal voltage is best adjusted by means of a rheostat Rh, in Figs. 62 and 65, and for AC tubes it can be adjusted by means of a rheostat in the primary of the supply transformer. The voltmeter, which is not shown in any of the circuits, should be connected directly across the filament terminals on the socket, or as near the socket as practicable.

CS OF TUBES

40, 201A, 112 and 171A Valves

d Herman Bernard

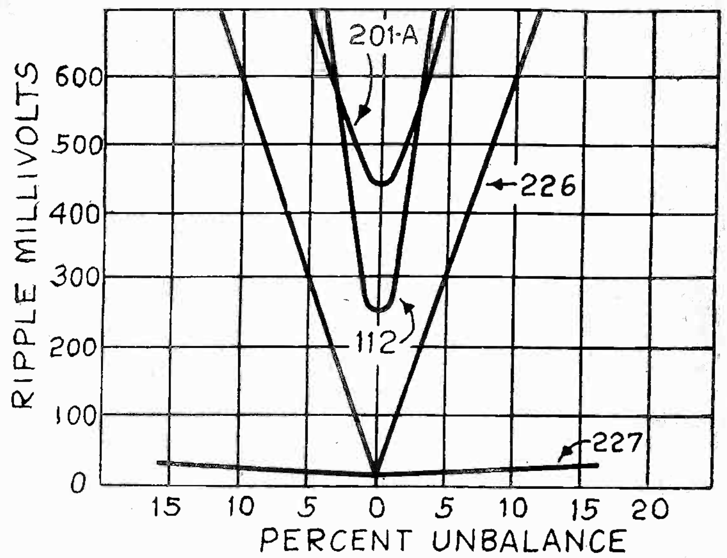

FIG. 68.
CURVES SHOWING THE RELATION BETWEEN HUM VOLTAGE IN THE PLATE CIRCUITS OF TUBES HEATED WITH AC AND THE PERCENTAGE UNBALANCE OF GRID RETURN TO THE FILAMENT OR HEATER.

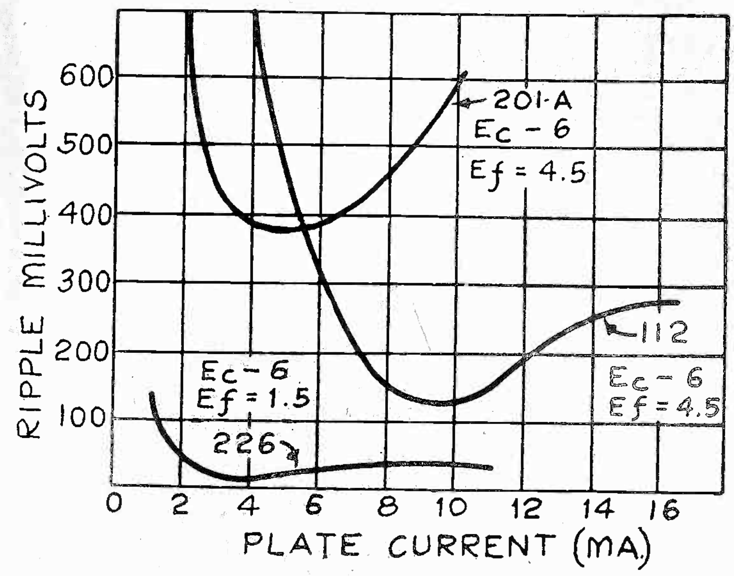

FIG. 69.
CURVES SHOWING THE RELATIONSHIP BETWEEN THE HUM VOLTAGE IN THE PLATE CIRCUITS AND THE AMOUNT OF PLATE CURRENT.

The plate battery voltage is applied at the terminals indicated and measured with voltmeter V2. The connection of this meter should be as indicated in each instance. The plate battery voltage should be adjusted to the value at which a grid voltage, plate current curve is desired, and the voltage selected should be held reasonably constant during the run. If a fresh battery is used throughout the voltage will not change during a run. If the plate voltage is obtained from a battery eliminator the voltage will change, and for that reason this kind of supply is not recommended.

In the two circuits for screen grid tubes, namely, Figs. 65 and 66, an additional voltage for the screen is required, measured with meter V3. The positive terminal for the screen grid voltage is indicated by D. The source of the screen grid voltage may be either a part of the plate battery, or a separate battery.

The grid bias applied is measured with voltmeter V1. It is important that this meter be connected in each instance exactly as shown, for otherwise it will not measure the grid voltage applied, and the meter should be left connected while taking every plate current reading.

The grid voltage applied is derived from a battery Eg, which should contain taps so that the voltage across the voltmeter can be varied in steps of about 3 volts or less. Across a portion of the grid battery, say about 4.5 volts, is connected a potentiometer P of about 2,000 ohms for adjusting the voltage in minute steps. While this potentiometer is not absolutely necessary in all instances, it is always convenient for adjusting the voltage to correspond exactly with the scale divisions on the meter. This facilitates plotting the curves.

Occasions arise when the plate current is so small that it is impossible accurately to measure it with ordinary meters available, yet the voltage drop in the plate load resistance is of considerable magnitude. Examples are the taking of curves on resistance-coupled amplifiers with resistances of the order of 1.0 meg. in the plate circuit and the taking of curves for grid bias values so high that the current is practically zero. In such instances the simplest way of obtaining the curves is to measure the voltage drop across the plate load resistance by means of a vacuum tube voltmeter.

One vacuum tube voltmeter arrangement is shown in Fig. 67. This is particularly convenient because it imposes no rigid requirements on the voltmeter circuit. The filament voltage on the voltmeter tube need not be kept at a specified value, just so it keeps constant for a few moments. The meter need not be calibrated. Neither does the plate voltage have to be constant for long periods. The indicating meter M in the plate circuit may be of the usual rugged type. The tube itself should preferably be one having a high mutual conductance, such as the 171A. The voltmeter V by means of which the unknown voltage is measured indirectly need not be one of high sensitivity. It may be any ordinary voltmeter having a range sufficient for the voltage to be measured.

The meter essentially employs the null method. The effect of the unknown voltage in the grid circuit of the voltmeter tube is balanced against another voltage introduced in series and in the opposite direction. This bucking voltage is the drop across the voltmeter V, the value of which is directly indicated.

The current necessary to operate the voltmeter V is taken from the battery serving the voltmeter tube, through a variable high resistance Rh1. When this is adjusted to a value much greater than the internal resistance of the voltmeter the voltage across the meter is small, and when the resistance in Rh1 is zero the entire battery voltage is across the voltmeter. Hence the range of this vacuum tube voltmeter is limited only by the range of V, or by the voltage applied to the tube. It is not possible to increase Rh1 to such a value that the voltmeter V reads zero, because that would require an infinite resistance. For this reason it is clear that a voltmeter of low internal resistance is preferable to one having a high resistance per volt.

In using this vacuum tube voltmeter, the first step is to establish a reference point on the indicator meter M. The double pole, double throw switch is thrown to the right and the single pole, double throw switch SS is thrown down. This makes a direct lead from the grid of the tube to the minus side of the filament battery. The voltmeter V is short circuited but the grid remains negative by the drop in R. This bias is needed to prevent any grid current when a reading is taken.

Next the rheostat Rh2 is adjusted until the meter M reads any convenient value. In order that any deviation from this reading may be detected the rheostat should be adjusted so that the needle on the meter points exactly to a division line on the scale of M. This reading is the reference point, or null point.

When this point has been established, the double throw, double pole switch DS is thrown to the left to make contact with the terminals Ex, across which the unknown voltage is connected with the polarity as indicated. This makes the grid of the tube negative, and the plate current decreases. Next switch SS is thrown up so as to connect with the line coming from Rh1. This impresses a bucking voltage on the grid, increasing the plate current. The setting of Rh1 is then adjusted until the needle on the meter M is brought back exactly to the reference point. The reading on voltmeter V then indicates the value of the unknown voltage across the terminals Ex. At the beginning Rh1 must be set at its highest value to protect M as well as the tube.

In a series of readings it is not necessary to check the reference point before every reading, unless there is reason to suppose that something in the circuit has changed.

If it is required to measure voltages higher than the voltage ap-

LOAD ON A TUBE

High Impedance Required for High Mu Valve

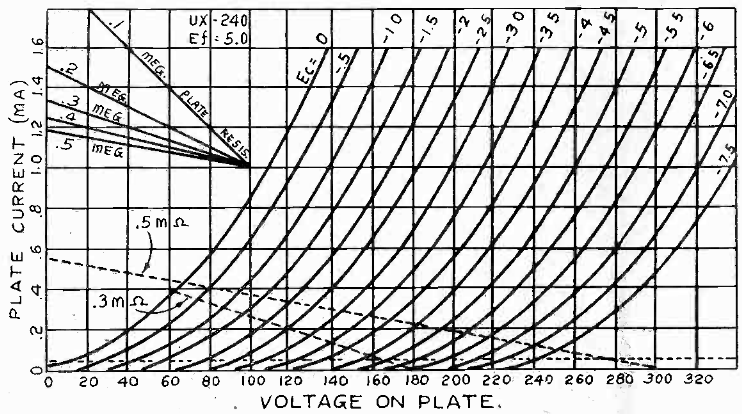

FIG. 70.
A FAMILY OF PLATE VOLTAGE, PLATE CURRENT CURVES FOR A 240 TYPE HIGH MU TUBE WITH VARIOUS LOAD LINES FOR OBTAINING THE PERFORMANCE CHARACTERISTICS.

(*Continued from preceding page*)

plied in the plate circuit of the vacuum tube, the positive end of Rh1 may be connected to a higher voltage.

If the drop in R is not sufficient to prevent grid current a small bias battery can be inserted in series with the grid lead, the negative being connected to the grid and the positive to the switch.

Hum in Amplifiers

When amplifier tubes are operated with alternating current on the filaments or heaters, a certain amount of hum is introduced into the signal, the amount of which depends on the type of tube, the filament voltage, the type of circuit, the amount of plate current, and other factors. The least hum is produced by indirectly heated tubes, like the 227 and 224, and the greatest by directly heated tubes with high filament voltage.

To operate successfully with alternating current in the filament of directly heated tubes, it is essential that the grid return be made to the electrical center of the filament, either by returning it to an accurately placed center tap on the filament winding on the supply transformer, or to a mid-tap on a resistor connected across the filament terminals.

The amount of hum in any such instance depends on the accuracy with which the grid return is made to the electrical center of the filament. The curves in Fig. 68 emphasizes this fact. This figure contains the relationship between the amount of hum and the percentage of unbalance of the grid return for four different tubes. The unbalance in the heater tube refers to connection between the heater winding and the cathode, the grid being returned to the cathode through the grid bias battery or directly.

As will be observed, there is practically no change in the amount of hum in the heater tube as the percentage of unbalance changes, and the amount of hum always is very small. This curve demonstrates the superiority of the heater tube in this respect.

The curve for the 226 starts at nearly the same value of hum as the curve for the heater tube, but as the percentage of unbalance is increased the hum increases rapidly. For an unbalance as low as 5 per cent. the hum in the plate circuit amounts to 300 millivolts. This may be a considerable fraction of the signal voltage, and indeed, in some instances it may exceed the signal voltage. It is clear that the 226 must be balanced very carefully if the hum is to be kept within tolerable limits.

The curve for the 112 tube not only shows a high percentage of hum when the balance is perfect but it also shows a more rapid change as the unbalance increases. Hence this tube is unsuitable for AC operation, except as an output tube. Even for this the unbalance must not exceed about one per cent. The 112A tube is slightly better than the 112 tube in respect to hum.

Of the four curves in Fig. 68, that of the 201A tube shows the greatest hum when the balance is perfect, being about 440 milivolts. The increase in the hum for this tube is not quite so rapid as that for the 112 tube but is slightly more rapid than that for the 226 tube. The 201A tube is not suitable for AC operation in any stage, for it does not handle large enough power to be used as an output tube.

The 171A has a filament similar to that of the 201A and its curve for hum and unbalance is similar. In this tube, however, a small amount of hum is not objectionable because the tube is used as an output tube where the signal voltage may me 400 or 500 times greater than the hum voltage.

The 245 power tube has a filament designed for comparatively low voltage and heavy current. Therefore the percentage hum in this tube is small, and its curve would be similar to that for the 226. As in the case of the 171A, the signal level in the plate circuit of this tube is so high that any hum voltage present would be negligibly small in comparison. Essentially the same applies to the 250 and 210 tubes, although in these the hum would be greater because of the higher filament voltage.

The relation between the amount of hum and the plate current is shown in Fig. 69 for three different tubes. These curves are for grid and filament voltages indicated. It will be noted that in each of these curves there is a point of minimum hum. Thus, for the 226, the minimum comes at 4 milliamperes, for the 201A, it comes at 5, and for the 112, at 9.5 milliamperes. Tubes can be designed so that the point of minimum hum falls at any desired value of plate current, and in practice they are designed so that it coincides with the normal plate current for normal operating grid and plate voltages.

A significant fact in these curves is that the hum increases rapidly as the plate current is reduced below the point of minimum hum. This indicates that if the tubes are used in circuits drawing very small current, such as resistance coupled amplifiers, the hum voltage will be exceedingly high. One would expect such circuits employing any of these tubes, or tubes with similar characteristics, to hum badly when AC is used on the filaments. As a rule, this is a fact.

However, it does not follow that the hum voltage will exceed the signal voltage developed across the plate resistance. If the signal impressed on the grid of the tube is high, the signal voltage across the plate resistor will be correspondingly high, and the hum, although large in absolute value, may be negligibly small compared with the signal voltage. Whether this is true depends on where the tube is in the circuit. If it follows the detector, the hum is likely to be great. Because of this rapid increase in the hum as the plate current is reduced, it is best to use heater type tubes in resistance coupled circuits, or else use DC on the filaments.

Most Useful Curves

The most useful curves of charasteristics of tubes are those giving the relation between the plate voltage and the plate current, taken without any load impedance, provided an entire family of such curves is available for each tube. One such family of curves is reproduced for each of the tubes used in power amplifiers, beginning with Fig. 70.

While the circuits shown in Figs. 62 to 67, inclusive, are primarily intended for taking grid voltage, plate current curves, they can be used also for taking plate voltage, plate current curves. It is only necessary to hold the grid voltage constant while the plate voltage is varied in suitable steps.

The 240 type high mu tube enters into power amplifiers only in direct coupled circuits, particularly in resistance coupled, and it is used only as a voltage amplifier. The performance of the tube when used in this manner can be seen from the family of plate current, plate voltage curves reproduced in Fig. 70.

In the upper left corner of the figure are five different lines representing load lines for five different load resistances as indicated. These lines are for convenience in drawing actual load lines such as the dotted lines. To draw any actual load line across the family of curves, the line should pass through the voltage on the plate voltage axis which is equal to the battery voltage in the plate circuit, and it should run parallel with the reference line representing the resistance actually used in the plate circuit. Thus the long dotted line passes through 300 volts, indicating that the plate battery voltage is 300 volts, and it is drawn parallel with the .5 megohm line, indicating that the plate coupling resistor is half megohm.

The short dotted line starts at 180 volts, indicating that the plate battery voltage is 180 volts, and it runs parallel with the .3 megohm reference line, indicating that the plate coupling resistance is 300,000 ohms. Load lines for resistance other than those represented among the reference lines can be drawn by noting that the slope of any line is the reciprocal of the resistance.

Due to the flow of grid current when the grid bias is near zero and to the fact that this current changes the actual grid voltage by the drop in the grid leak, the signal voltage should never be permitted to approach zero grid voltage closer than —.5 volt. And on account of the curvature of the characteristics when the grid voltage is excessively negative, the signal should not be permitted to make the plate current less than about .05 milliampere. This limiting current is shown by the dotted line running parallel to the plate voltage axis.

AN ABC SUPPLY

for 224, 227 and 245 Tubes, up to Eight

[The first instalment of this article on the construction of an ABC supply for 224, 227 and 245 tubes, was published last week. The final instalment follows. The supply furnishes all filament, plate and grid voltages. The total number of heater type tubes —224 and 227— should not exceed six. The 245 may be used singly or in push-pull. For push-pull connect a 1,500-ohm 10-watt resistor between points (1) and (4). The maximum drain should not exceed 100 milliamperes. An 8-tube set should not draw more than that.—Editor.]

* * *

FOR those who use a transformer with center-tapped 5-volt winding for the filament of the 280 tube, in building the ABC compact for 224, 227 and 245 tubes, the diagram is published schematically on this page. Last week the schematic showed the positive B voltage taken off one side of the filament—it matters not which side—as some will have transformers from which the center tap is omitted. But the recommended transformer block, made by Polo Engineering Laboratories, has the 5-volt winding center-tapped.

The center of the 12-ampere 2.5-volt winding is shown connected to negative of the B supply in Fig. 4 this week, which is a good place to put this lead. The only other change is respect to last week's diagram of the ABC supply is that the fuse and switch are in the primary of the transformer only, and not in the lead emerging from the convenience outlet shown in the lower left-hand corner. This alteration simplifies the wiring just a little. Last week a condenser for aerial pickup was shown, too. There is no substantial difference whatever between what was published last week and what is published this week in the wiring diagrams. The front cover illustration this week, which is pictorial, agrees in all respects with the schematic published herewith.

Mershon Bracket Grounded

The Mershon condenser has a special bracket, and one of the anchoring points of this bracket is used for establishing as negative the copper can that contains the Mershons. Always the copper can must be negative. The Mershons will not work the other way. These condensers are shown as C6, C7, C8 and C9, and all four are in the one can.

The piece of wood or bakelite used for supporting the high-voltage condensers C1, C2, C3, C4 and C5, each 2 mfd., will have to be improvised by the constructor. This is a simple stroke of work. The HV condensers are placed side by side and the position of the mounting holes recorded on the mounting strip or on a piece of paper. Then these holes, if on paper, are transferred to the strip by piercing the paper, and a 6/32 hole is drilled for each of the two feet of each condenser. A projection of ½-inch of the strip at one end will permit use of two small right-angle brackets, side by side, these being fastened to the strip with screws and nuts, while the other arms of the brackets are screwed onto the baseboard.

The fuse may be a small one, physically, and the size of the fuse shown on the front cover is not at all controlling. The only objective is to have a 1 ampere fuse, and this may be of the tiny cartridge type familiar to users of automobiles.

Limited Latitude in Resistors

The resistance values for the five sections of R1, represented by points (1), (2), (3), (4), (5) and (6), were given last week, and it is well to follow them in their approximate commercial values, as stated then. A variation will produce only little different results if confined to the sections between points (4) and (5) and between points (5) and (6).

The baseboard is 9 x 12-inches, and the layout of parts can be followed by from the front cover illustration, which is two-thirds actual size.

Some who desire to try out the method of obtaining the aerial input for a receiver from the ABC supply, and include perhaps the two extra binding posts, twelve in all, may refer to last week's diagram. The inclusion is a simple matter, but as the aerial pick-up from the AC line does not work in all locations, it is not shown in this week's diagrams. The fact that it works only on very sensitive receivers in some locations was stated last week.

Get it Working Same Night

The wiring of this supply does not amount to much work, in fact, it takes less time to do the wiring than to mount the few parts used, so there is no reason why you can not get the device working the same night you start to build it.

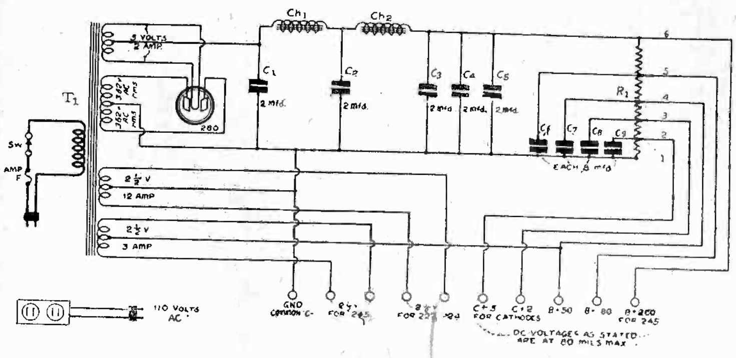

FIG. 4

CIRCUIT OF THE ABC SUPPLY FOR 224, 227 AND 245 TUBES, SHOWING TEN BINDING POSTS USED. THE FILAMENT CENTER TAP OF THE RECTIFIER IS CONNECTED TO THE FIRST CHOKE, CH. 1. THE CENTER OF THE 12 AMPERE 2½-VOLT WINDING IS JOINED TO THE NEGATIVE OF THE B SUPPLY. THE FUSE AND SWITCH ARE IN THE TRANSFORMER CIRCUIT.

If you meet any trouble do not suspect any error in the diagrams, as all of them are wholly correct, but look to your connections, especially such as are unfamiliar. One of these is the connection of B plus 50 volts to the same joint to which the midtap of the 3-ampere 2.5-volt winding is joined. This connection is absolutely correct, but if you try to figure out that it is wrong, and "improve" the diagram, you may get no grid bias for the last audio tube, or no B plus voltage for the screen grids of the other tubes.

Voltmeters will not do much good in measuring the grid bias voltages, particularly the small voltages, .5 and 2 volts, respectively. A vacuum tube voltmeter would do it, because it draws no current, but you may expect any other meter to make it appear that the .5 volts are zero and the 50-volt bias is something less than 50. However, good readings will be obtained from the other taps (5) and (6), if a voltmeter of 1,000 ohms per volt is used. If a meter of a few hundred ohms per volt is used, remember that the actual voltage is a little larger than what the meter reads. This is because the lower resistance meter draws enough current to make the extra drain effective in reducing the actual voltage present when the meter is thus in circuit. A suitable method of getting an approximate voltage for the 50-volt section, when a fair meter is used, is to measure the total voltage from point (6) to point (1), and the voltage between points (6) and (4), and subtract the second from the first, to obtain the approximate voltage between points (1) and (4).

Other Trouble-Shooting

Test the fuse, as it is open if voltage is in the circuit only when the clips are shorted.

If no voltage readings are obtained, use a screw type socket in a wall bracket or electrolier,, where an electric lamp was lighted immediately previously, then insert the wall plug of the supply's convenience outlet into this screw socket. This will insure a working voltage source. Next determine whether the transformer primary is open or shorted. This is easily done by removing the plug from the screw socket and putting an indicating device in series with a voltage source, and connecting the primary in the circuit. For instance, connect a 110-volt lamp in series with the primary and one AC cable, putting the cable ends to the wall or other outlet. If the primary is shorted the lamp will light with usual brilliance. If the primary is open the lamp will not light at all, and if in good condition there will be just a faint evidence of illumination.

Satisfied as to the primary, test the 5-volt secondary by putting a 2.5 or 6-volt lamp across it. If the winding is O. K. the lamp will light. For the 2.5-volt secondaries use the same small lamp. A 0-600 AC-DC meter will test each half of the secondary, but, lacking this, put a 5,000-ohm resistor across one section, next across the other. If it gets warm that secondary is O. K., so test out the 280 tube, the filter condensers and chokes, by-pass condensers and voltage divider.

LOAD ON A TUBE

High Impedance Required for High Mu Valve

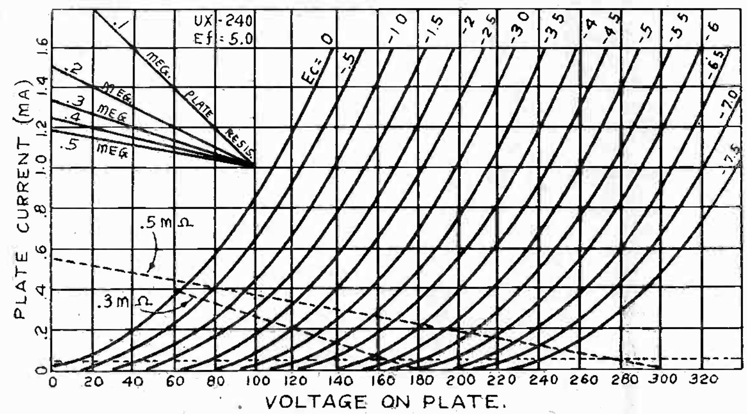

FIG. 70.
A FAMILY OF PLATE VOLTAGE, PLATE CURRENT CURVES FOR A 240 TYPE HIGH MU TUBE WITH VARIOUS LOAD LINES FOR OBTAINING THE PERFORMANCE CHARACTERISTICS.

(*Continued from preceding page*)

plied in the plate circuit of the vacuum tube, the positive end of Rh1 may be connected to a higher voltage.

If the drop in R is not sufficient to prevent grid current a small bias battery can be inserted in series with the grid lead, the negative being connected to the grid and the positive to the switch.

Hum in Amplifiers

When amplifier tubes are operated with alternating current on the filaments or heaters, a certain amount of hum is introduced into the signal, the amount of which depends on the type of tube, the filament voltage, the type of circuit, the amount of plate current, and other factors. The least hum is produced by indirectly heated tubes, like the 227 and 224, and the greatest by directly heated tubes with high filament voltage.

To operate successfully with alternating current in the filament of directly heated tubes, it is essential that the grid return be made to the electrical center of the filament, either by returning it to an accurately placed center tap on the filament winding on the supply transformer, or to a mid-tap on a resistor connected across the filament terminals.

The amount of hum in any such instance depends on the accuracy with which the grid return is made to the electrical center of the filament. The curves in Fig. 68 emphasizes this fact. This figure contains the relationship between the amount of hum and the percentage of unbalance of the grid return for four different tubes. The unbalance in the heater tube refers to connection between the heater winding and the cathode, the grid being returned to the cathode through the grid bias battery or directly.

As will be observed, there is practically no change in the amount of hum in the heater tube as the percentage of unbalance changes, and the amount of hum always is very small. This curve demonstrates the superiority of the heater tube in this respect.

The curve for the 226 starts at nearly the same value of hum as the curve for the heater tube, but as the percentage of unbalance is increased the hum increases rapidly. For an unbalance as low as 5 per cent. the hum in the plate circuit amounts to 300 millivolts. This may be a considerable fraction of the signal voltage, and indeed, in some instances it may exceed the signal voltage. It is clear that the 226 must be balanced very carefully if the hum is to be kept within tolerable limits.

The curve for the 112 tube not only shows a high percentage of hum when the balance is perfect but it also shows a more rapid change as the unbalance increases. Hence this tube is unsuitable for AC operation, except as an output tube. Even for this the unbalance must not exceed about one per cent. The 112A tube is slightly better than the 112 tube in respect to hum.

Of the four curves in Fig. 68, that of the 201A tube shows the greatest hum when the balance is perfect, being about 440 milivolts. The increase in the hum for this tube is not quite so rapid as that for the 112 tube but is slightly more rapid than that for the 226 tube. The 201A tube is not suitable for AC operation in any stage, for it does not handle large enough power to be used as an output tube.

The 171A has a filament similar to that of the 201A and its curve for hum and unbalance is similar. In this tube, however, a small amount of hum is not objectionable because the tube is used as an output tube where the signal voltage may me 400 or 500 times greater than the hum voltage.

The 245 power tube has a filament designed for comparatively low voltage and heavy current. Therefore the percentage hum in this tube is small, and its curve would be similar to that for the 226. As in the case of the 171A, the signal level in the plate circuit of this tube is so high that any hum voltage present would be negligibly small in comparison. Essentially the same applies to the 250 and 210 tubes, although in these the hum would be greater because of the higher filament voltage.

The relation between the amount of hum and the plate current is shown in Fig. 69 for three different tubes. These curves are for grid and filament voltages indicated. It will be noted that in each of these curves there is a point of minimum hum. Thus, for the 226, the minimum comes at 4 milliamperes, for the 201A, it comes at 5, and for the 112, at 9.5 milliamperes. Tubes can be designed so that the point of minimum hum falls at any desired value of plate current, and in practice they are designed so that it coincides with the normal plate current for normal operating grid and plate voltages.

A significant fact in these curves is that the hum increases rapidly as the plate current is reduced below the point of minimum hum. This indicates that if the tubes are used in circuits drawing very small current, such as resistance coupled amplifiers, the hum voltage will be exceedingly high. One would expect such circuits employing any of these tubes, or tubes with similar characteristics, to hum badly when AC is used on the filaments. As a rule, this is a fact.

However, it does not follow that the hum voltage will exceed the signal voltage developed across the plate resistance. If the signal impressed on the grid of the tube is high, the signal voltage across the plate resistor will be correspondingly high, and the hum, although large in absolute value, may be negligibly small compared with the signal voltage. Whether this is true depends on where the tube is in the circuit. If it follows the detector, the hum is likely to be great. Because of this rapid increase in the hum as the plate current is reduced, it is best to use heater type tubes in resistance coupled circuits, or else use DC on the filaments.

Most Useful Curves

The most useful curves of charasteristics of tubes are those giving the relation between the plate voltage and the plate current, taken without any load impedance, provided an entire family of such curves is available for each tube. One such family of curves is reproduced for each of the tubes used in power amplifiers, beginning with Fig. 70.

While the circuits shown in Figs. 62 to 67, inclusive, are primarily intended for taking grid voltage, plate current curves, they can be used also for taking plate voltage, plate current curves. It is only necessary to hold the grid voltage constant while the plate voltage is varied in suitable steps.

The 240 type high mu tube enters into power amplifiers only in direct coupled circuits, particularly in resistance coupled, and it is used only as a voltage amplifier. The performance of the tube when used in this manner can be seen from the family of plate current, plate voltage curves reproduced in Fig. 70.

In the upper left corner of the figure are five different lines representing load lines for five different load resistances as indicated. These lines are for convenience in drawing actual load lines such as the dotted lines. To draw any actual load line across the family of curves, the line should pass through the voltage on the plate voltage axis which is equal to the battery voltage in the plate circuit, and it should run parallel with the reference line representing the resistance actually used in the plate circuit. Thus the long dotted line passes through 300 volts, indicating that the plate battery voltage is 300 volts, and it is drawn parallel with the .5 megohm line, indicating that the plate coupling resistor is half megohm.

The short dotted line starts at 180 volts, indicating that the plate battery voltage is 180 volts, and it runs parallel with the .3 megohm reference line, indicating that the plate coupling resistance is 300,000 ohms. Load lines for resistance other than those represented among the reference lines can be drawn by noting that the slope of any line is the reciprocal of the resistance.

Due to the flow of grid current when the grid bias is near zero and to the fact that this current changes the actual grid voltage by the drop in the grid leak, the signal voltage should never be permitted to approach zero grid voltage closer than —.5 volt. And on account of the curvature of the characteristics when the grid voltage is excessively negative, the signal should not be permitted to make the plate current less than about .05 milliampere. This limiting current is shown by the dotted line running parallel to the plate voltage axis.

AN A B C SUPPLY

for 224, 227 and 245 Tubes, up to Eight

[The first instalment of this article on the construction of an ABC supply for 224, 227 and 245 tubes, was published last week. The final instalment follows. The supply furnishes all filament, plate and grid voltages. The total number of heater type tubes —224 and 227— should not exceed six. The 245 may be used singly or in push-pull. For push-pull connect a 1,500-ohm 10-watt resistor between points (1) and (4). The maximum drain should not exceed 100 milliamperes. An 8-tube set should not draw more than that.—Editor.]

* * *

FOR those who use a transformer with center-tapped 5-volt winding for the filament of the 280 tube, in building the ABC compact for 224, 227 and 245 tubes, the diagram is published schematically on this page. Last week the schematic showed the positive B voltage taken off one side of the filament—it matters not which side—as some will have transformers from which the center tap is omitted. But the recommended transformer block, made by Polo Engineering Laboratories, has the 5-volt winding center-tapped.

The center of the 12-ampere 2.5-volt winding is shown connected to negative of the B supply in Fig. 4 this week, which is a good place to put this lead. The only other change is respect to last week's diagram of the ABC supply is that the fuse and switch are in the primary of the transformer only, and not in the lead emerging from the convenience outlet shown in the lower left-hand corner. This alteration simplifies the wiring just a little. Last week a condenser for aerial pickup was shown, too. There is no substantial difference whatever between what was published last week and what is published this week in the wiring diagrams. The front cover illustration this week, which is pictorial, agrees in all respects with the schematic published herewith.

Mershon Bracket Grounded

The Mershon condenser has a special bracket, and one of the anchoring points of this bracket is used for establishing as negative the copper can that contains the Mershons. Always the copper can must be negative. The Mershons will not work the other way. These condensers are shown as C6, C7, C8 and C9, and all four are in the one can.

The piece of wood or bakelite used for supporting the high-voltage condensers C1, C2, C3, C4 and C5, each 2 mfd., will have to be improvised by the constructor. This is a simple stroke of work. The HV condensers are placed side by side and the position of the mounting holes recorded on the mounting strip or on a piece of paper. Then these holes, if on paper, are transferred to the strip by piercing the paper, and a 6/32 hole is drilled for each of the two feet of each condenser. A projection of ½-inch of the strip at one end will permit use of two small right-angle brackets, side by side, these being fastened to the strip with screws and nuts, while the other arms of the brackets are screwed onto the baseboard.

The fuse may be a small one, physically, and the size of the fuse shown on the front cover is not at all controlling. The only objective is to have a 1 ampere fuse, and this may be of the tiny cartridge type familiar to users of automobiles.

Limited Latitude in Resistors

The resistance values for the five sections of R1, represented by points (1), (2), (3), (4), (5) and (6), were given last week, and it is well to follow them in their approximate commercial values, as stated then. A variation will produce only little different results if confined to the sections between points (4) and (5) and between points (5) and (6).

The baseboard is 9 x 12-inches, and the layout of parts can be followed by from the front cover illustration, which is two-thirds actual size.

Some who desire to try out the method of obtaining the aerial input for a receiver from the ABC supply, and include perhaps the two extra binding posts, twelve in all, may refer to last week's diagram. The inclusion is a simple matter, but as the aerial pick-up from the AC line does not work in all locations, it is not shown in this week's diagrams. The fact that it works only on very sensitive receivers in some locations was stated last week.

Get it Working Same Night

The wiring of this supply does not amount to much work, in fact, it takes less time to do the wiring than to mount the few parts used, so there is no reason why you can not get the device working the same night you start to build it.

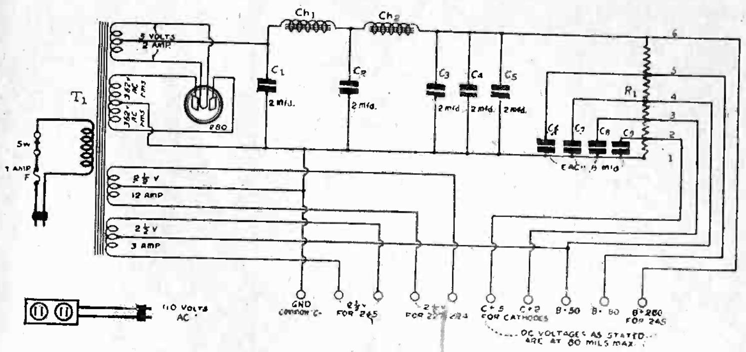

FIG. 4

CIRCUIT OF THE ABC SUPPLY FOR 224, 227 AND 245 TUBES, SHOWING TEN BINDING POSTS USED. THE FILAMENT CENTER TAP OF THE RECTIFIER IS CONNECTED TO THE FIRST CHOKE, CH. 1. THE CENTER OF THE 12 AMPERE 2½-VOLT WINDING IS JOINED TO THE NEGATIVE OF THE B SUPPLY. THE FUSE AND SWITCH ARE IN THE TRANSFORMER CIRCUIT.

If you meet any trouble do not suspect any error in the diagrams, as all of them are wholly correct, but look to your connections, especially such as are unfamiliar. One of these is the connection of B plus 50 volts to the same joint to which the midtap of the 3-ampere 2.5-volt winding is joined. This connection is absolutely correct, but if you try to figure out that it is wrong, and "improve" the diagram, you may get no grid bias for the last audio tube, or no B plus voltage for the screen grids of the other tubes.

Voltmeters will not do much good in measuring the grid bias voltages, particularly the small voltages, .5 and 2 volts, respectively. A vacuum tube voltmeter would do it, because it draws no current, but you may expect any other meter to make it appear that the .5 volts are zero and the 50-volt bias is something less than 50. However, good readings will be obtained from the other taps (5) and (6), if a voltmeter of 1,000 ohms per volt is used. If a meter of a few hundred ohms per volt is used, remember that the actual voltage is a little larger than what the meter reads. This is because the lower resistance meter draws enough current to make the extra drain effective in reducing the actual voltage present when the meter is thus in circuit. A suitable method of getting an approximate voltage for the 50-volt section, when a fair meter is used, is to measure the total voltage from point (6) to point (1), and the voltage between points (6) and (4), and subtract the second from the first, to obtain the approximate voltage between points (1) and (4).

Other Trouble-Shooting

Test the fuse, as it is open if voltage is in the circuit only when the clips are shorted.

If no voltage readings are obtained, use a screw type socket in a wall bracket or electrolier,, where an electric lamp was lighted immediately previously, then insert the wall plug of the supply's convenience outlet into this screw socket. This will insure a working voltage source. Next determine whether the transformer primary is open or shorted. This is easily done by removing the plug from the screw socket and putting an indicating device in series with a voltage source, and connecting the primary in the circuit. For instance, connect a 110-volt lamp in series with the primary and one AC cable, putting the cable ends to the wall or other outlet. If the primary is shorted the lamp will light with usual brilliance. If the primary is open the lamp will not light at all, and if in good condition there will be just a faint evidence of illumination.

Satisfied as to the primary, test the 5-volt secondary by putting a 2.5 or 6-volt lamp across it. If the winding is O. K. the lamp will light. For the 2.5-volt secondaries use the same small lamp. A 0-600 AC-DC meter will test each half of the secondary, but, lacking this, put a 5,000-ohm resistor across one section, next across the other. If it gets warm that secondary is O. K., so test out the 280 tube, the filter condensers and chokes, by-pass condensers and voltage divider.

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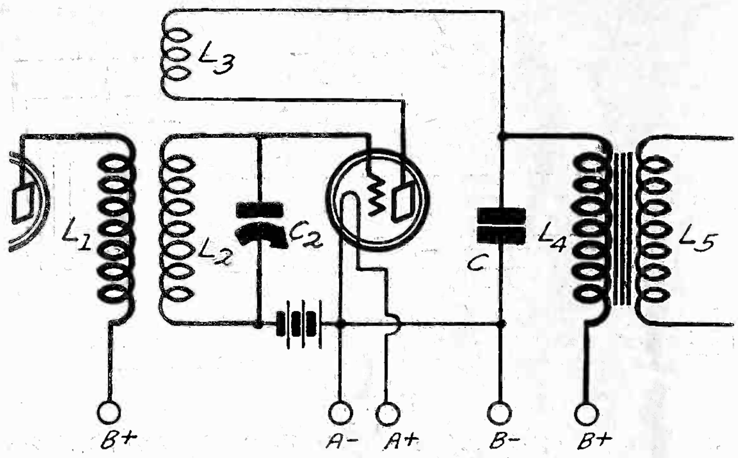

FIG. 778

THE BYPASS CONDENSER C IS USUALLY EFFECTIVE IN IMPROVING THE DETECTION ACTION OF EITHER TYPE DETECTOR. A CAPACITY FROM .00025 TO .001 IS USUAL.

I WOULD like to fuse my B supply, to protect the rectifier tube in case of a short. What is the best place to put the fuse? I thought of putting it between the output of the filter section and the present junction of this output to the voltage divider.—J. K.

It is a good idea to fuse the B supply. Then a short blows an inexpensive fuse, and no damage to the rest of the circuit will result. The place you selected to put the fuse is singularly inappropriate. If you want to put the fuse on the secondary side, then use it as an interceptor of the positive lead running from the filament of the rectifier to the beginning of the filter chokes. A better position, however, is in the primary circuit, 110 volts AC. Then the fuse will be active in respect to all that the voltages, including the AC input, the filament voltages and the plate voltage. A cartridge type fuse of 1 ampere would be adequate for the average set, consisting of six heater tubes, a 280 rectifier, and a 245 output tube. This combination draws .63 ampere in the primary, so a 1 ampere fuse in such a circumstance provides a good safety factor.

* * *

IS it necessary to include bypass condensers in a battery-operated receiver? I have a five-tube set, but never used any bypass condensers.—T. R.

It is seldom necessary, but always advisable to use them, especially if the B batteries are retained until their period of useful life is over. This is really the most economical way to use B batteries, and is better than the arbitrary method of discarding them when their voltages drop below a certain level, since even when this drop is exceeded many such batteries are useful. The bypass condensers reduce the effective impedance of the used B batteries, and prevent common coupling between circuits that may assert itself as either radio-frequency or audio-frequency oscillation, particularly audio-frequency. Also the condensers bypass radio frequencies around the batteries and improve selectivity a little, and often stability as well. The capacities should be as large as you can readily afford. While in many instances reports of "no difference" will result, there is always a difference, which, under most favorable operating conditions, is rather subtle. The fact may be, of course, as your own experience teaches you, that the circuit will work well without the bypass condensers, but it can never work better without them.

* * *

IS IT practical to have a power transformer and filter chokes all in one block, encased? How do results compare with separated units? What should be the voltage reading across the entire secondary of a power transformer, for the high voltage of a 280? —O. K.

The single block, housing the 110-volt AC primary, all the filament secondaries, the high voltage secondary and the choke coils, with separate cores, is thoroughly practical, indeed is the common method in factory-made receivers. The results compare favorably indeed with those of the separate unit method. The high voltage winding, across its total, supposing a drain of 60 milliamperes, and not allowing for drop in the filter chokes, should be 550 volts for a resultant 295 volts D. C. This 295 is distributed on the basis of 5-to-1, power tube plate voltage to power tube bias voltage, assuming a 245 is used. There is a tendency to favor a somewhat lower than maximum allowable voltages on the rectifier secondary, as it is not necessary to work any power tube up to its very limit of maximum undistorted power output, and safety and life factors are introduced by scaling down the voltage a little. The present trend is toward 750 or so volts across the secondary (375 volts root mean square across each half) so that at 60 mils, allowing for drop in chokes, the applied plate voltage is 245 volts on a 245 bias on the last tube 50 volts. When the drain is larger the voltages are lower. As the larger drains are usually due to push-pull audio, the favoring of lower than "hilt" voltages is satisfactory.

* * *

SHOULD the bleeder current be high or low?—J. H. D.

It should be high, if the set itself draws relatively little current, say, 40 mils or so, and the rectifier is a 280 or larger tube. Then the high bleeder tends to establish stability of voltages, and the biasing section of the voltage divider in particular gains the advantage of lower resistance being used to establish the desired voltage potetnial difference, hence the bypass condensers are more effective. Their impedance is relatively larger, due to the decreased resistance of the voltage divider or biaser. This heightening of the impedance efiect of bypass condensers holds good throughout, but does not apply to the filter condensers.

* * *

IN A resistance-coupled audio amplifier many have noticed, no doubt, the fact you pointed out in a recent issue, that the signal seems to block, but that when you put your wetted fingers across a resistor, particularly the one in the last audio grid circuit, the circuit functions normally. A lower value of resistor certainly cures this. However, you stated that this blocking was due to the grid going positive. Everywhere that I ever read anything about this phenomenon it was stated that blocking of the grid circuit was due to the grid becoming too negative. How come?—T. G. F.

That's what we'd like to know, how come that this condition has been referred to so much in other quarters as one caused by the grid swinging too much negative. A milliammeter is the only instrument any one needs to determine the fact—and it certainly is a fact—that the grid goes positive. You should see the plate current swing up and you wouldn't doubt.

* * *

WHAT makes a radio set go?—O. T.

Electricity. The fact that the set receives electrical pulsations emitted by a station, and renders them audible to a reproducer, makes the set valuable.

* * *

WILL a horn type speaker unit, with a horn of the exponential type, to which the unit is attached, enable good tone quality?—H.F.

Yes.

* * *

PLEASE print a table for converting broadcast frequencies to wavelengths, with the wavelengths given to .1 meter, and for converting wavelengths of that accuracy to frequencies of absolute accuracy.—M.J.O'B.

You will find the table on page 4 of the July 27th issue of RADIO WORLD.

* * *

IS A detector bypass condenser absolutely necessary, or may it be omitted on the ground that it will bypass some of the higher audio frequencies in the transmitted wave?—J. F. R.

In some circuits the condenser is imperative, in others it is actually a deterrent, while in some others it makes little difference in or out. Fig. 778 shows a negative grid bias detector, with C as the detector bypass condenser from the return end of the tickler coil to filament minus. The usual capacity is from .00025 mfd. to .001 mfd., but a good compromise is .0005 mfd. The only safe advice is that the condenser be tried in and out of circuit and the difference, if any, noted. The .0005 mfd. capacity need not be feared as a high audio frequency cutoff, as frequencies as high as the audio amplifier and speaker will pass are permtited to go through with a minor percentage of attenuation.

* * *

MY aerial is one of twenty-six on the roof of an apartment house. It is difficult for me to raise it much higher than it is, as I must use the mast provided by the superintendent. However, I would like to get more than ordinary results, especially in regard to distance. What do you suggest?—P. E. R.

Under the circumstances all you need do is to provide yourself with a very sensitive receiver. You may use your present aerial and regularly receive stations thousands of miles away, many of them in the daytime, while at night you may get reception from one coast to the other. Examples of extra-sensitive receivers are the MB29 (using AC tubes), and the Silver Marshall's successor to the Sargent-Rayment, soon to be made public.

* * *

BOOMY effects produced by a dynamic speaker in a cabinet box in my home are not present when I use an inductor speaker in the same box. Is this due to the inductor speaker working better out of my set than the dynamic speaker?—F. D.

No. The box resonance is present in both instances. With the dynamic speaker in the box, however, this resonance is additive, since the speaker itself has some strong resonance points in the same general audio frequency region. In the instance of the inductor speaker there is no cumulative effect, so that speaker gives you a better result when used in the same box. If you used a different make of dynamic speaker you might find the speaker worked the same as the inductor type in this respect. Different manufacturers use different "natural pitches" in their dynamics. Some even include frequency filters in the speaker, to cut down or build up certain audio frequency bands.

* * *

I MOVED my home receiver to a bungalow at the seashore, but the volume isn't what it used to be, by any means. It goes up, however, when I hold my hand on the cold water pipe to which the set is grounded. Of course I can not stand there interminably, holding my hand on the pipe, so look to you for assistance.—R. F.

Obviously there is nothing the matter with the receiver, but there is too low a pickup. When you touch your hand to the cold water pipe you establish yourself as a temporary aerial. Your statement indicates that by mistake you connected the ground lead to the antenna post of the receiver, hence the aerial may be grounded on the batteries or other supply. Reverse aerial and ground connections. Double the length of your antenna and raise the height of the antenna all along the line. If possible, raise the height at the lead-in end several feet above the height of the rest of the aerial. Have the lead-in be simply a continuation of the aerial itself, and use insulated wire for the entire aerial and lead-in as a precaution against the effects of grime and soot and interfering connections.

* * *

MY volume control is a resistor across the secondary of the first audio transformer, really a high-resistance rheostat. Is this a good volume control? It does not seem to correct the condition of overloading as nicely as it should.—H. F.

It is not a good volume control. The impedance presented to the first audio tube is constantly changed, by adjustment of the movable arm of the resistor, and you depend on lower impedance producing lower volume. This lower resistance also sadly affects the low-note reproduction. It would be preferable to use a potentiometer across this secondary, say of 500,000 ohms total, and connect the movable arm to the grid, so that the full resistance always will be in circuit, but the voltage taken off the drop in the resistor-and-secondary will be only so much as you desire. Overload correction is difficult even by this method, as the volume control is in the wrong place. Preferably it should be ahead of the detector, as that tube is likely to overload before the power tube, especially if leak-condenser detection is used. An adjustable antenna coupling is a good volume control, provided the set does not squeal at low values of coupling.

* * *

I WOULD like to use a B supply for the 227, 224 and 245 tubes, where the filament voltages also are furnished. Please state when such a diagram was published.—R. W.

The constructional details were presented last week, in the August 10th issue, while this week the picture diagram of the wiring, and some additional textual information, are printed.

* * *

MY B eliminator is one that provides 180 volts maximum and has adjustable intermediate taps, marked 22 to 45, 67 more or less, 90 more or less. The zero point and 180 are fixed, of course. But I get somewhat different voltages on my set calibrated in one or the other?—P. T. A.

Any B eliminator provides different voltages as the current drain is made different. The voltages depend considerably on the amount of current drawn, and this applies also to the individual taps. Thus, at a given setting one tap may provide 70 volts for one receiver, but when more current is drawn from this tap the voltage may go down to 65 or less. The adjustment should be changed to provide the voltage you desire, or, in some instances it will be necessary to use the next highest tap, to get about the desired voltage, because of larger drain from this tap than normally would be expected.

* * *

WHICH is the better system to use in classifying stations—frequency or wavelength? How shall I use a dial on my set calibrated in one or the other?—P. T. A.

The frequency designation is favored in scientific circles, and for years an effort has been made to impress on the public the desirability of using frequency instead of wavelength. One reason is that the allocation of stations is on the basis of frequency. There is a 10 kc separation between channels. The separation on a wavelength basis is different all through the scale, due to the changing proportion that affects the formula of conversion of frequency to wavelength. The calibration of the dial can not be utilized unless the coil-condenser system is specially designed to render it possible, or a calibration is taken of an existing tuning arrangement, and special dial scale made to furnish readings in frequencies or wavelengths. Usually these calibrated dials are closely approximate, but not absolutely accurate, in broadcast receivers. Laboratory instruments that read frequency or wavelength directly are more accurately made.

* * *

IN THE Push-Pull Diamond of the Air, AC model, you have an impedance coil in the output of the push-pull pair, while the speaker is connected from plate to plate. I do not see where you get a voltage drop across the speaker or why this method works

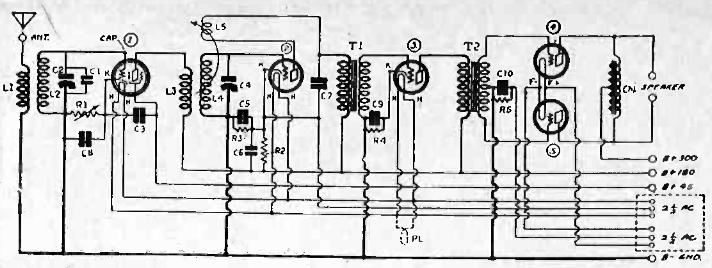

FIG. 779

THE PUSH-PULL DIAMOND. THE OUTPUT IS TAKEN FROM PLATE TO PLATE. ONE READER INQUIRES WHERE THE VOLTAGE IMPRESSION ARISES ACROSS THE SPEAKER.

at all. How about direct current through the speaker windings eventually burning out the speaker magnet coil?—P. H. W.

The two push-pull tubes work 180 degrees out of phase in the plate circuits, and as the speaker magnet coil, or the voice coil of a dynamic speaker, is across these two points, there are only an alternating current and voltage across the speaker. This AC power is positive at one extreme end of the coil (one plate of one tube) when it is negative at the other extreme end of the coil (plate of other tube). The direct current does not flow through the speaker because the equal and opposite direct currents cancel. The midtap connection to B plus makes this possible. See Fig. 779.

* * *

MY B batteries do not last as long as they should on a 5-tube set. I have a 171A power tube and four 201A tubes. My speaker is of the magnetic type and is fed through an output filter.—J. H. R.

Defective tubes or incorrectly biased tubes will result in quick ruin of B batteries, which otherwise should last for six months or more of average use on a receiver like yours, provided large-sized B batteries are used, as is advisable where the output tube is a 171A. Your set should not draw more than 36 to 38 milliamperes at rated voltages. The first suspicion should attach to the bias on the last tube, 171A. Perhaps the battery furnishing the C voltage has run down far below its original voltage. That would increase the plate current materially, and shorten the B battery life. At 180 volts applied, the negative bias should be 40.5 volts, but a 45-volt B battery used as a C battery will serve nicely, if you have no battery at the lower voltage. Test the plate current drawn by each tube. Under ordinary conditions each 201A tube should not draw more than 4 or 5 milliamperes, except the detector, which would not require more than 1 milliampere. The 171A output tube should draw about 20 milliamperes under the rated voltages, as stated.

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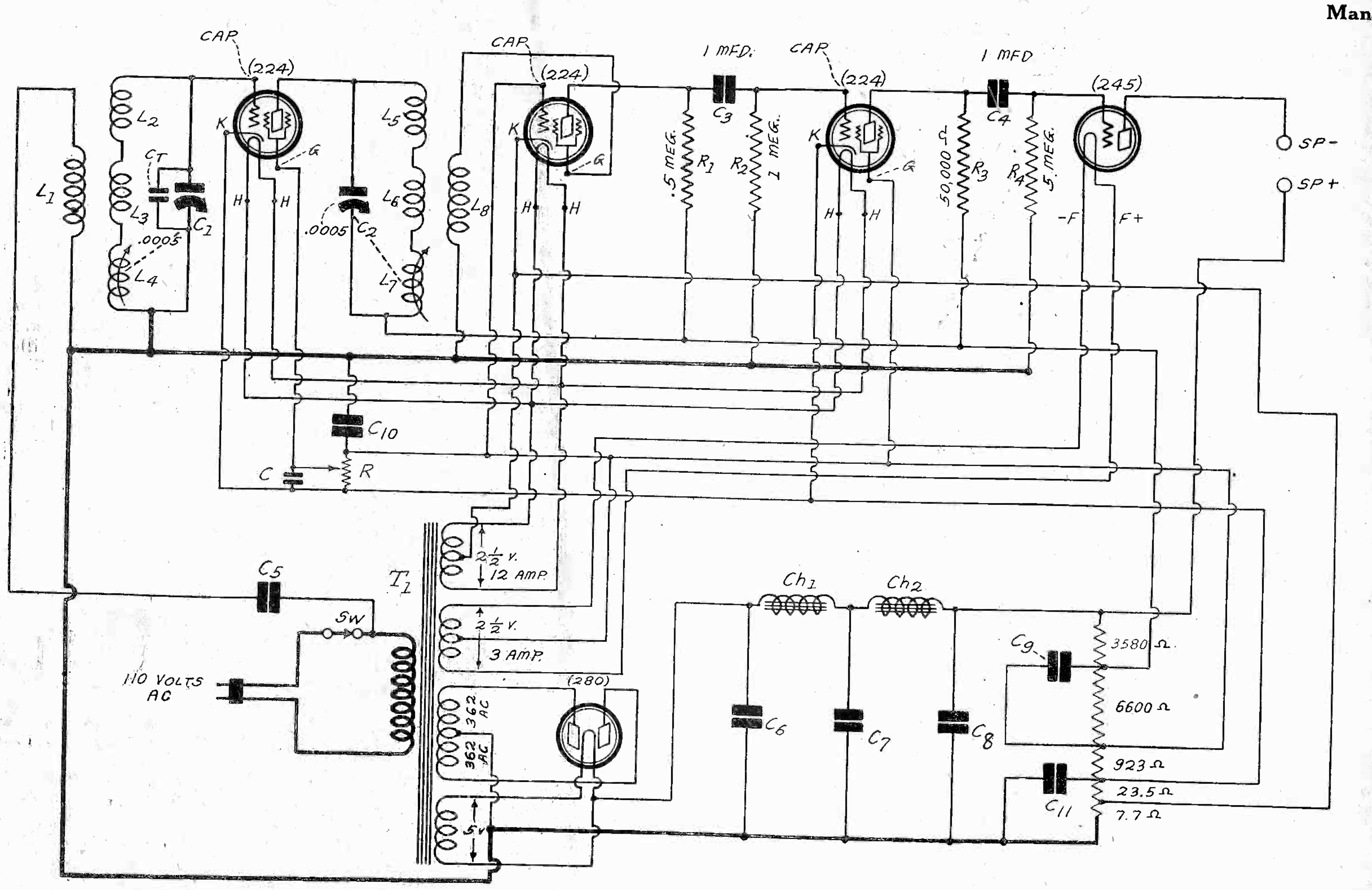


FIG. 1
ADVANCE SHOWING OF AN AC CIRCUIT DESIGN TO BE KNOWN AS THE HB COMPACT, MODEL AC. THE 224 RF TUBE IS USED AT MAXIMUM GAIN, THE DETECTOR (SECOND FROM LEFT) IS THE SPACE-CHARGE GRID TYPE, WITH NEGATIVE BIAS DETECTION, WHILE THE 224 FIRST AUDIO AND 245 OUTPUT COMPLETE THE CHAIN. A NEW TUNING SYSTEM IS USED. IF OTHER THAN A DYNAMIC SPEAKER IS USED AN OUTPUT FILTER IS REQUIRED.

THE tuning arrangement whereby a considerable part of the tuned winding is a rotatable coil, coupled to the shaft of the condenser that is across the circuit, may be used in an AC design as shown in Fig. 1. The method of tuning, as described in the July 27th and August 3rd issues, enables one to cover a wider range of frequencies than just the broadcast band, going to higher or lower frequencies, as desired, or to cover the broadcast band only, when the circuit formation is such as to defeat this objective otherwise.

The present instance is one where the special tuning arrangement is used for insuring tuning in the lowest and the highest frequencies of the broadcast spectrum, even though a tuned plate circuit, using a screen grid tube, will develop a large minimum capacity across it, and though substantial coupling to the detector makes the untuned secondary reflect in the tuned primary a still more substantial starting capacity, due to the cumulative effect of the distributed capacities of the two coils. It was necessary therefore to devise some method of overcoming this obstacle, which presented itself in the Screen Grid Universal last year, where an enormously sensitive receiver was developed, at the expense, however, of missing out on some of the lower wavelengths, due to the high starting capacity.

Highest Possible Amplification

The reasons why the new coil system overcomes this difficulty were explained fully in the July 27th and August 3rd issues. In a sentence, the moving coil, in series with a fixed winding, gives full aiding coupling, hence increases inductance, at one parallel position, while the position of the coil at zero coupling, or right angles to the fixed form, produces no different effect than if the moving

NER IN AMAZINGLY C COMPACT

d as Detector and First AF, with 245 Output

n Bernard

Editor

coil were out altogether, and rotation thereafter, to the opposite parallel position, makes the moving coil buck the fixed winding, hence decreases the inductance, so variation in inductance is in the same direction as variation in capacity, enabling tuning in the full frequency spectrum.

There is no known method of obtaining full amplification from the screen grid tube at radio frequencies without tuning the plate circuit, but in may circuit designs maximum gain would be impracticable. In the present circuit not only is the plate circuit tuned but an actual step-up ratio to the detector input is established.

Data On the Coils

Different data on the construction of the coils were given in the two previously mentioned issues, and it was explained that the new system of tuning could be accomodated to a variety of special needs, the geometry of the coil so arranged as to produce the desired results. Some persons like to tune below the broadcast band without changing coils or condensers, say, go down to 150 meters, which is not difficult with this system, using .0005 mfd. tuning condensers with suitable coils. But where highest gain is desired the coils in the present circuit must be used only to insure covering the entire broadcast band, as the high minimum capacity prevents reaching frequencies much higher than the highest in that spectrum, except at the expense of missing out on lower frequencies, and the object is to miss nothing.

For the present circuit neither of the coils described in the previous issues should be used, as the intent is to provide a still mightier input to the detector. The circuit previously discussed was for battery operation. This one is AC operated, and the parts are fitted nicely into a 7 x 15 x 9½" steel cabinet, a joyfully compact housing that helps make this, I believe, the smallest-sized AC circuit ever presented for construction by experimenters and the like. Remember that everything is housed in this little cabinet.

The layout was not easy to establish. Early in April, for instance, I started work on the battery model, about a month after I had reduced the new system of tuning to practice. In three weeks the battery model's kinks were solved, and all was serene. Next I tried a companion model in AC. The AC circuit always was about the same. During the first week in May it was built on a breadboard, no space limitations prevailing, and most extraordinary results were obtained. The first model reconstructed in a small cabinet worked well, but not quite as well as the breadboard layout. Another arrangement of parts was tried. This was a fizzle. The radio frequency oscillation was bad, the operation of the receiver so erratic that different results were obtained each time the switch was turned "on." This was instability of about the worst possible order.

Success After Three Months

Then another layout was attempted, and this fortunately was remodeled by the end of July, so that the remarkable results obtained from the breadboard arrangement were even exceeded, that is, still greater sensitivity resulted. This was no doubt due to taking the "bugs" out of the layout of the previous AC models, and also to an increase in the degree of coupling of the screen grid tube to the detector. The looser coupling aided instability in a bedevilled fashion. At first blush this seemed contrary to theory, but reconsideration proved that the results were just what should have been expected. The greater number of turns on L8 accounted for not only greater minimum capacity in the tuned circuit, C2, L5L6L7, but also for the extra radio frequency resistance that was required for stability, as negative resistance had been prevailing.

So it took almost three full months to achieve the desired result

Those who delight in trying out new arrangements may follow the diagram, Fig. 1, for the constants not given there are printed here. The diagram happens to show three windings in a chain as constituting the tuned circuit, but the coils used had only two windings thus connected, for simplicity, although the electrical performance is of course the same. It was simply a question whether for production convenience the moving coil's shaft should protrude from the center of a split winding or from one end of a single winding. Finally the single winding was selected. So L2L3 may be considered as one winding, and L5L6 likewise. They are on the fixed form. L4 and L7 are the moving coils, the shafts of which connect to the tuning condenser shafts. Two separately tuned circuits are preferable for this design.

A Rewound Tuner

A standard three-circuit tuner may be rewound to fit the present needs. Provide a shaft for extension from rear. Whether the coil is made for .0005 mfd. or .00035 mfd. tuning, remove one-third the total number of turns on the secondary. Make this removal at the end opposite the one where the primary is wound, as you will want to use the primary. Now connect one end of the moving coil to one end of the reduced secondary, and use the two remaining ends of moving coil and fixed secondary for connection to the cap of the screen grid tube and to grid return, respectively. The primary remains intact and is connected to the B negative lead and to C5, which may be .001 to .02, mfd., but must be of mica dielectric. If you need more selectivity, favor the lesser capacities. The circuit therefore will operate "without aerial, ground or batteries," where the phrase is used in its popular but not its technical sense, as the capacity connection to the AC line constitutes an aerial. In some locations no pickup is obtainable by this method, so C5 would be omitted and one terminal of L1 would go to the lead in of an outdoor aerial.

The interstage coil may be revamped along the same lines, so far as the winding for the tuned circuit is concerned, but the small winding, or primary, is removed. A 60-turn coil is inserted inside the other, hence must be on a smaller diameter, say ¼" less. The 60 turns are used for coupling to the detector.

If only the forms are available, and it is not desired to revamp existing three-circuit tuners, then for .0005 mfd. the winding data may be: On a 2½" diameter tubing, 2" or more high, wind 14 turns of No. 24 silk covered wire, leave ¼" space, and wind 36 turns adjacent, using the same size wire. On a 1¾" diameter wind 10 turns on each side of a shaft, total 20 turns, using No. 24 wire, and mount the movable coil on the fixed form with shaft extending front and back. One end of the moving coil is connected to one end of the fixed winding in the tuned circuit, the total series constituting the secondary. The two remaining ends of these two series-connected windings are brought out to lugs for connection to the tuning condenser, grid (cap of tube) and grid return.

Dials Read in Step

The moving coil is therefore in the tuned secondary on the antenna coil, but in the tuned primary on the interstage coupler.

The secondary for the interstage coupler is a fixed winding of 60 turns of No. 24 wire on a 2¼" form, fastened inside the other. The primary is like the antenna coil secondary.

CT is whatever capacity is necessary to equalize the tuning, that is, make the dials read exactly alike all through the scale of broadcast frequencies, and of course is used for building up the starting capacity of the first circuit to equal that of the second. About 50

(Continued on next page)

NEW TUNERS

Shaft is Made Solid from Front to Back

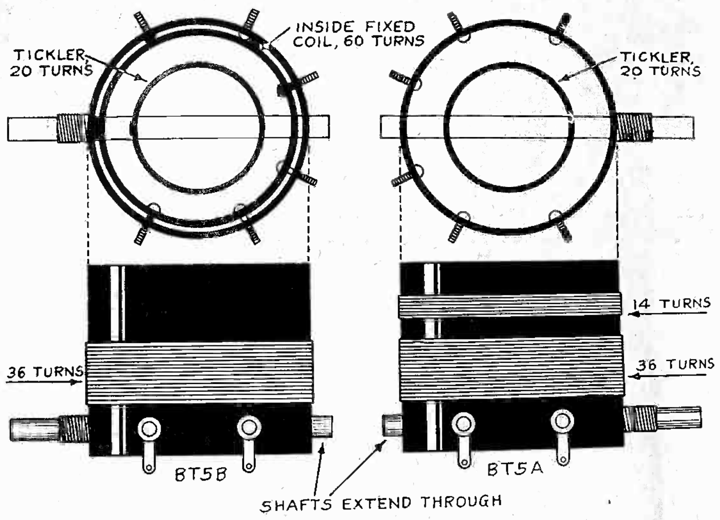


FIG. 2

THE TWO COILS FOR THE HB COMPACT, THE SAME INDUCTANCES TO BE USED FOR AC OR BATTERY MODEL. THE SHAFT HAS TO GO ALL THE WAY THROUGH THE COIL FORM TO ENGAGE THE TUNING CONDENSER SHAFT BY MEANS OF AN ADDITIONAL FLEXIBLE COUPLING. THE NUMBER OF TURNS IS STATED ON THE DIAGRAM. THE WIRE IS NO. 24 SILK COVERED. THE DATA ARE FOR .0005 MFD. TUNING.

(*Continued from preceding page*)

mmfd. maximum has been found sufficient, the condenser being permanently set at something less.

The coils may be mounted on the front panel, if condensers are used that do not have shafts projecting at their back, since the coils provide the projecting piece. But if condensers with extension shaft from rear are at hand, the condensers may be mounted on the front panel, the coils behind them. Insulate the second condenser from a metal panel. In either instance an insulated flexible coupling is used.

In the final laboratory model the coils were mounted on the front panel, because the windings have no electrical connection with the moving form, whereas with a condenser the moving plates and the shaft are one electrical lead. Hence though a metal cabinet, of which the front panel is a part, was in the B minus lead, no short resulted when the interstage coil was put on the front panel. The absence of electrical connection between coils and front panel, plus the precaution of using an insulated flexible coupling device, preserved the independence of the circuits, so that the tuned plate circuit, in the B plus lead, was not connected to the B minus lead, which would have shorted the B supply.

Constructional Details Soon

The discussion of the circuit shown in Fig. 1 is preliminary to the publication of articles detailing the construction. These articles are scheduled to be published in RADIO WORLD beginning in September, but they will be preceded by constructional articles on the battery model. For those who desire to experiment with the AC circuit in advance of the details of just how it should be constructed the following data are given: C is 1 mfd.; C10 is 4 mfd.; C6 and C7 are 2 mfd. each; C8 is 4 mfd. C9 is 2 mfd. The power transformer block, with choke coils Ch1 and Ch2 built in, is the product of Polo Engineering Laboratories. The second is used as a space charge detector.

Some slight changes may be expected in the circuit formation when the constructional articles are published, although at present no reason appears for making any changes. The reservation is made, however, so that any who distinguish a difference between what is published in the present preliminary article, and what will appear later, will know that considerations of simplicity or performance have made it advisable to include the changes. It is promised, however, that any alterations will be slight, so those who feel like going ahead with a working model now will not have any trouble including subsequent changes. At present they would have to develop their own layout, and if all the parts are to be encompassed in the small space as previously stated, the builder will have to resort to a little ingenuity.

Shaft In Three Pieces

The construction of the coils may have baffling features to some experimenters, especially as the shaft has to run through the coil to extend from the rear. The front part of the shaft is standard and projects outward in the same manner and to the same degree as any ordinary three-circuit tuner. The rear piece emerges only ¼ inch, however, because the longer this part is made, the greater the distance of the tuning condenser from the coil, and the greater the lost space. The shaft really consists of three pieces: first, the piece that pierces the coil form from the front, a screw at inside end; second, a connecting piece, tapped hole to fit the screws; third, the piece that projects ¼ inch at rear, with screw at inside. As the necessary implements for providing screws at the extreme pieces and for tapping the center piece may not be at hand, it is suggested that any stiff shaft, of copper or brass, be soldered to the two extreme pieces to produce the unified result. This is a makeshift, but it will do nicely.

Look Out for the Roof

The best warning that can be given to any who attempt to follow the preliminary data and build up this receiver is to see that the roof is secure to the rest of the house, as the volume produced by this circuit is far and away ahead of anything that you would expect from a 4-tube design. It is a 4-tube set, not counting the rectifier, but a custom is growing up of including the number of rectifier tubes at the end, so this would be a 4-1 receiver, meaning four AC tubes and one rectifier.

Some tests are being made now to determine if this is the best four-tube AC receiver, or 4-1 receiver, that has been developed so far, considering of course the usual standards of sensitivity, selectivity and tone, and as a fourth consideration including stability. It is easy enough to obtain high sensitivity from a receiver consisting of few tubes if the set is made tediously critical, of the squealing type, hard to control, but where decent stability is included, then the design of a sensitive and selective receiver consisting of few tubes becomes more difficult.

So far nothing has proved itself superior to the present design for AC operation, but the tests have not been completed, although a fair and true report of the results, whatever they may be, will be published.

Commercial Coils

The coils are now obtainable commercially, being known as BT5A for the antenna coil, and BT5B for the interstage coupler, both for .0005 mfd. The two coils of the commercial type, with winding data, are illustrated on this page. They are manufactured by the Screen Grid Coil Company. There are six terminals on the coils, but interconnecting one tickler terminal and one terminal of the fixed secondary will reduce the externally connected outlet lugs to four for either coil: two for the primary and two for the secondary. Remember that the 14 turns are the primary for antenna connection, while the tuned winding is the primary for the interstage coupler.

[*Other interesting data on the Bernard Tuner next week.*]

A THOUGHT FOR THE WEEK

Through a love song we sit and we listen
You and I, in the twilight grey;
Never thought, dear, of lovin' or kissin'.
Not a word, dear, have we to say.

Singer's voice, with emotion so laden,
Clearly comes o'er my radio.
All is dark—but there's no use evadin'
Gleamin' eyes of you, lady O!

—R. B. H.

EFFECTS OF GRIDS

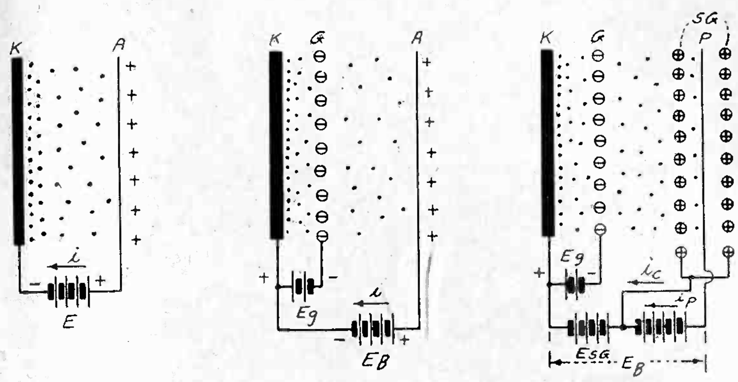
Electron Action in Tube Analyzed

By Harrington J. Forbes

[What an electron is, how it behaves, and finally, what its importance is to the operation of a vacuum tube, were exposed last week in the August 10th issue. An understanding of the electron theory is highly important to a cultured appreciation of vacuum tube action. This week the electrons in the two-, three- and four-element tubes are discussed in the final instalment.—Editor.]

THE currents indicated by arrows in Fig. 3A are the electron stream and not the conventional current, as is clearly indicated by the direction.

The scheme indicated in Fig. 3A is that of the diode, or two-element tubes first put to radio use by Fleming. It is used for detection and for rectification, for example, in B supply units in which the rectifier tube is of the filament type.



A B C

FIG. 3

THE ELECTION CURRENTS IN THREE TYPES OF TUBES. A REPRESENTS A DIODE, K BEING THE HOT EMITTER AND A THE PLATE OR ANODE. IN B THE TRIODE IS REPRESENTED, IN C THE SCREEN GRID TUBE OR TETRODE. THE ELECTION FLOW, NOT THE REGULAR A AND B CURRENT FLOW, IS SHOWN.

Insertion of Grid

Now let the arrangement in Fig. 3A be changed as shown in (b). A grid G, consisting of parallel connected together metallically, and indicated by circles, is interposed between A and K. The grid is kept negative with respect to K with the battery Eg, while the plate is kept positive with respect to the K with the plate battery Eb.

Since G is negative with respect to K it will repel the electrons shot out from K, and it will therefore aid K in pulling them back. The greater the negative charge, or potential, on G, the more effective G will be in repelling the electrons. Since G is a grid in physical structure there are spaces where there is no repelling force and where electrons may get through if they come up with sufficient velocity. The electrons are aided to get through the open spaces of the grid by the fact that the positively charged plate acts through the openings, attracting the electrons. Once an electron has passed through an opening in the grid, they are not only attracted by the plate, but they are pushed in the same direction by the repulsion of the grid. It is only those electrons which are projected from the cathode with the highest velocities that are able to overcome the combined attraction of the cathode, the repulsion of those electrons farther away and the repulsion of the grid.

If G is maintained at a sufficiently high negative potential, for a given cathode temperature and a given plate potential, all the electrons emitted are repelled so that none can get to the plate. This condition obtains when the negative grid voltage multiplied by the amplification factor of the tube is greater than the voltage of the plate battery. Then there is no plate current.

Screen Grid Added

Now let a second grid be introduced into the tube, one surrounding the plate as shown in Fig. 3C. In this drawing the circles containing plus signs on the sides of the plate represent the cross sections of the screen grid wires. This grid is connected to a positive potential somewhat lower than that applied to the plate. The portion Esg of the plate battery Eb is used for maintaining the screen grid positive with respect to the cathode.

The action of the cathode and the grid G is not changed materially by the introduction of the second grid, but the number of electrons reaching the plate is different. Now both the plate and the screen grid attract electrons. They compete, so to speak, for the electrons that succeed in getting through the grid openings. Suppose the screen grid voltage is fixed and the plate voltage varied from zero up to a value several times greater than the screen grid voltage.

Plate Begins to Attract

When the plate voltage is zero the screen grid alone will attract electrons and the plate current ip will be zero. The screen grid current ic will be high, provided that the grid voltage is not so much negative as to stop completely the electrons. As the plate voltage is increased the plate will begin to attract electrons and plate current will flow. At the same time the number of electrons attracted to the screen grid will be reduced. When the screen grid and plate voltages are approximately equal the number of electrons attracted by the two electrons will also be equal. Then as the plate voltage is inreased above the value of the screen grid voltage, the number of electrons attracted to the screen grid will decrease continually and those attracted to the plate will increase. A plate saturation current is soon reached as the voltage is increased, and this is determined by the electron emission from the filament and on the number of electrons passed by the grid.

How to Operate Tube

The screen grid tube should be operated so that the effective plate voltage is never less than about twice the value of the screen grid voltage. When it is less the action of the tube is very irregular.

Shielding Valuable But Exacts Tax

The eddy currents induced in any shielding, and which actually do the shielding, require some energy, because no shielding material is a perfect conductor. This energy must come from the coil surrounded by the box, for there is no other source of energy. Any energy loss signifies resistance, and therefore the shielding introduces resistance into the coil and lowers the selectivity of the circuit of which it is a part.

The shielding has other detrimental effects. First it reduces the effective inductance of the coil, for the inductance is the magnetic field per unit current, and the reflected field opposes the original field. Thus when shielding is used more wire must be used to obtain a given inductance. The added wire adds more resistance.

However, there is an effect which offsets this effect, and that is the capacity between the shield and the components of the tuned circuit. This added capacity is quite considerable if the shield material is close to the coil. The distributed capacity thus added decreases the tuning range of a given coil and condenser. In order to cover the broadcast band with a single coil and condenser it may be necessary to make the range of the condenser 0-750 mmfd. instead of 0-500 mmfd.

Shielding is not necessary in all instances, only when there are three or more tuned stages with a high degree of amplification in each. When there are only two tuned circuits, even when one or two screen grid tubes are used, shielding as a rule does more harm than good. It may stop oscillation, but at a high cost of sensitivity and selectivity. There are other methods of securing stability in simple circuits.

STATIONS KEEP AIR CLEAR OF STOCK GAMBLE

While the New York Stock Exchange has established rules to govern broadcasting of stock quotations and other financial information by its members, New York radio stations do not manifest much interest in such broadcasts.

John Gordon, sales manager for the Columbia Broadcasting System, said that several brokerage firms had made requests to broadcast stock reports and advice, but that all requests had been rejected.

"We have always fought shy of any broadcasting of a speculative nature," he said, "and when such propositions were submitted they were immediately rejected."

No requests by financial concerns for the broadcasting of stock quotations have been made to the National Broadcasting Company, a representative of that company said, and if any request is made, it will be accepted only on the same basis as the stock broadcasts by WJZ daily, which information is now supplied by the Associated Press.

A year ago WMCA settled the question of stock quotations sponsored by a brokerage firm by deciding in the negative, according to a representative of that station.

"Radio Questions" in a New Edition

Radio Operating Questions and Answers, by Arthur R. Nilson and J. L. Hornung. McGraw-Hill Book Company, Inc., New York ($2.00).

This is the second edition of the author's book, "Radio Questions and Answers," brought up to date to meet the many changes in the art of radio communication since the publication of the first edition in 1921.

The book is primarily intended for those students of radio preparing to take the United States Government examination for commercial operating licenses, and, as the title indicates, the treatment is in the form of questions and answers. There are 399 questions in the book, with complete answers, covering every subject necessary for understanding the operation of commercial and broadcast radio stations. There are also two appendices covering Government regulations and international abbreviations and conventions. The book is well indexed for ready reference.

Station in Buffalo Would Fight Monopoly

Washington.

The Buffalo "Evening News" filed with the Federal Radio Commission an application for authority to construct and operate a broadcasting station in Buffalo, N. Y. The channel of 900 kilocycles is requested for full time operation and with 1,000 watts power.

Reasons for the request are stated as follows:

"Since the four leading radio stations in Buffalo have come under the control and management of the Buffalo Broadcasting Corporation, service to the public gradually has deteriorated. Programs are being interrupted with all kinds of direct advertising announcements. The present local monopoly is not in the public interest. The effective competition and high-grade radio service, which will be insured if this application is granted, will restore to the public its rights in radio."

Forum

Just What He Wanted

IT'S great to read how to build an ABC supply for 224, 227 and 245 tubes, including push-pull, if you like. The article in the August 10th issue was just the thing, especially as the resistance values were given clearly, and the AC secondary high voltage and equivalent DC results were stated and explained. I shopped around for a commercial outfit of this kind but found none, so will build the ABC compact. Good luck to you and thanks.

Howard Brush, Miami, Fla.

* * *

Not One Tumble

I HAD my name in the Literature Wanted column, with a keyed address, but nobody sent me any literature. Is not this column a waste of space?

Jonah Fallerton, Tulsa, Okla.

* * *

He Has Tubes in Mind

TUBES and how to use them constitute the most interesting subject in radio. Publish more and more and more about tubes, tubes, tubes. Characteristic curves, load requirements, mus, voltages, currents, power. Please, please, please!

Emil Bass, Detroit, Mich.

MICROPHONES ARE EXACTING

A. J. McCosker, director of WOR, Newark, N. J., said:

"One of the mysteries of radio is why the microphone accentuates the faults of some artists and builds up the excellence of others. I have heard singers 'knock 'em dead' who obviously should have been boardcasters instead of broadcasters. On the other hand, a tenor who had been selected over eighty competitors, because of his excellent voice, as the juvenile lead in an operetta, proved an unqualified 'flop.' And this was in spite of his years of study and training.

"Technicians are unable to explain it. J. R. Poppele, WOR's chief engineer, likens the mystery to that of the camera. 'Why is it,' he asks, 'that the camera will flatter one person and damn another? Photographers have a lot of theories for such phenomena, but nothing tangible.'

"It is the same with the microphone. It plays many tricks on radio entertainers, but like the practical joker, will stand for none on itself. One cannot convince the victims of the camera and microphone that they do not lie.

"Science has learned a lot about voice frequencies and all other vibrations. We know that all material responds to a natural frequency. It may be that the artist who broadcasts well vibrates at the same or nearly the same as the microphone itself. At any rate, it furnishes an interesting basis for speculation.

"The condenser microphone has eliminated much of the trouble, although I am still convinced that the study of microphonology is only beginning."

WINR LICENSE EXTENDED

Washington.

The radio license of WINR of Bay Shore, L. I., has been extended until Oct. 31. The station's status is being investigated by the legal division of the Radio Commission.

WEST RECEIVES BETTER, BOARD MEMBER FINDS

By Harold A. Lafount

FEDERAL RADIO COMMISSIONER

The sale of radio receiving sets has been much larger during the Summer than had been anticipated. Indications are that during the Fall and Winter months there will be a very substantial increase in the sale of receiving sets over last year.

There is plenty of talent in Los Angeles, San Francisco, Seattle, and Denver. These cities are drawing from the Middle and Far West, and to some extent from the East, with the result that the available supply of artists has increased 40 per cent in a year. California's climate is partly responsible for the assembling of artists in that State.

The West is highly appreciative of the wonderful programs broadcast by the two Eastern chain broadcasting companies. These programs, originating in New York City, are extremely popular and thoroughly enjoyed. The Western chain stations are also presenting programs of unusual merit. Little or no complaint is made about duplication of programs.

Reception Materially Better

Reception was without doubt improved materially by the November 11th allocation. There are, however, still some rough spots which I hope can be ironed out soon.

Everywhere I found the radio supervisors, under the Department of Commerce, working in perfect harmony with all broadcasters and others interested in radio. They are doing a wonderful work and too much credit cannot be given to them. It is, however, unfortunate that they are without sufficient help, room and equipment.

Radio dealers are well organized in all Western States and are doing some real constructive work. The radio broadcasters are also forming local organizations and many are joining the national organization. They are adopting a code of ethics and dignifying the profession a great deal, all of which is without doubt in the public interest.

Reports on Listeners' Clubs

Listeners' clubs are organized in many Western cities and are doing some good work and furnishing valuable information. In Butte, Mont., the club has 2,000 active members, who employ a trouble man to check upon all local interferences, remedying them wherever possible.

Some cities and States are passing, or have already on record, laws and ordinances against local radio interferences.

In general I am delighted with the results of my trip.

There is a great improvement in Western programs. Certainly there are yet stations which rely too much on phonograph records and there is still too much advertising and talk over some stations, but, generally speaking, programs are much better than they were a year ago. More educational features and better music are directly responsible for the improvement.

NO USE

Theatrical managers, who only a year or so ago, would have nothing to do with radio, are linked up so closely with broadcasting that it forms one of their greatest activities. Their thought seems to be: "What's the use of swimming against the tide?" The R. C. A. has answered the query.

WDAF SEEKING FULL TIME AND 10 KILOWATTS

Washington.

Seven stations have made application to the Federal Radio Commission for permission to make changes, including power and time.

KID, Jack Duckworth, Idaho Falls, Idaho, requests authority to reconstruct station and also requests an increase in assigned power from 250 watts day and night to 500 watts day and 250 watts night.

KGDM, E. F. Peffer, Stockton, California, requests authority to install new equipment, an increase in power from 50 watts to 500 watts, and increase in hours of operation.

WHN Asks 5,000 Watts

WDAF, at Kansas City, Mo., operated by the "Kansas City Star," asks permission to increase from 1,000 to 10,000 watts. The station recently applied for full-time operation.

WSSH, Boston, Mass., asks an increase in power from 100 watts day 250 watts night to 500 watts power day and night and also requests a change of frequency from 1,420 to 1,360 kilocycles.

WHN, Marcus Loew Booking Agency, Inc., New York, requests permission to install new equipment, increase in power from 250 watts to 5 kilowatts, change in frequency from 1,010 to 1,100 kilocycles, and more hours of operation.

Application for WISN

WNYC, operated by the City of New York, requests a license to cover construction permit issued for reconstruction of station only.

WISN, Evening Wisconsin Company, Milwaukee, Wis., requests an increase in power from 250 to 500 watts, a change in frequency from 1,120 to 940 kilocycles, and full time from dividing with station WHAD.

REPLOGLE APPOINTED

The National Carbon Company appointed Delbert E. Replogle as sales engineer in the Product Development Division. Mr. Replogle left the Raytheon Manufacturing Company, the control of production and sales of whose products recently was acquired by the National Carbon Company.

NEW CORPORATIONS

Motor Matic Radio Appliances, radio—Atty. I. Golembe, 17 John St., New York, N. Y.

American Acoustic Co., Wilmington, Del., patents—Corporation Service Co.

Peekskill Radiophone Corp., Peekskill—Atty H. Civilett, 27 William St., New York, N. Y.

Raffer's Radio Service—Atty. S. Cohn, 50 Court St., Brooklyn, N. Y.

H. A. Roth, radio stores—Atty. H. Schwartz, 26 Court St., Brooklyn

Hub Radio Co.—Atty. S. Rothenberg, 353 Stone Ave., Brooklyn, N. Y.

Rent-A-Radio, radios—Attys. Joseph & Demov, 1431 Broadway, New York

Beverly Radio Laboratories—Atty. F. C. Howard, Buffalo, N. Y.

Silber's Radio Stores—Atty. A. Bauman, 26 Court St., Brooklyn, N. Y.

Trutone Radio Products, Buffalo—Atty. P. Catalano, Buffalo, N. Y.

Federal Radio Broadcasting Corp., elevision experiments—Delaware Registration Trust Co.

International Talking Pictures, Inc., Dover, Del. —Arley B. Magee, Inc., Dover, Del.

Black Radio Corp.—Attys. Kohn & Goldman, 120 Broadway, New York

South Jersey Radio and Electric Co., Riverton, N. J.

Universal Coin Radio Co., Inc., Wilmington, Del. radio sets—Delaware Registration Trust Co.

Literature Wanted

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

RADIO WORLD,
145 West 45th St., N. Y. City.
I desire to receive radio literature.

Name ....

Address ....

City or town ....

State ....

Wm. Benert, Apt. 6L, 8716 Ridge Blvd., Brooklyn, N. Y.
H. R. Elvey, 295 First Ave., Manasquan, N. J.
Edward Hooker, 1040 Park Ave., New York, N. Y.
Wm. L. Vogel, 4 Clarendon St., Roslindale, Mass.
Albert J. Santoro, 203 Tillary St., Brooklyn, N. Y.
Richard E. Rose, P. O. Box 93, Gilroy, Calif.
F. A. Wallace, R. No. 3, Box 060, Auburn, Wash.
Joseph C. Roney, 1402 W. 3rd St., Grand Island, Nebr.
F. Mohlar, 1653 Broadway, Brooklyn, N. Y.
John Leitham, Jr., 180 E. Kilbourn, Milwaukee, Wis.
Eugene F. Badger, 2723 N. La Salle, Indianapolis, Ind.
K. T. Gan, 5739 Drexel Ave., Chicago, Ill.
W. R. Cameron, 4245 Saline St., Pittsburgh, Pa.
Roy G. Wild, Big Pine, N. C.
Wright Ellis, 902 E. Adams, R. No. 6, Pittsburg, Kansas.
E. Lee, Box 501, Florence, S. C.
Ernest Mayo, 1409 Jefferson St., New Berry, S. C.
R. H. Mitchell, 210 34th St., Newport News, Va.
Robt. L. Margeson, Berwick, Nova Scotia.
S. K. Hale, 10 Sussex Apartment, Portsmouth, Va.
S. V. Boone, 204 N. Sycamore St., Charlotte, N. C.
H. N. Stone, 196 Howard St., Framingham, Mass.
H. L. Adams, 208 Barclay St., Astoria, L. I., N. Y.
John T. Gerber, 131 Vine St., East Providence, R. I.
Wm. Ebling, 431 Fairview Ave., Turtle Creek, Pa.
L. T. DeaTelhauser, State Sanatorium, Maryland.
W. L. Newton, 4th and Wall Sts., Joplin, Mo.
Chas. Vogel, 566 Eagle Ave., Bronx, N. Y. City.
G. A. Thurling, Humber Bay, Ont., Can.
Wm. W. Groom, Addison, Mich.
H. Burke, 3 Wykagyl Terrace, New Rochelle, N. Y.
Anthony J. Truskey, 3942 Pulaski Ave., Phila, Pa.
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John A. Larson, 422 Brook Ave., Bronx, N. Y. City.
Carl E. Schneider, 1255 Shelby St., Indianapolis, Ind.

SUMMER SALES CALLED LARGE

A survey of the radio industry, according to H. B. Richmond, president of the Radio Manufacturers' Association, indicates another excellent radio year. Summer sales, President Richmond states, are in unusual volume, although the present season lacks the stimulus of the Presidential election campaign enjoyed last year.

"The actual number of receiving sets sold this year may not equal last year's record total," said Richmond, "but, all in all, this season shapes up as an excellent one. Business in accessories, such as tubes, is greatly increased, and during the 1929-30 season probably will smash all previous records.

"Whether the total volume of radio sales will change materially over last year is questionable, as the average price of receiving sets will be lower, with a decrease in unit cost, despite an increase in performance and value given to the public per dollar."

Richmond is an engineer, the first engineer to head the national organization of radio manufacturers.

PROFESSIONALS ONLY, THE RULE FOR AIR ACTORS

The employment of professional actors and actresses by the larger broadcasting stations, particularly those stations from which chain programs emanate, is fast becoming the inflexible rule, owing to the higher quality of programs prevailing. The change is expected to be complete when the new season starts in September, marking the full transition of radio artistic work from the amateur to the professional class.

The stations that try to get free talent, including getting professionals to whom the lure of "publicity" is offered, are having a harder time succeeding, not only because large opportunities exist to obtain paying employment but also because some of the professional alliances have enacted rules prohibiting their members from making free appearances.

Stations Follow Suit

High-class programs by advertisers are largely responsible for the confinement of employment to professionals, as the advertisers say they are not interested in indifferent performances. But the large stations themselves employ professional talent regularly for "sustaining" programs, these being paid for entirely by the stations, and distinguished from programs paid for by advertisers, which are called "sponsored" programs, even though the money received for time on the air is the more sustaining.

In dramatic performances only professionals are desired, and the National Broadcasting Company, which maintains a dramatic department, called Radio Guild, now having from 25 to 50 professionals, depending on the demand, is expected soon to increase the number to 150, and to hold it at this figure during the height of the season.

Pay the Actors Get

Leading actors and actresses are said to receive $50 to $100 for a performance, and some of them are booked for two or three performances a week. Several are said to average from $150 to $200 a week.

Decline in the opportunities offered by the "legitimate" stage, meaning dramatic and comedy performances, with or without music, as distinguished from vaudeville, has made quite a dent in this branch of the acting profession. The talkies provided an opportunity, but not for everyone, owing to the requirement of good looks, so radio presents an opportunity that is expected to last until television institutes the "good-looks" requirement in radio also. Most of the radio performers, however, are not hard to look at.

Big New Factory To Make E-R Tubes

With most of the machinery installed in its new plant at Newton, Mass., the Raytheon Manufacturing Company is rapidly preparing to meet the demands of increased production put upon it by its recently ratified agreement under which the National Carbon Company assumes control of Raytheon's manufacture and distribution.

The new factory is three and one-half times as large as the former plant at Cambridge and will provide facilities for increasing the production of Eveready-Raytheon tubes five-fold.

Aluminum Subpanel

The best appearance of the New Diamond of the Air results from using the official aluminum subpanel, 10 x 20 inches, with the four sockets built in, and with self-bracketing front. Hardware and insulating washers supplied with each sub-panel. The aluminum sub-panel is exactly the same as the one used in the laboratory models of the battery operated and the AC Screen Grid Diamonds. Holes are drilled for mounting parts, but as this aluminum drills like bakelite you can drill any holes you want.

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☐ Enclosed please find $3.00 for which please send one aluminum subpanel 10x20" for the new battery model 4-tube SG Diamond of the Air, with sockets built in, and with self-bracketing front and side and rear supports; also send hardware and insulating washers.

☐ Enclosed please find $2.35 for which please send 7x21" drilled Bakelite front panel for the new battery model Diamond.

☐ Enclosed please find $3.25 for the 10x20" aluminum subpanel, etc., for the new AC Screen Grid Diamond.

☐ Enclosed please find $2.35 for the 7x21" drilled Bakelite front panel for the new AC Screen Grid Diamond.

☐ Enclosed please find $5.00 for both the aluminum subpanel, etc., and the drilled Bakelite front panel of the battery model.

☐ Enclosed please find $5.25 for both the aluminum subpanel, etc., and the drilled Bakelite front panel of the AC model.

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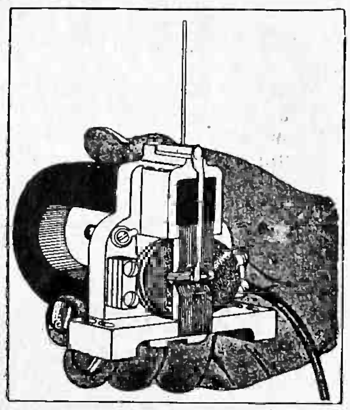

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New Diamond

PARTS FOR BATTERY MODEL DIAMOND

C1—Aerovox .0005 moulded fixed	.25
C2—Hammarlund .0605 mfd. Midline	3.30
C3, C4—Two Aerovox moulded .006 mfd. @ .50 ea.	1.00
C5—Hammarlund .0005 mfd. Midline	3.30
C6—Aerovox .00025 moulded fixed with clips	.30
C7—Aerovox .0005 moulded fixed	.25
A1—622 Amperite with mount	.85
A2, A3, A4—Three 1A Amperites, three mounts @ .85	2.55
R1—50-ohm Frost rheostat	1.00
R2—5-meg. Lynch metallized leak	.40
T1, T2—Two National A100 audios @ $5.70 ea.	11.40
Ant., Gnd., Sp. —, Sp. + posts @ .10 ea.	.40
P1—Yaxley jewel window bracket .35 with pilot lamp .20	.55
Sw—Yaxley No. 10 A battery switch	.35
7 x 21-inch front panel	2.35
10 x 20-inch official battery Diamond subpanel, self-bracketing, with four sockets affixed; subpanel hardware, insulated bushings, washers	3.00
Front panel and subpanel together	5.00
Two dials with pointers	2.00
Two knobs @ .20	.40
One roll stranded Braidite	.30
Hammarlund 70 mmfd. Equalizer	.40
Four Kelly tubes: one 222, two 201A, one 112A or 171A	7.00

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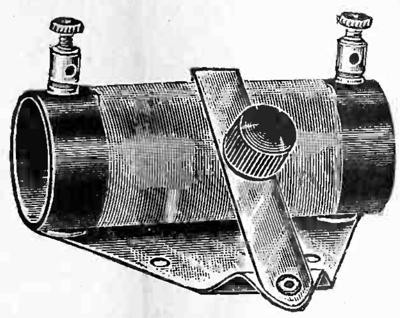
AERIAL TUNER
Improves Summer Reception



Remove aerial lead from set. Connect aerial instead to one of the binding posts of the Aerial Tuner. Connect the other binding post of the Aerial Tuner to antenna post of your set. Then move the lever of the Aerial Tuner until any weak station comes in loudest. The lever need not be moved for every different frequency tuned in. The Aerial Tuner acts as an antenna loading coil and puts the antenna's frequency at any frequency in the broadcast band that you desire to build up. It makes high wavelengths come in loud as low wavelengths. It helps separate stations and clear up reception. Makes great improvement in Summer reception. Price, $1.00.

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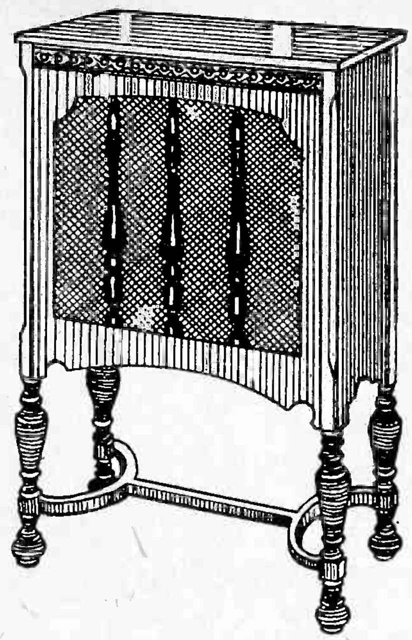
With Molded Wood Horn of 8 ft. tone travel (exponential type) with baffle and horn motor built in. Extraordinary bargain. **$20.00**



The speaker cabinet is walnut finish, 33" high, 24½". wide, 17½". deep, with carved legs. Golden cloth grille covers front opening. Built inside is No. 595 molded wood horn with baffle and No. 203 driving motor unit that stands 250 volts without filtration. Horn and motor removable. Table alone is worth price asked. Remit with order and we pay cartage on Aristocrat Floor Speaker.

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Mershon Electrolytic Condensers, four in one Copper Container

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10-10-10-10 mfd. List price, $7.75 — **$4.65** Net

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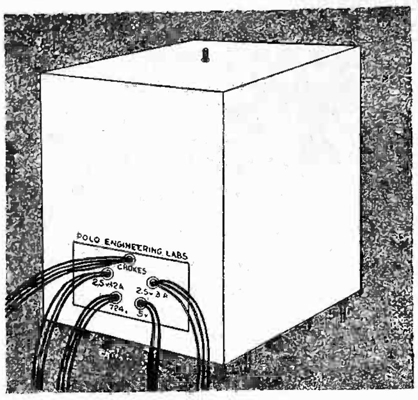

HERE is a compact transformer block, enabling you to build an ABC supply of finest design, to furnish the required voltages to operate screen grid AC tubes, 227 AC tubes, and 245 power tubes in single or push-pull circuit. This transformer block is expertly engineered and properly voltaged. The high voltage secondary, for instance, is fully high enough, so that when the voltage drops in the choke coils, tube and other apparatus in the B supply are taken into consideration, the direct current output across the voltage divider is 300 volts when the maximum current flowing through a section of the divider is 80 milliamperes. This enables correct proportion of 250 volts for the plate of the 245 and 50 volts for negative bias for the last audio tube or tubes, total 300 volts.

Notice particularly that the filament winding for the radio frequency and first audio frequency amplifier tubes and detector tube is rated conservatively at TWELVE amperes. Look around for a transformer that has such a high current rating. Twelve amperes mean that you can operate six tubes from this winding without any danger of overload, while the overload in operating seven such tubes would be less than 5 per cent. The power tube filament winding enables the heating of single or push-pull 245 tubes, as the 3 amperes will easily satisfy requirements.

This transformer block is housed in a shielded, cadmium-plated metal casing, with mounting feet and a top projection, so that upright or horizontal mounting may be used. The total height of the casing is only 6⅛", so even that if a ¾" thick baseboard is used, the casing fits upright into a receiver that has the usual 7" high front panel.

The voltage leads emerge from a clearly marked plate, with center taps in red. You can make no mistake. Everything is plain and clear.

Notice that even the choke coils are included inside this same casing, so all you need are the resistors, tube and condensers, and you have the ABC supply that you've been craving for.

[Center taps on all windings except primary.]

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to provide all filament, grid and plate voltages for A.C. hookups, using 224, 227 and 245 tubes, including push-pull, up to seven tubes, 100 milliamperes.

One Polo transformer block, with two chokes, of 400 ohms D.C. resistance each, all in one cadmium-plated shielded casing, 6⅛" high, 4⅛" wide and 4½" front to back, with mounting feet attached; voltages, 2.5 at 3 amperes, center-tapped; 2.5 at 12 amperes, center-tapped; 724 A.C., rms., center-tapped; 5 volts at 2 amperes. Voltages marked at openings from which insulated connecting wires emerge; center taps are red. Cat. TBH 245 ....$10.00

C1, C2, C3, C4, C5—Five 2 mfd. compact filter condensers, size of case, 2" high, 1 3/16" wide, 1 3/16" front to back; provided with mounting feet at bottom and connection lugs at top. Cat. HV2. $1.70 ea., total $8.50

C6, C7, C8, C9—Four Mershon electrolytic condensers in one copper can, 8, 8, 8 and 8 mfd....................$4.65

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One mounting strip for the five filter condensers, with bracket. Cat. HVS....................$0.40

R1—Five resistors as follows: 6 ohms, 20 ohms, 800 ohms, 4,500 ohms, 2,500 ohms, the last three of 10 watts rating or higher. Cat. ABCS....................$1.95

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One sub-panel. Cat. ABCSP $2.00

One socket, UX type (four prongs)....................$0.30

One 1,500-ohm 10 watt resistor (for push pull 245s). Cat. B15 ....$0.50

Total $30.65

[NOTE: The 1 ampere fuse, fuse holder, lamp cord, two male plugs, 2-way convenience outlet and A.C. pendant switch are carried by most hardware and all electrical stores, and there is no advantage ordering these by mail.]

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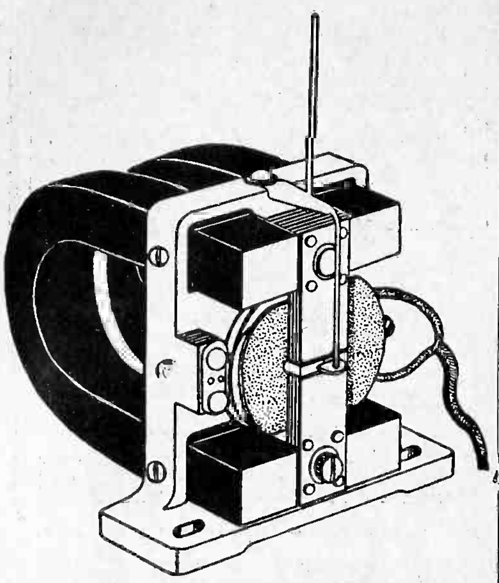
New Junior Model

POLO UNIT $4



The famous twin magnet principle for double sensitivity, large magnets for great flux, permanently adjusted armature, all are in the new junior model Polo Unit. Weight, 2¾ lbs. Stands 150 volts unfiltered. Stands up to 250 push-pull filtered. Works any output tube, power or otherwise. Supplied with 10-ft. cord. Order unit now. Five-day money-back guarantee.

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Velvet B Eliminator 180 Volts (280 Tube Free) **$16.13**

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R. E. LACAULT, E.E., I.R.E., who died recently, was one of the outstanding authorities on the Super-Heterodyne. He wrote a book, "Super-Heterodyne Construction and Operation," that explains in a non-technical manner the phenomena associated with a Super-Heterodyne. More, it gives a clear outline of the way such a receiver functions, and naturally gives the clues to solving virtually all the troubles that may arise in a Super.

So thoroughly did Lacault do his wrok that he covered associated topics, thus making his book a sidelight on radio in general, including advice on trouble-shooting.

Therefore the service man, the home experimenter, the custom set builder and the student will welcome this book.

It consists of 103 pages and includes 68 illustrations. It is bound in maroon buckram.

There are three valuable tables in the book, also. One classifies harmonics into groups, e.g., sound, radio, short waves, heat, light, chemical rays, X-rays and "unknown." Another is a trouble-shooting chart, classifying "trouble experienced" and "causes" and referring to the text for specific solutions. The third is a table for converting broadcast frequencies to wavelengths (accurate to .1 of a meter) or for converting the wavelength into frequency.

THE book begins with a comparison of alternating and direct current and proceeds to a discussion of the relation of wavelength to frequency. Then tuning is explained.

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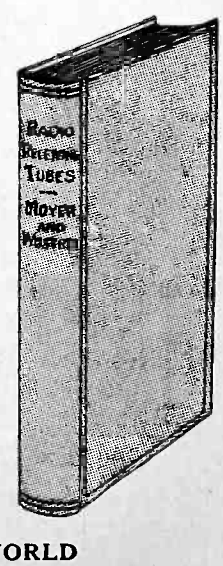

"RADIO RECEIVING TUBES," by James A. Moyer and John F. Wostrel, first edition just off the press. No radio service man, experimenter or student of radio should be without this authoritative book on the principles and applications of vacuum tubes. It answers all your questions relating to receiving, amplifying and rectifying tubes. It is a complete discussion of tube principles, functions and uses, thoroughly up-to-date.

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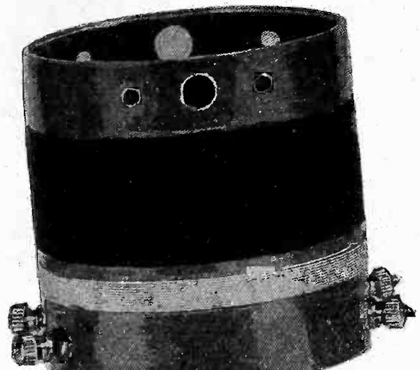
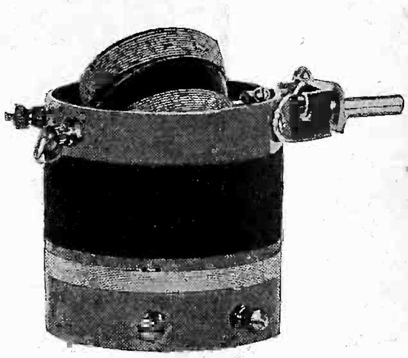
Coils for All Circuits

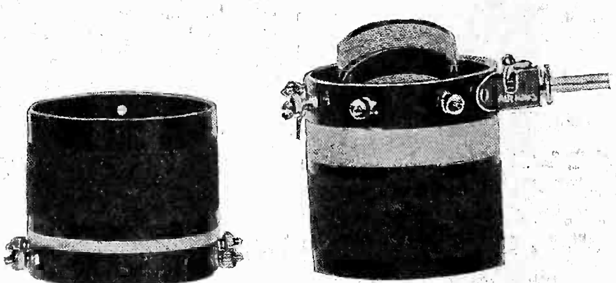
Outside Diameters 2½"; All Wire Silk Insulated



Antenna coil for all circuits, interstage radio frequency transformer for all circuits except where primary is in plate circuit of a screen grid tube, 224 or 222.
For .0005 mfd. tuning order Cat. RF5 @ $0.75
For .00035 mfd. tuning order Cat. RF3 @ 0.80



Standard three-circuit tuner for coupling all tubes—except where primary is in the plate circuit of a screen grid tube—provides adequate, smooth tickler control. Tickler is furnished with end-stop.
For .0005 mfd. tuning order Cat. T5 @.$1.25
For .00035 mfd. tuning order Cat. T3 @. 1.30



Antenna coil and three-circuit tuner, matched Diamond pair, for one stage of screen grid RF and tickled detector.
For .0005 mfd. order Cat. DP5 (two coils) @...............$2.00
For .00035 mfd. order Cat. DP3 (two coils) @............... 2.10
The screen grid 3-circuit coil alone, distinguished from T5 and T3 because of large (high impedance) primary, is Cat. SGT5 for .0005 mfd. @ **$1.25**, and Cat. SGT3 for .00035 mfd. @ **$1.30.**

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Enclosed please find $.........for which send parcel post prepaid at once:

Qun'ty-Cat. No.		Qun'ty-Cat. No.	
☐ RF5	@...$0.75 each	☐ SGT3	@ $1.30 each
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OTHER COILS

Radio-frequency transformer to couple screen grid stages, where large primary is in plate circuit of screen grid tube.
For .0005 mfd. tuning order Cat. SGRF5 @..$0.75
For .00035 mfd. order Cat. SGRF3 @....... 0.80

Antenna coil with variable primary, affording volume control by turning rotary coil; two windings, variable primary and fixed secondary.
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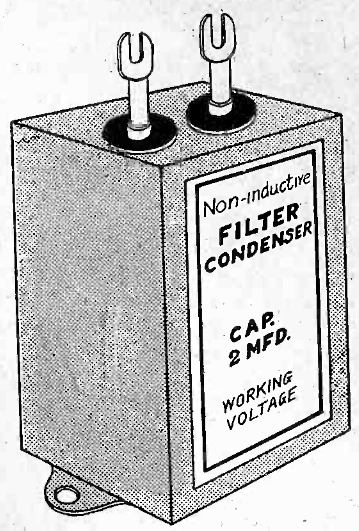
Bernard tuners, consisting of a fixed primary, with rotary coil in series with a fixed secondary, for tuning the combined rotary and fixed windings of the secondary, to exceed the broadcast band of wavelengths. The condenser shaft and rotary coil shaft are physically coupled so one motion turns both. Increases wavelength range so it is about 150 to 600 meters.
For .0005 mfd. (Ant. coil) order Cat. BT5A @$2.50
For .0005 mfd. (interstage SG) order Cat. BT5B $2.50

800 Volts DC
550 Volts AC

The Working Voltages of New

Filter Condensers

at Economical Net Prices



Actual size of new 2 mfd. non-inductive filter condenser for power supplies. 2 1/2" high including lugs, 1 3/16" wide, 1 3/16" front to back. Mounting holes 1 1/2" apart.

These compact high voltage (VH) condensers are obtainable in the popular capacities @ 85c per mfd. Their superiority as filter condensers, of course, fits them for the lesser voltage strain of by-pass condensers. Think of all the space you save! Condensers of such high voltage rating are usually 6" square for a block of three. You could get 16 of the compact HV type in that space!

Rated at 800 volts D.C. and 550 volts rms. A.C., guaranteed working voltages, these compact condensers have a breakdown voltage of 2,600 volts D.C., power factor (loss) of less than 1%, D.C. resistance of more than 600,000,000 ohms per mfd., are non-inductive, accurate to 5% and have mounting flaps, a part of the shielded metal case. Finished in maroon.

These filter condensers are just the thing for power supplies, even including four 250 tubes in parallel-push pull! And, of course, for 210 type packs, 245, 171 and any other pack using 550 volts or less.

1 mfd., Cat. HV1 @..........................$0.85
2 mfd., Cat. HV2 @..........................$1.70
4 mfd., Cat. HV4 @..........................$3.40

[NOTE: To use capacities higher than 4 mfd., connect individual HV condensers in parallel, thus adding capacities directly.]

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

Enclosed please find $........ for which please send me

Quantity	*Type*	*Price*
☐	Cat. HV1 (1 mfd.)................	@ $0.85
☐	Cat. HV2 (2 mfd.)................	@ $1.70
☐	Cat. HV4 (4 mfd.)................	@ $3.40

All rated at 800 volts D.C., 550 volts A.C. (root mean square).

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5-DAY MONEY-BACK GUARANTY

PUSH-PULL DIAMOND

using one 224 AC screen grid tube, two 227 AC tubes, two 245 AC power tubes and a 280 rectifier, was described in the June 8th and 15th issues. Send 30c for these copies to RADIO WORLD, 145 West 45th Street, N. Y. City.

PANEL AC VOLTMETERS

(Panel meters take 2-5/64" hole)

No. 351—For reading 0-15 volts AC..........$2.25
No. 352—For reading 0-10 volts AC.......... 2.25
No. 353—For reading 0-6 volts AC.......... 2.25

(See No. 348 under "Pocket and Portable Voltmeters.")

PANEL VOLTMETERS

No. 335—For reading DC voltages, 0-8 volts, $1.00
No. 310—For reading DC voltages, 0-10 volts, 1.00
No. 316—For reading DC voltages, 0-16 volts, 1.00
No. 326—For reading DC voltages, 0-6 volts, 1.00
No. 337—For reading DC voltages, 0-50 volts, 1.00
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All Parts

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as described and specified by J. E. Anderson—$40.

245 PP Power Amplifier, built up, $55.00

Thrill Box, Complete Parts, all 6 coils, cabinet—$33

GUARANTY RADIO GOODS CO.
145 West 45th Street N. Y. City

Socket Wrench FREE!

One of the handiest tools for a custom set builder, service man or home constructor is a BERNARD socket wrench. It consists of a 6½" long metal tubing in which is a plunger, controlled by a knob. The plunger has a gripping terminal (called a socket, hence the name "socket wrench") that may be expanded or contracted to fit 6/32, 8/32 and 10/32 nuts, the most popular sized nuts in radio. Use the knob to push out the plunger, press down on the handle to grip the nut, then turn the nut to left for removal or to right for fastening down. Total length, distended, including stained wooden handle, 10". Gets nicely into tight places. Send $1 for 8 weeks' mail subscription for RADIO WORLD and get this wrench FREE. No other premium with this offer. Present subscriber may extend subscription by stating he is one.

LACAULT'S BOOK

"Super-Heterodyne Construction and Operation," giving the master's most masterful exposition of the theory, performance and construction of this fascinating type of circuit, is a necessity to every serious radio experimenter. More than 100 pages and more than 50 illustrations. Buckram cover. This book by R. E. Lacault, FREE if you send $1.00 for an 8-weeks subscription for Radio World. Present subscribers may accept this offer. Subscription will be extended.

RADIO WORLD 145 W. 45th St., N.Y. City Just East of B'way

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- ☐ 0-50 Voltmeter D.C. .... No. 337
- ☐ 6-Volt Charge Tester D.C. .... No. 23
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- ☐ 0-25 Milliamperes D.C. .... No. 325
- ☐ 0-50 Milliamperes D.C. .... No. 350
- ☐ 0-100 Milliamperes D.C. .... No. 390
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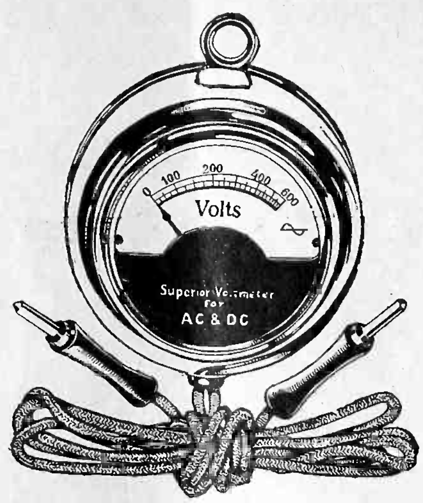
High Resistance Meter

Same Meter Reads Both AC and DC
Accurate to 1 per cent.



The O-600 volt AC and DC meter (Cat. No. 600), with 3-ft. cord, de luxe tips and hanger $7.00.

THE output voltages of all B eliminators, the voltages of all B batteries, as well as the house current line voltage, whether AC or DC, and the voltage across power transformer secondaries, can be accurately measured by this meter. The full scale is 0-600 volts, and this same meter measures both AC and DC.

GUARANTY RADIO GOODS CO.,
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Equip Yourself Now With Necessary Meters!

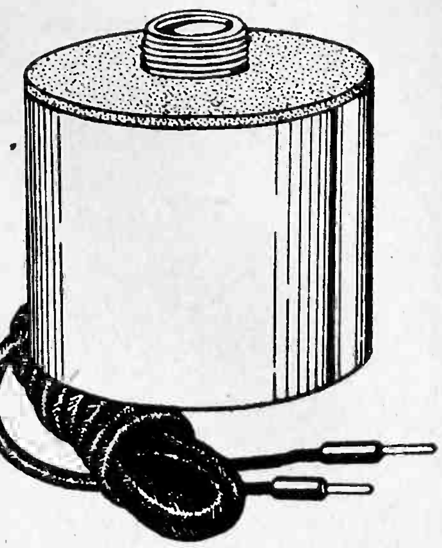
To do your radio work properly you need meters. **Here is your opportunity to get them at no extra cost. See the list of nine meters at left.** Heretofore we have offered the choice of any one of these meters free with an 8-weeks subscription for RADIO WORLD, at $1, the regular price for such subscription. Now we extend this offer. For the first time you are permitted to obtain any one or more or all of these meters free, by sending in $1 for 8-week's subscription, entitling you to one meter; $2 for 16 weeks, entitling you to two meters; $3 for 26 weeks, entitling you to three meters; $4 for 35 weeks, entitling you to four meters; $5 for 44 weeks, entitling you to 5 meters; $6 for 52 weeks, entitling you to six meters. Return this offer with remittance, and check off desired meters in squares at left.

RADIO WORLD will help you in your radio work, so you will be able to use the meters most valuably. Keep abreast of all the new circuits, intimate details on perfecting existing sets, and get inside track on sensitivity, distance reception, tonal quality, and news of radio, technical and non-technical. Enjoy the writings of Dr. Lee De Forest, McMurdo Silver, J. E. Anderson, Herman Bernard and a host of other radio engineers who contribute their knowledge to you through the medium of RADIO WORLD, the first and only illustrated national radio weekly. You can find no magazine that better caters to your needs than RADIO WORLD. Short waves? RADIO WORLD will tell you all about them. Extremely sensitive broadcast receivers? Their construction and operation are fully discussed with confident regularity. Power supplies—push-pull or otherwise? AC receivers? Screen grid tubes? Large receivers that give a super-abundance of performance—small, economical receivers that give performance out of all comparison to their size? Are you interested in these? Then you're interested in RADIO WORLD.

Present mail subscribers may renew their subscription under this remarkably generous offer. Put a cross in square. ☐

RADIO WORLD
145 W. 45th St., N. Y. City—Published Weekly.
All Newsstands. 15c per copy—$3, six months—$6 a year

Horn Unit $2.25



This unit is pre-eminent for horn-type speakers, such as the exponential horns or other long tone-travel horns. The faintest word from a "whispering tenor" or the tumultuous shout of the crowd or highest crescendo of the band is brought out clearly, distinctly. Stands up to 450 volts without filtering. Works right out of your set's power tube, requiring no extra voltage source. Standard size nozzle and cap are die-cast aluminum, one piece, with milled platinum-like finish. The casing is full nickel, of highest possible polish. Works great from AC set, battery set or any other set, push-pull or otherwise.

For Portable Use

This unit can be used in a portable without any horn attached and will give loud reproduction. Order Cat. 225, with 4½ ft. cord attached . . (Shipping weight, 2 lbs.) $2.25

Air-Column Horn

8-ft. tone travel molded wood horn (less unit No. 225) is obtainable already mounted in a baffle box. Outside overall dimensions of baffle box, 21¼" high, 18" wide, 15" front to back. Shipping weight, 27 lbs. Order Cat. 596 @ $8.00.

The 225 unit and 596 horn built into a ply-walnut table 33" high, 24½" wide, 17½" front to back. Shipping weight, 50 lbs. Cat. No. 597 . . @ $20.00

Acoustical Engineering Associates,
145 W. 45th St., N. Y. City (Just E. of Bway).

Please ship C. O. D.
☐ Cat. No. 225 @ $2.25 ☐ Cat. No. 596 @ $8.00
☐ Cat. No 597 @ $20.00

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FIVE-DAY MONEY-BACK GUARANTEE

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DIAMOND OF THE AIR, SCREEN GRID MODEL, battery operation, four tubes, described in February 9th, 16th, 23d and March 2d issues, 1929. Send 50c for these four copies. Blueprint free with 8 weeks' subscription to RADIO WORLD at $1.

AC DIAMOND, screen grid, 4 tubes, published in March 23d and 30th issues. Send 25c for these two numbers. Blueprint free with 8 weeks subscription for RADIO WORLD at $1.

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PATENT YOUR IDEAS. Easy terms. Booklet Free. Established 25 years. H. Sanders, Rand McNally Building, Chicago, Ill.

RADIO TUBES, Screen Grid, 24's, A.C. $3.25. 22's, D.C. $3.00. 27's, $1.50. 26's $1.30. 71's, $1.50. 80's, $2.00. 12's, $1.50. Filament transformers, 5, 2½, and 1½ volt windings center tapped $4.00. Postpaid in U. S. D. McLarty, 926 Ardmore St., Jacksonville, Fla.

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WANTED a radio engineer to assist an inventor. Must be a good mechanic, capable of designing and doing his own machine work and with inventive ability and vision to develop the idea. Address P. O. Box 530, New Haven, Conn.

LOUDSPEAKERS TESTED and guaranteed, 24" diameter, contain powerful unit. $21.75. Lemsers Shop, 6326 Frontenac, Detroit, Mich.

THRILL BOX of National Co., Cat. SW4C all parts, including all six coils, 15 to 570 meters, and cabinet, $33. Wired by Abbott Laboratories $6 extra. P. Cohen. Room 1214. 145 W. 45th St., N. Y. City. Come in and see it.

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If your receiver or amplifier, no matter of what kind, is not giving proper results, send it to us. prepaid. We will test it FREE and let you know what's wrong, telling you cost of repairs. Our charges are very reasonable. Six years' experience. Loudspeakers and units repaired. Burnt-out coils replaced. Jaynxon Laboratories, 57 Dey Street, New York City.

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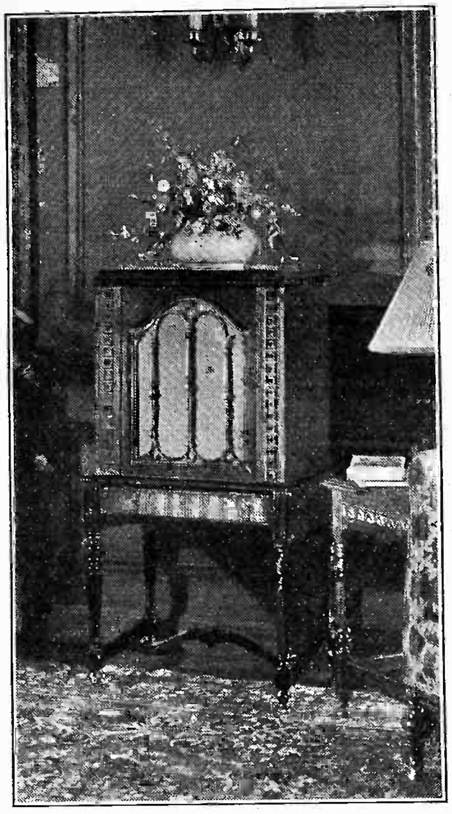
PEERLESS

12″ AC Dynamic Speaker in

SONORA Highboy Cabinet

At Only **$37.50**

LIST PRICE, $155.00



The famous Peerless AC dynamic speaker, with Kuprox rectifier and 1,500 mfd. hum-killing condenser built in, all housed in this 40″ high Sonora cabinet of fascinating ply-walnut. The cabinet is all one piece—carved legs, marqueterie panel and grille **pillars.** Sliding back is made of cane. This imposing floor model speaker, exactly as illustrated, in original factory packing case, shipping weight 100 lbs. **37.50**

Amazing Buy!

Never in your life did you hear of such an amazing bargain—highest class, perfect, guaranteed merchandise at more than 75% off list price! Look at that beautiful highboy cabinet, its graceful legs, with archer's bow tiepiece; its rosetted side panels at front, its shapely grille pillars, all in two-tone effect, with high-polish surface of walnut. The speaker sets against a golden grille, with ample baffle board concealed.

Money-Back Guarantee!

Every precaution has been taken to produce the finest possible tone. The speaker is the genuine famous Peerless, operating directly from the 110-volt 50-60 cycle AC line. The cane back leaves the cabinet acoustically open, to avoid box resonance. The entire outfit—speaker, rectifier, 1,500 mfd. condenser, AC cable, speaker cords and AC switch, all built up and wired—is sold only in this handsome cabinet.

Order yours **TODAY** on a 5-day money-back guarantee basis. No C.O.D. orders filled.

ACOUSTICAL ENGINEERING ASSOCIATES,
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Gentlemen: Enclosed please find $37.50 for which please ship by express at once one 12″ diameter genuine Peerless AC dynamic speaker, with built-in Kuprox dry rectifier, 1,500 mfd. hum-killing condenser, AC cable, speaker cord, and AC switch built in, all contained in the Sonora ply-walnut highboy cabinet, with cane removable back; the cabinet consisting of one piece, ply-walnut; all in original factory carton. No C.O.D.

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5-DAY MONEY-BACK GUARANTEE

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¶ A recent survey among the readers of RADIO-CRAFT has disclosed the fact that our circulation is mostly among professional radio men.

¶ These men naturally want to read and talk "shop."

¶ Our Magazine, starting with the October issue, will be the romping ground of radio technicians.

¶ We want to publish your experiences, your wishes, your constructive ideas.

¶ Let the other fellow in the trade know what's going on, so that the whole radio fraternity may benefit from it.

¶ Send us your articles, letters, experiences, questions, stories, etc.

¶ We will pay you for every line published.

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Articles giving the professional radio man's experience with radio sets, power amplifiers, talking sound film equipment, experience with tubes.

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Send all contributions to:

Editor
RADIO-CRAFT
98 Park Place, New York

A Courtesy to the Professional Radio Man

In order to make it possible for all Radio Technicians to read RADIO-CRAFT regularly, each month, we have put into effect a special subscription price.

The regular price of RADIO-CRAFT is $2.50 per year (12 issues). The newsstand rate is 25 cents a copy.

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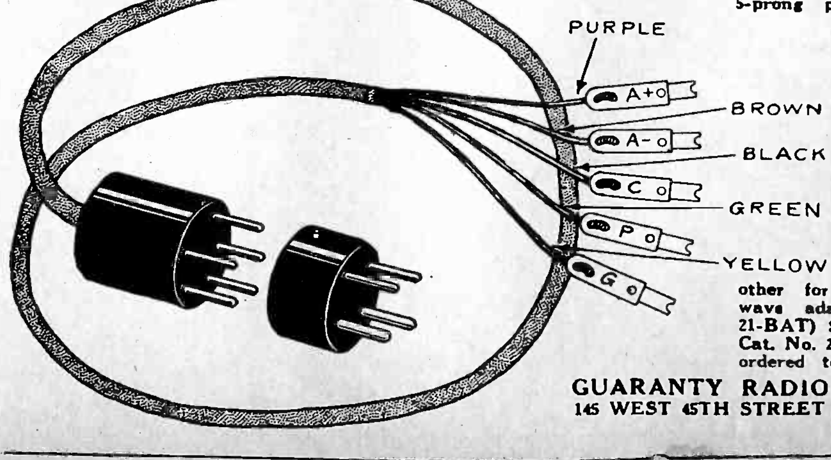
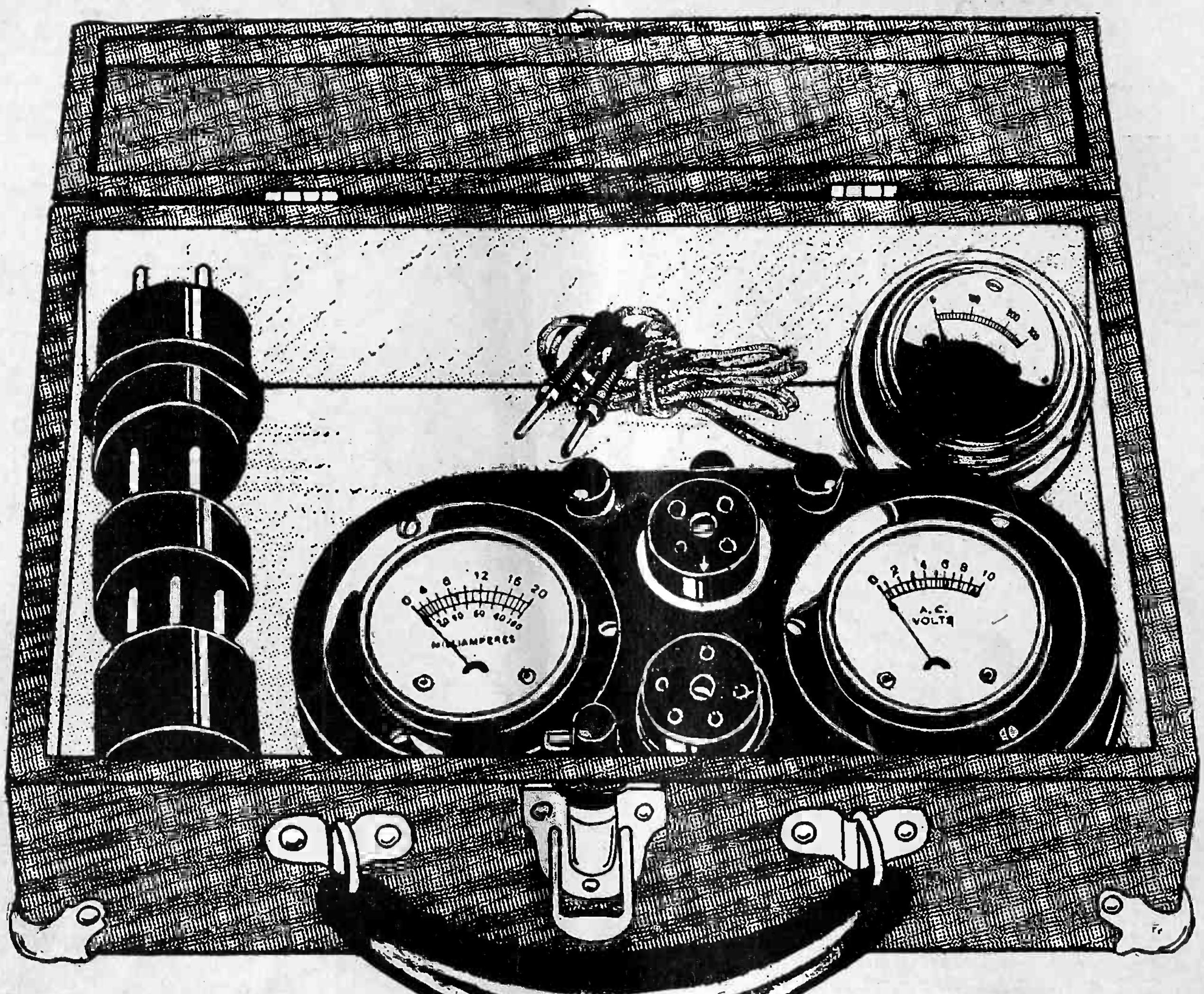
Handiest thing for ANY short-wave adapter. Put detector tube of your present set in socket of any short-wave adapter you build, put plug in detector socket of your broadcast receiver. Cable 34″. Leads identified both by color scheme and tags 5-prong plug and 5-lead cable for AC short wave adapter. May be used as 5-lead battery cable plug with UY socket (Cat. No. 21AC) $1.50 4-prong extra plug only necessary addition to other for battery short-wave adapter (Cat. No. 21-BAT) $0.50.
Cat. No. 21AC and 21-BAT ordered together $1.75.



GUARANTY RADIO GOODS CO.
145 WEST 45TH STREET New York Ci--

New Style DeLuxe Leatherette Carrying Case FREE with each Jiffy Tester!

This combination of meters tests all standard tubes, including the new AC screen grid tubes and the new 245 tube, making thirteen tests in 4½ minutes! Instruction sheet gives these tests in detail.



A PORTABLE testing laboratory is yours when you possess a combination Jiffy Tester, for then you can measure the filament and plate voltages of all standard tubes, including AC tubes, and all standard battery-operated or AC screen grid tubes; also plate voltages up to 500 volts on a high resistance meter that is 99% accurate; also plate current.

The Jiffy Tester consists of a 0-20, 0-100 milliammeter, with change-over switch and a 0-10 volt AC and DC voltmeter (same meter reads both), with two sockets, one for 5-prong, the other for 4-prong tubes; a grid bias switch and two binding posts to which are attached the cords of the high resistance voltmeter; also built-in cable with 5-prong plug and 4-prong adapter, so that connections in a receiver are transferred to the Tester automatically. Not only can you test tubes, but also opens or shorts in a receiver, continuity, bias, oscillation, etc. The instruction sheet tells all about these tests.

In addition you can test screen grid tubes by connecting a special cable, with clip to control grid (cap of tube) and other end of special cable to the clip in the set that went to the cap before the tube was transferred to the tester.

THE new carrying case, which is furnished FREE with each order for a Combination Jiffy Tester, contains the entire outfit, including the three meters, cable and plug, and three adapters (one for 4-prong tubes, two for 199 tubes). This case is 10½x 7¾x3½" and has nickel corner pieces and protective snap-lock. The case is made of strong wood, with black leatherette overlay.

To operate, remove a tube from the receiver, place the cable plug in the vacant receiver socket, put the tube in the proper socket of the Tester, connect the high resistance meter to the two binding posts, and you're all set to make the thirteen vital tests in 4½ minutes!

The Combination Jiffy Tester is just the thing for service men, custom set builders, experimenters, students, teachers and factories. Order "Jiffy 500." The price is only $14.50.

If a 0-600 AC and DC high resistance meter (99% accurate) is desired, so house electricity line voltage and power transformer voltages can be measured, as well as plate voltage, instead of the 0-500 DC voltmeter, order "Jiffy 600" at $15.50.

GUARANTY RADIO GOODS CO., 145 W. 45 St., N. Y. City. (Just East of Broadway).

☐ Please ship at once on 5-day money-back guaranty one "Jiffy 500," at $14.50, consisting of
(1) One Two-in-One 0 to 10 voltmeter for AC and DC. Same meter reads both. Scale especially legible at 1½ to 7½ volts. This meter reads the AC and DC filament voltages.
(2) One DOUBLE reading DC milliammeter, 0 to 20 and 0 to 100 milliamperes, with change-over switch. This reads plate current.
(3) One 0-500 volts high resistance voltmeter, 99% accurate; with tipped 30" cord to measure B voltages.
(4) One 5-prong plug with 30" cord for AC detector tubes, etc., and one 4-prong adapter for other tubes.
(5) One grid switch to change bias.
(6) One 5-prong socket.
(7) One 4-prong socket.
(8) Two binding posts.
(9) One handsome moire metal case.
(10) One instruction sheet.
(11) One de luxe carrying case.
(12) One screen grid special cable.

☐ If 0-300 DC high resistance 99% accurate voltmeter is preferred to 0-500, put check here. Price is same, $14.50.

☐ Same as above, except substitute a 0-600-volt AC and DC high resistance 99% accurate voltmeter (same meter reads both) for the 0-500 DC meter. Price $15.50.

NAME ....

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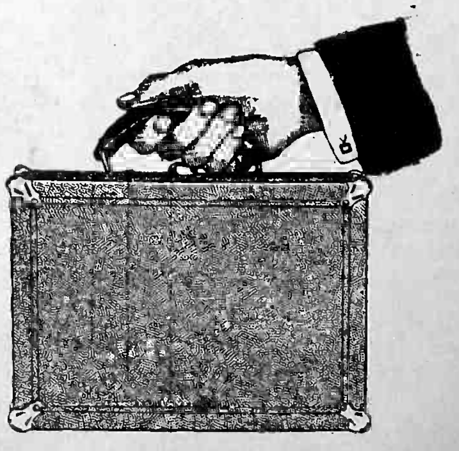
FIVE-DAY MONEY-BACK GUARANTY



The new de luxe leatherette carrying case is compact and handy. Size 10½" long, 7¾" wide, 3½" deep.