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RADIO WORLD

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The First and Only National Radio Weekly

384th Consecutive Issue—EIGHTH YEAR

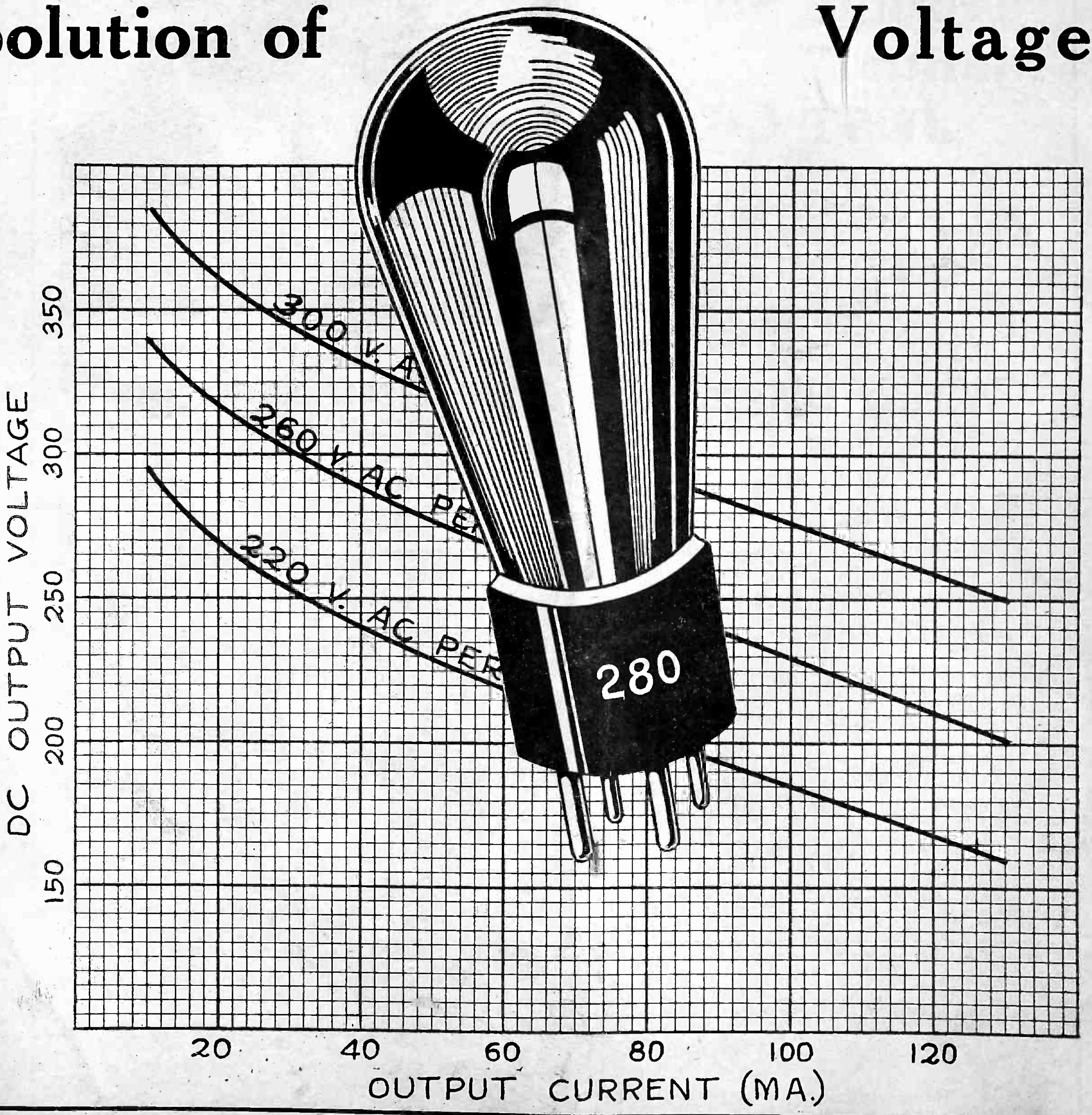
AUTOMATIC VOLUME CONTROL

Why SG Tubes Need High Plate Voltages

Hum Elimination

4-Tube Battery Set

Solution of Voltages

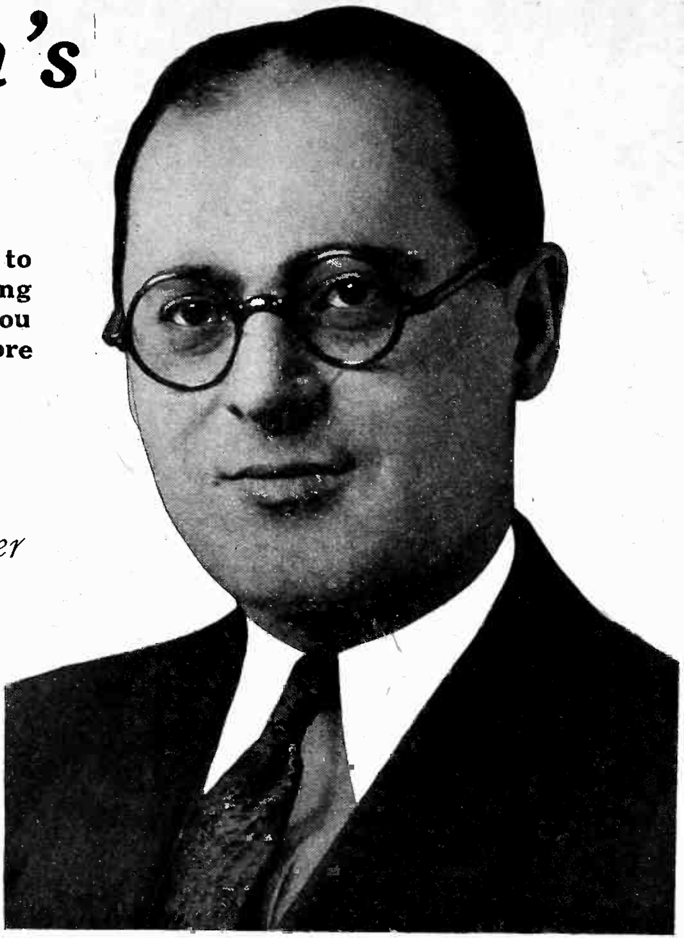


See pages 12 and 13 for Article on How to Select Rectifier Voltages

RADIO WORLD, owned and published by Hennessy Radio Publications Corporation, Roland Burke Hennessy, President and Treasurer; Herman Bernard, Secretary, all of 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 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.

SPARTAN
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, noice; 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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Enclosed please find:

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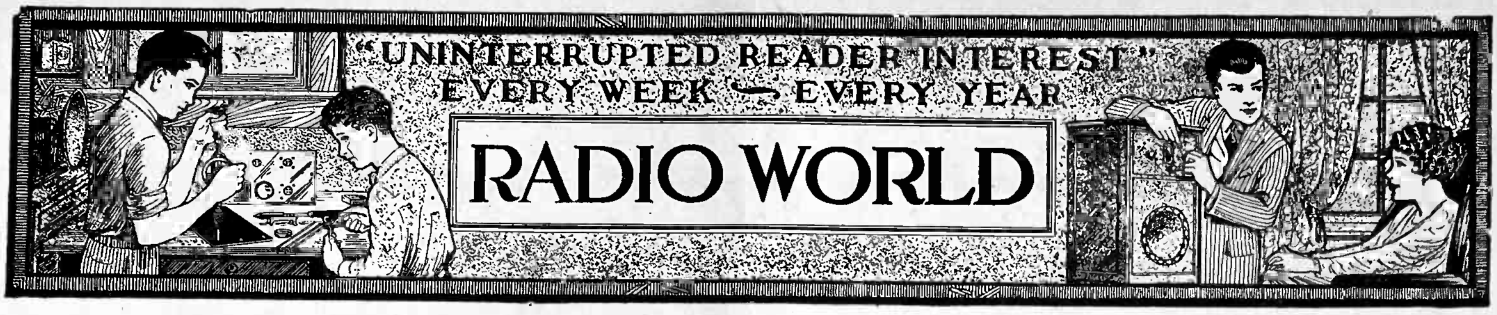
See advertisement of "The Mathematics of Radio" on page 21.



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AUTOMATIC VOLUME

New Design to Provide Uniform Sound Level

By Rodman Baskerville

THE volume of a receiver may be controlled automatically by inclusion of the device illustrated in Fig. 1, which embodies a 199 tube in series with that leg of the voltage divider of a B supply wherein all the receiver plate current flows. If the total plate current is 60 milliamperes, or a little less, then the automatic volume control tube may be placed directly in the circuit, but as the current is different in various receivers, a shunt rheostat, R4, of about 30 ohms, will enable operation of this system even if the total plate current is 120 milliamperes. Also R4 in any instance may be used for determining the steady volume level.

The theory of the operation of this system of automatic volume control is that of alteration of the negative bias on radio frequency amplifying tubes. The louder the signals, the higher the bias, hence the less the amplification. This tends to equalize the volume. Those volume levels exceeding the steady level are reduced to the steady level. Signals too weak to be heard plainly do not come up to the clear audibility point, because weak signals are not affected, only strong ones.

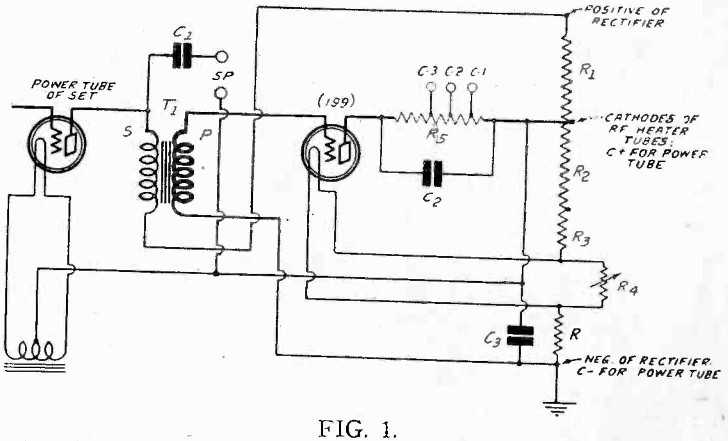


FIG. 1.

AN AUTOMATIC VOLUME CONTROL. A 199 TUBE IS CONNECTED IN SERIES WITH THE VOLTAGE DIVIDER OF A B SUPPLY, FOR FILAMENT HEATING. THE POWER TUBE'S OUTPUT IS IMPRESSED ON THE 199, WHICH RECTIFIES IT. CHANGING VALUES OF NEGATIVE BIAS FOR RADIO AMPLIFIERS IN AC CIRCUITS ARE PROVIDED, TO REDUCE TOO-LOUD STATIONS TO THE DESIRED LEVEL OF SOUND

Power Tube's Divided Output

Therefore the filament of the volume control tube is heated to a point of emission that gives the desired volume, and the louder signals will be reduced to this volume, while the softer signals are naturally below it, and are not diminished in any way.

The power tube of the receiver is shown at left. This has an output transformer T1 in its plate circuit, plus a filter condenser, C1. The secondary of this transformer is used as a filter choke, and the direct current from the B supply to the power tube is passed through this choke. The signal current for operation of the speaker is taken from one side of the filter condenser C1 and with return made to the center-tap of the filament winding heating the power tube. The power taken from the power tube is slight.

The other winding, or theoretical primary, of this transformer is connected in the grid circuit of the volume control tube. Therefore the fluctuations at audio frequencies are impressed on the grid of the volume control tube, which is in a circuit that really forms a C eliminator design affording instantaneously changing biases, as determined by the signal intensity. The 199 tube is used as a rectifier, due to the connection of the grid return to a point sufficiently negative in respect to its minus filament to create the condition required for best operation as a grid bias rectifier.

The plate of the 199 tube has a tapped resistor as the load, and the return is made to a point about 50 volts above negative of the rectifier, or about 45 volts above the potential of the negative leg of the 199 filament. The difference, or 5 volts, constitutes the negative bias on the 199, which is correct for rectification with a plate voltage of 50. The power tube under such circumstances could be a 245 biased 50 volts negative, but not affected by the automatic operation.

Type of Current Changed

The voltage drop in this tapped resistor, R5, provides the available bias for the radio frequency tubes. It is not good practice to make the audio tubes responsive to bias changes, although if grid bias detection is used in the receiver, the detector tube might be subjected to this same method.

As the signal is impressed on the grid of the 199 it is alternating, with the plate current changing at the rate of, say from, 16 to 10,000 cycles a second, and beyond. The plate resistor in the volume control circuit, on the other hand, requires that the current be reduced to direct current in its simplest form. The output from the power tube was alternating on account of the creation of the magnetic lines or field force about the transformer. Rectification by the 199 provides the desired type of current, except that in some instances a filter might have to be arranged in the plate circuit of the 199 to eliminate any stray ripples.

If the cathodes of RF heater type tubes, 224 or 227, are connected to the high voltage side of the resistor R5 in the 199 tube's plate circuit, then any grid return connection made to any other point on R5 will be negative in respect to the cathode, and negative bias will result. As the impressed audio signal in the grid circuit of the 199 produces corresponding changes in plate current in the 199 tube's output, the voltage drop in the resistor changes as the volume changes, and the greater the signal impressed the greater the drop in R5, and the greater any bias obtained from R5.

So if R5 is 20,000 ohms, the total resistance, adding the plate load to the plate resistance of the 199, is 40,000 ohms, across which is dropped 45 volts, or about one volt per thousand ohms. Hence from the cathode connection point on the voltage divider, the point where R1 and R2 meet, to the point on R5 marked C-1, may be 1,500 ohms for biasing a 224 tube at 1.5 volts minimum. As the signal always increases the plate current in grid bias detection, the bias always will exceed 1.5 volts. Or a 227 tube might be connected with cathode as before, and grid return to C-2, which would be 4 volts negative, if the total resistance between the cathode point and C-2 is 4,000 ohms.

The system outlined, devised by Herman Bernard, works out approximately, the only factor defeating absolute conformity to requirements being that the ratio of amplification to bias is not a straight line. There are dips and flattened stretches in the curve. It is true that the higher the bias the lower the amplification, but the proportion is not wholly uniform. However, it is not necessary that it be so, for the automatic volume control does its work well.

HIGH PLATE VOLT
FOR HIGH GAIN FROM

Screen Voltage Should Be Les

By J. E

Techni

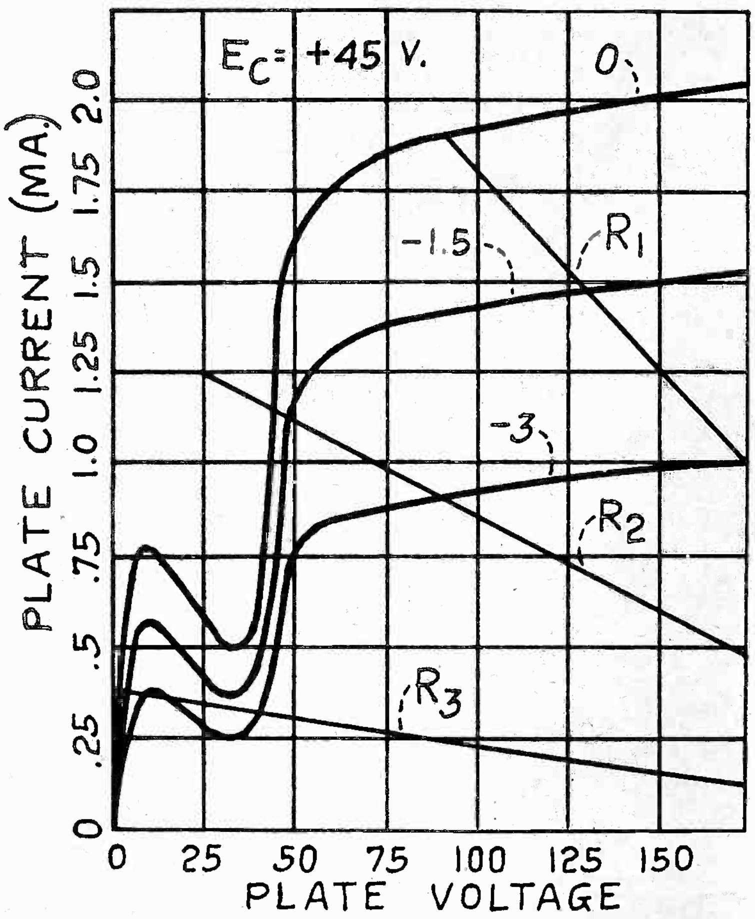


FIG. 1

PLATE CURRENT, PLATE VOLTAGE CURVES FOR A 222 TYPE SCREEN GRID TUBE, SHOWING THE EFFECT OF DIFFERENT PLATE RESISTANCES IN THE LOAD. THE SCREEN VOLTAGE IS 45 VOLTS

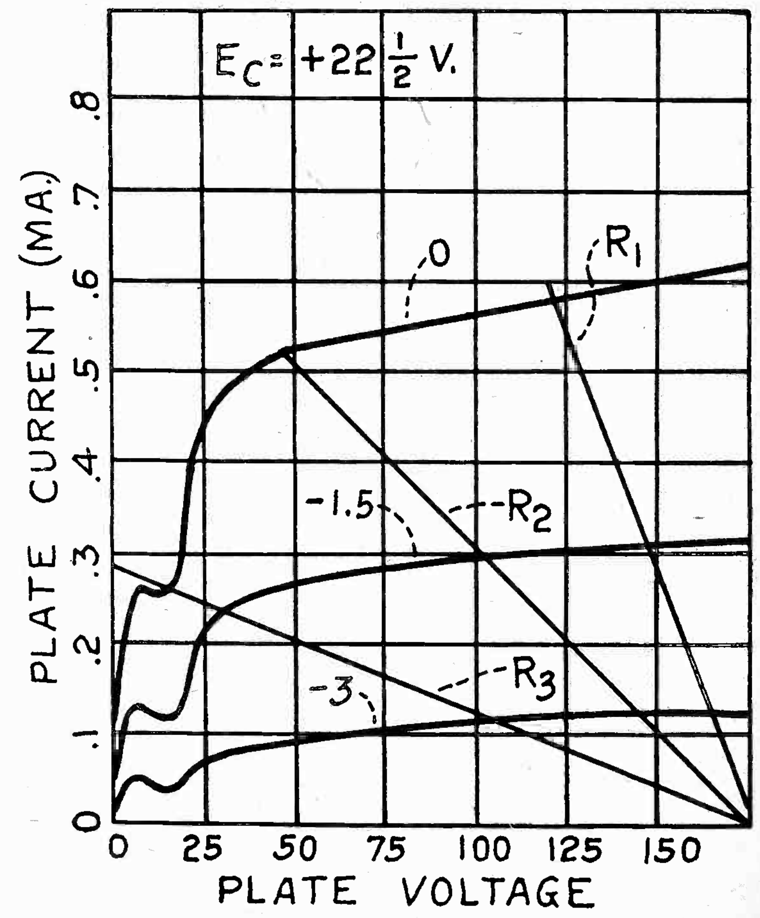


FIG. 2

THE PLATE CURRENT, PLATE VOLTAGE CURVES FOR A 222 TYPE SCREEN GRID TUBE WHEN THE SCREEN VOLTAGE IS 22½ VOLTS. THE STRAIGHT LINES ARE LOAD LINES FOR VARIOUS RESISTANCES.

THE theory of the screen grid tube shows that the amplification is the product of the mutual conductance and the load resistance. Thus if the mutual conductance remains constant the amplification is limited only by the load resistance. But the mutual conductance does not remain constant, because it depends on the effective voltage on the plate of the tube, and it varies approximately in the same manner as the plate current. When the effective plate voltage is zero, the mutual conductance is zero. As the voltage on the plate increases, the mutual conductance at first increases very rapidly, then it falls, then rises again and approaches a value depending on the structural constants of the tube. The variation is about the same as that of the plate current curves in Figs. 1 and 2, except that for high plate voltages the mutual conductance curve flattens out more to a constant value.

The effective plate voltage is not the voltage of the B battery when there is an impedance in the plate circuit. It is the applied voltage less the voltage drop in the plate load. As the load is increased the drop in it increases so that the effective plate voltage is decreased, when the applied voltage is constant. Hence the higher the load resistance, or impedance, for a given value of the voltage applied, the lower is the effective value of plate voltage. Likewise, the lower is the mutual conductance.

The lowering of the effective plate voltage is clearly shown in Figs. 1 and 2. In each of these figures for the 222 tube the curves show the plate currents for various plate voltages effective on the plate at three different grid bias values. The straight lines are the so-called load lines. On each drawing the three straight lines start from a common point, which is the point of zero current and the plate battery voltage. The slope of any line depends on the resistance which it represents, the lower the resistance the steeper the line. The intersection of any of the lines with the plate current curves gives the effective plate voltage for given plate current and grid bias. For example, the line R1 in Fig. 1 crosses the plate current curve for zero bias at 1.9 milliamperes and 92 volts. Thus the effective voltage is only 92 volts when this current flows. The line R1 represents a load resistance of 100,000 ohms.

The line R2 represents a load resistance of about 275,000 ohms. This line crosses the two plate current curves for zero and 1.5 volts at two points very close together. Thus a change of 1.5 volts on the grid produces only a very small change in the plate current or in the voltage drop in the plate load resistance. It is evident that there is very little amplification. If the resistance were a little greater the load line would cut the three lines at points very close together. Then there would be no change in the plate current or effective plate voltage for a change of 3 volts in the grid circuit.

If the resistance is increased still further the load line will be like that of R3, which represents a resistance of 750,000 ohms.

If the tube is to function as an amplifier the load resistance must

AGE AND IMPEDANCE
SCREEN GRID TUBES

than Half of Effective Plate Voltage

Anderson

itor

not be so high that the load line intersects the plate current curve for zero bias below the upper bend in the curve. R1 represents about the highest resistance that can be used when the plate battery and the screen grid voltage are as in Fig. 1.

Effect of Screen Voltage

Fig. 2 represents the case when a screen voltage of 22½ volts and a plate battery voltage of 180 volts are used. The load line R1 represents a resistance of 100,000 ohms, as in the preceding case. R2 now represents a resistance of 250,000 ohms. This line still cuts the plate current curve for zero bias above the upper bend and hence this resistance can be used when the screen grid voltage is 22½ volts. But a higher value of resistance is not safe for the curve drops rapidly below the point of intersection.

Line R3 in Fig. 2 represents a resistance of 615,000 ohms. It cuts the plate current curve for zero bias well down and at the kink. It is clear that the resistance is much too high for the particular combination of screen and plate battery voltages.

It will be observed that the sudden drop in the plate current curves occurs when the effective plate voltage is equal to the voltage applied to the screen grid, and also that the curves do not become regular until the effective plate voltage is about twice as high as the voltage on the screen. This gives us a convenient relation for design purposes. For example, if the voltage on the screen is 45 volts, the effective voltage on the plate at zero bias should not be less than 90 volts. The battery voltage and the load resistance should be selected to satisfy this condition. If a high amplification is desired a high resistance must be used, and that in turn requires that the plate battery voltage be high.

Mutual Curves

The effect of too high a resistance in the load circuit on the grid voltage plate current, or plate output voltage, curves, is shown in Fig. 3. In this figure are four curves, for all of which the plate battery voltage was 130 volts. The load resistance was one megohm. The curves show the voltage across the one megohm resistor for various values of grid voltage. The plate current is proportional to the voltage drop so that the curves may be taken to represent the plate current as well.

In three of these curves there is a flat portion at the top, indicating that there is no change in the plate current accompanying a change in the grid voltage. This portion is longer the higher the screen grid voltage, and it corresponds with the region in the curves in Figs. 1 and 2 which lies to the left of the double kink. Then there is a sudden drop in the curves, followed by a double bend. These irregularities correspond with the irregularities in the curves in Figs. 1 and 2 when the effective plate voltage is equal to the voltage on the screen. It will be noticed that if the voltage be measured from the 130 volt line, the lower of the double bends falls at a value equal to the screen grid voltage. In other words, the curves assume their regularity as soon as the effective plate voltage is equal to the screen voltage.

If a high resistance is used in the plate circuit, the control grid bias must be high in order to bring the operating point on the regular portion of the curve. This is illustrated in all three drawings. But increasing the grid bias is no remedy for inadequate voltage in the plate circuit. The tube is not a good amplifier when operated on the curved portion of the characteristic.

The effect of increasing the plate battery voltage is clear from a study of the curves in Figs. 1 and 2. For any given resistance in the plate circuit the load line has the same slope, but the higher the plate battery voltage the farther out on the voltage axis does it begin. Hence increasing the plate battery voltage is equivalent to moving the load lines to the right, keeping them parallel to their original position. Consider line R2 in Fig. 1, for example. If it is moved parallel to itself toward the right, its intersection with the plate current curve for zero bias will move up. If it is moved far enough it will intersect the curve where R1 now cuts it.

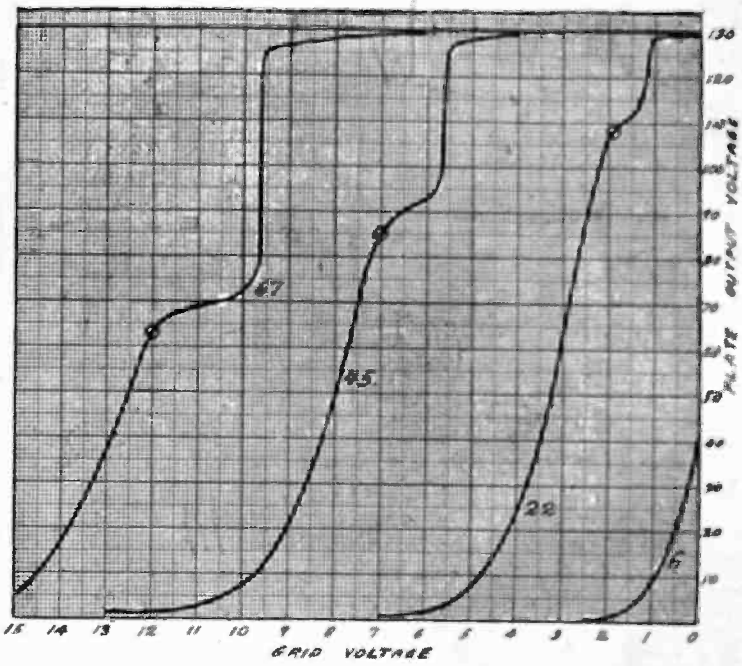


FIG. 3.

GRID VOLTAGE, PLATE OUTPUT VOLTAGE CURVES FOR A 222 SCREEN GRID TUBE SHOWING THE BENDS WHEN THE SCREEN VOLTAGE IS EQUAL TO THE EFFECTVE PLATE VOLTAGE.

Likewise in Fig. 2, the load line R3, if moved parallel with itself to the right far enough, will cut the plate current curve for zero bias where R2 now cuts. Even the line R3 in Fig. 1 could be moved far enough to the right to make it cut the plate current curve for zero bias above the irregular region, but to move it would require a very high plate battery voltage.

In Fig. 3 it is clear what happens when the plate battery voltage is increased. The irregularity in each case appears at a distance from the top equal to the screen grid voltage. At the same time the irregularity moves toward the right. Thus if the top line, that is, the applied battery voltage, is raised, the irregularity in any curve moves upward and into the positive grid voltage region. The curve in the lower right corner for a screen voltage of 6 is regular all the way. The next curve is irregular at the top, and it would require a battery voltage of about 200 volts to remove the irregularity.

The battery voltage for screen grid voltages of 45 and 67 volts could also be increased until the curves become regular throughout, but the voltages required would be enormous.

When a high load resistance is used it is best to use a moderate value of screen grid voltage, for example 22 volts, and then raise the voltage on the plate until the curve is regular throughout the operating range of negative grid voltage.

Since very high voltages are not available, when a screen voltage as high as 45 volts is used, a lower plate load resistance is preferable.

While the amplification theoretically is limited only by the load resistance on the tube, actually it is limited by the amount of voltage that is available for applying in the plate circuit.

The same general considerations set forth in respect to the 222 tube apply to the 224.

FRIENDLY METERS

How They Help a Fellow Out of Trouble

By James H. Carroll

Contributing Editor

METERS have improved as fast as any other piece of radio apparatus and have gained in growth and use. The 49ers of radio, so to speak, will remember the good old days when meters were scarce. Practically the only meters used were the pocket ammeters wrongly used to "measure" dry cells and low resistance voltmeters used to "measure" the voltages on the early form of B batteries. Milliammeters were out of the question. If one ventured to predict the common use of an 0-600 high resistance voltmeter he would have been laughed at. Such meters were in use in laboratories.

Later on, a few advanced Super-Heterodyne experimenters built meters into the front panel, finding them of great advantage in those days of low battery power. A milliammeter and a combination voltmeter for measuring A and B voltages, proved helpful in many ways, as, for instance, in checking up and keeping voltages to standard and in helping the set to bring in DX stations, by the advantage of proper voltages. From then on meters came into their own, until today they are common accessories to almost every fan and indispensable instruments in the laboratory kit of every custom-set builder, service man and serious-minded home experimenter.

Meters Good for Ordinary Use

In the earlier days there were practically only three makers of measuring instruments, two of high-priced and one of popular-priced meters. Today there are several and even the low-priced meters are reliable and accurate enough for any ordinary radio purpose.

There are three varieties of voltages to be measured in every receiver. They are, filament voltages, grid voltages and plate voltages. The filament and grid voltages will run the lowest and will be on the order of only a few volts, except for the grid voltages of large power tubes. The grid and filament voltages on all types of tubes, excepting the AC tubes, will be DC voltages. Therefore a voltmeter of from 0-10 volts is necessary. A meter of that range that measures both AC and DC is indeed handy. The plate voltages in all receivers of today run higher, and 180 volts is now the minimum with power packs running from 220 volts to 400 and more, so the 0-600 AC and DC voltmeter amply covers our requirements, also giving the advantage of reading the AC line voltage and the AC voltage across power transformers' "high" windings.

This volt meter should be high resistance. We now have an 0-10 volt AC and DC and an 0-600 AC and DC. Combine these with an 0-20 and 0-100 milliammeter, the same meter reading both ranges, and we have a working outfit that will solve testing problems.

These meters can be mounted in a handy case and with the addition of two sockets, one four-prong for DC tubes and one five-prong for AC tubes, and a five-prong plug and a four-prong adapter, one can measure the filament and plate voltages and plate current on all standard DC and AC tubes, including screen-grid tubes of all types.

Performance Depends On Voltages

An outfit of this kind is of real value to every fan, and a necessity to every service man. The fan can readily test his home-built receivers from time to time as he builds them from designs in his radio periodical, and can work into the service end, building up a good business testing out recalcitrant receivers, and trouble-shooting for neighbors and friends. The service man can locate troubles in a jiffy that would ordinarily take hours. A good book on trouble shooting helps this speedy, accurate accomplishment.

The high-range scale of the 0-600 AC and DC high resistance voltmeter is used to read all the plate voltages in the receiver so as to make sure that each tube is getting its proper plate voltage. Most tubes will work to some extent with almost any plate voltage within reason, sometimes with an astonishingly low voltage, and with too-high voltage, but there is always one proper plate voltage, with suitable bias and plate load, for each tube at which it will work the best. Tests should be made for proper adjustment of grid bias voltage. However, it is most important that we know first exactly what voltages we are applying to the plate. This is of prime importance in the case of audio and power tubes. Finding the plate voltage applied to a certain type of tube, the proper grid bias can be computed or a table of tube constants consulted.

In many parts of the country one will often be called upon to shoot trouble on battery-operating sets and the outfit will prove equally effective, and this applies to tests of A powers, B eliminators and combination power packs. In a case of this kind, the voltmeter shows the condition of the B batteries and if the voltage falls below approximately 38 volts on a 45-volt battery, the question arises whether these batteries are at fault. One run-down battery in a bank of three or more will cause many varieties of trouble. But a B battery is good as long as it gives satisfactory service, no matter what the voltage reads.

If a B eliminator or a combination power pack and amplifier is being used, the high resistance voltmeter is the only rapid means of accurately telling the voltages applied to the plates of each respective tube. The maximum output voltage generally will be fixed, but the amplifier, intermediates and detector plate voltages may all be variable by many volts and controlled by some adjustor.

Here is seen the necessity of the voltmeter being of the high resistance type. A low resistance meter will draw an appreciable amount of current from the supply across which it is connected and in the case of eliminators where the total current is limited by the regulation, a heavy current drain results in a large voltage drop in the rectifier, therefore making the reading with the meter in circuit too low by many volts. The voltmeter should be of high resistance so that it will draw little current and thus give a true reading.

How to Connect Meter

In using a high resistance voltmeter for testing or checking up a B eliminator or power pack, the receiver should be operated so that full drain will be thrown on, or a working load will be carried, while the tests are being made. The meter is then applied across each terminal and the measurements obtained will be the actual working voltages. Each voltage tap should be carefully checked in turn so that any drop or defect may be determined.

In power packs, the final or terminal output voltage on the power tube should be, for the —71 tube, 180 volts maximum, excluding bias section; for the —45 tube, 250 volts maximum; for the —10 tube, 350 maximum, and for the 250 tube 450 volts maximum.

The low voltage voltmeter should be used to check up on the filament voltages, which, while they are not critical, should be checked for over-voltage which greatly shortens the life of the tubes, retarding efficiency and disagreeably affecting tone. A tolerance of 5% is allowable from rated constants. Preferably see that the filament voltages are kept slightly below the rated voltages.

In measuring the effective plate voltage, the positive side of the high-resistance voltmeter should be connected to the plate terminal of the tube socket and the negative side to the filament or cathode. Grid voltages important and should be carefully checked, as they have much to do with the all-round efficiency and tone quality of the receiver.

The general rule is that the greater the amount of grid bias on the RF end, the greater the selectivity and the less the sensitivity of the receiver. These negative grid biases are obtained from a separate C battery or C eliminator or from the voltage drop across a resistance carrying plate on only filament current.

In measuring audio tubes, it will be found that the negative bias applied to the audio end has great effect on the quality of reproduction.

Some Good Books to Study

PLEASE recommend some books for me to read. I am a novice, in the sense that I have just a smattering knowledge of radio technique. As I advance I would like to read other books. Please state what I should start with.—H. G.

One of the best books for the beginner is "Elements of Radio Communication," by Prof. John H. Morecroft, recently published. Prof. Morecroft is the author also of "Principles of Radio Communication," long recognized as the outstanding text book on radio, but not of much attraction for the novice. Everybody, novice or expert, should have "Elements" in his library. "Practical Radio," by James A. Moyer and John F. Wostrel is another useful book for the beginner. For a thorough understanding of tubes, "Radio Receiving Tubes," by Moyer and Wostrel, is an outstanding volume written as non-technically as possible. As you advance beyond the novice state, get Morecroft's "Principles," second edition; "Thermionic Vacuum Tubes," by Hendrik J. Van der Bijl; Circular 74, issued by the Bureau of Standards, Department of Commerce; "The Mathematics of Radio" and "Trouble Shooter's Manual," by John F. Rider; and "Power Amplifiers," by J. E. Anderson and Herman Bernard.

HUM ELIMINATION

Even Battery-Operated Sets Often Need Remedy

By Herbert E. Hayden

A COMMON complaint about receivers is that they hum. This is not limited to receivers using AC tubes but extends to all types of receivers regardless of their design. Sets employing batteries throughout often are subject to this complaint.

Usually the complaint is that there is a 60-cycle hum present. But a statement like that simply means that the receiver is emitting a noise which is not a part of the signal, for investigation of complaints has shown that the "60-cycle hum" has had practically all frequencies within the audible range. Ask certain persons who are complaining of a "60-cycle hum" what the pitch of the hum is, and they are sure to reply that it is very loud. Ask what the frequency of the hum is and the reply is a shrug of the shoulder, or some other equally significant gesture.

The fact is that a 60-cycle hum rarely occurs in any receiver. Nearly every factor which contributes hum from the power line contributes it at 120 cycles. This hum may be heard in many receivers—in most receivers, in fact, which in any way are connected to a 60-cycle supply. It is just a question how intense the 120-cycle hum is. If it is so weak that it cannot be heard more than a few inches from the loudspeaker it may be said not to exist for practical purposes.

Hum Often Severe

In many instances the hum is much too loud to be tolerable, and something must be done to reduce its intensity. To do that requires a knowledge of where hum usually gets into the set, and what conditions should obtain for humless operation.

The principal causes of hum are: (a) inadequate filtering, (b) unbalanced filaments, (c) excessive regeneration at audio or radio frequency, or actual oscillation at some frequency.

Inadequate filtering in AC sets may be due to overloading of the B supply device, that is, to excessive current drain, to defective rectifier tube, or to insufficient by-passing in the filter. Perhaps the weakest point on most B supply units is the choke coils. They are not wound on cores of sufficient size for the current that is drawn from the rectifier. The cores become saturated and the inductance becomes very low. When the inductance is low the coils serve no useful purpose.

A defective rectifier tube is the cause of hum occasionally. A new tube in the socket should clear up the situation if this is the cause of the hum.

The size of the by-pass condensers also has a bearing on the amount of hum, as does their distribution in the filter. It is advisable to use a moderately large condenser next to the rectifier tube, say not larger than 4 mfd.

Condensers Without Limit

The other by-pass condensers in the filter may be of any size, just so they are large, for the larger they are the better the filtering. It is especially advantageous to make the last condenser very large.

If the current drain is so high that the choke coils are much overloaded, there will be little gain by adding condensers to the filter.

Unbalance of the filaments with respect to the grid return point is a frequent source of hum. It arises from the fact that if the grid return is not made exactly to the center of the filament, or to an external point potentially equivalent to it, an AC voltage is introduced into the grid circuit. This voltage is amplified together with the signal. If the introduction of this voltage occurs in the first audio tube or in the detector, the intensity of the resulting hum will be very great by the time it reaches the loudspeaker.

It is comparatively simple to balance the filaments with respect to the grid returns either by returning the grids to the center taps of the filament transformers or to the midpoint of a resistor connected across the filament near the tube. The hum introduced by unbalance has a frequency of 60 cycles.

Even if the filaments are accurately balanced there will be some 120-cycle hum produced. This is due in part to the heating and cooling of the filament as the supply current rises and falls. Nothing can be done by the experimenter to remedy this, but the tube designer can design the tube so that this effect is negligible.

Regeneration Brings Hum

If there is much regeneration or any oscillation at any frequency the receiver will hum provided there is AC around. It need not actually be introduced into the set conductively. Introduction by magnetic or electric coupling is just as effective. The effect is one of modulation or detection, and it is for this reason that filament type AC tubes cannot be used for detection. The remedy for this type of hum is to stop the oscillation or to reduce the regeneration.

If the oscillation occurs at a radio frequency, it can be stopped by any one of the several familiar methods for controlling regeneration and oscillation. It should be remarked that the oscillation may not be inside the tuning range of the tuning condensers. It may be a parasitic oscillation which causes the trouble.

If the oscillation or regeneration occurs at an audio frequency, any of the methods for stopping motorboating will be effective. These are explained in the current installment on power amplifiers.

In many instances, the hum called 60-cycle hum does not come from the power line at all. It is neither 60-cycle nor 120-cycle hum. Neither is it a hum having a harmonic frequency of these. There are many types of noise which have been called 60-cycle hum. For example, motorboating, which may occur at any frequency. Another noise is that due to acoustic feed back or microphonic tubes. The frequency of this noise is generally around 500 cycles, but may be much lower or much higher depending on the flexibility or rigidity of the elements in the tubes of the receiver, especially of the detector. Jarring the receiver or one of the tubes will make this noise louder, which gives a simple way of identifying the noise. Also, if the loudspeaker is moved about the noise will change, and if the speaker is moved a long distance from the set, the noise will cease.

One source of hum is the field coil in the dynamic loudspeaker. If this coil is supplied from a low-voltage built-in rectifier the filtering is often inadequate to remove the ripple. This is especially true when the speaker is capable of high efficiency on the low note, and when it is connected to a receiver which is equally effective on the low notes. A 2,000 to 4,000 mfd. electrolytic condenser across a 6 volt field winding will remedy this difficulty. In connecting the condenser make sure that it is not across the filter choke in the speaker and in series with the field coil. This would make the hum worse.

Right or Wrong?

(Answered on page 11.)

1—The mutual conductance of a vacuum tube is a measure of the plate current change caused by a change of one volt on the grid.

2.—The heating effect of a DC current of a given amperage is equal to that of the root mean square of an AC current of the same amperage.

3.—A direct-current ammeter in which both AC and DC is flowing measures the heating value of the complex current.

4.—A vacuum tube voltmeter measures the peak value of the AC impressed on it.

5.—A vacuum tube can be used for measuring extremely high voltages by applying these voltages in the plate circuit and measuring with a voltmeter in the grid circuit.

6.—There is no reason for amplifying the extremely low frequencies occurring in music because if all the higher harmonics are amplified the low tone will be heard just the same, the low notes being recreated from difference tones.

7.—If a vacuum tube distorts the plate current the current in the tuned circuit following the tube will contain all the distortion.

8.—In a well-balanced push-pull amplifier all the odd harmonics remain in the output.

9.—The frequency limits of hearing are the same for all intensities of sound.

10.—Two tandem stages of amplification produce more distortion than a single stage.

ATTAINMENT IN TRANSFORMER-COUP

Effect of Common Impedance

By J. E. Anderson

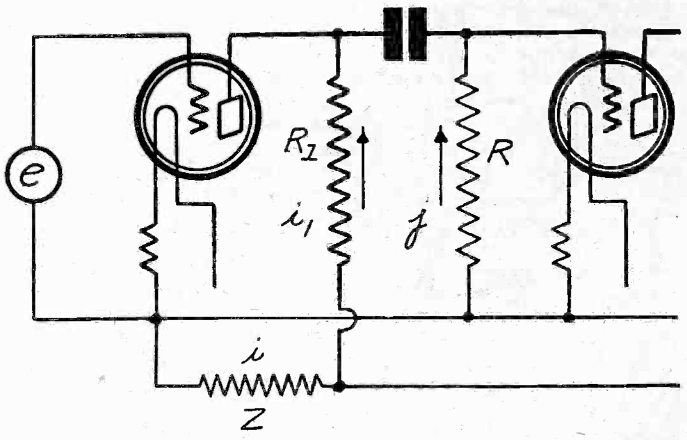


FIG. 53.
A CIRCUIT SHOWING THE EFFECT OF THE ADDITION OF A GRID LEAK AND STOPPING CONDENSER. THE CHANGE FROM A STRAIGHT RESISTANCE COUPLED CIRCUIT IS MAINLY AT THE LOW FREQUENCIES.

[Here is the tenth consecutive instalment of one of the most notable series of articles we have ever published—"Power Amplifiers." The most important of the difficult problems associated with audio amplifying circuits are analyzed intimately, and the remedies are offered. The subject of oscillation in audio amplifiers is now under discussion. Last week most of the instalment dealt with resistance-coupled audio. This week transformer circuits are dissected. Tubes used in audio amplifiers will be discussed next week. Follow this important series of articles from week to week.—Editor.]

It will be seen that the first and the third currents flow in one direction through Z and that the second and fourth flow in the opposite direction. Since the currents increase progressively, it is clear that the sum of the two even-numbered currents is much greater than the sum of the odd-numbered. Hence the direction of i, the current in Z, is determined by the two even numbered currents.

Since i flows in the opposite direction from $i1$ the voltage drop Zi is subtracted from the drop $R1i1$, and therefore the feedback through Z reduces the amplification. The greater Z is the greater the reduction. Thus it is plain that a resistance-coupled amplifier having four plate circuits on the common impedance is stable. Indeed, the stabilizing effect may be so great that the total amplification is only a small fraction of what it would be were the common impedance not in the circuit.

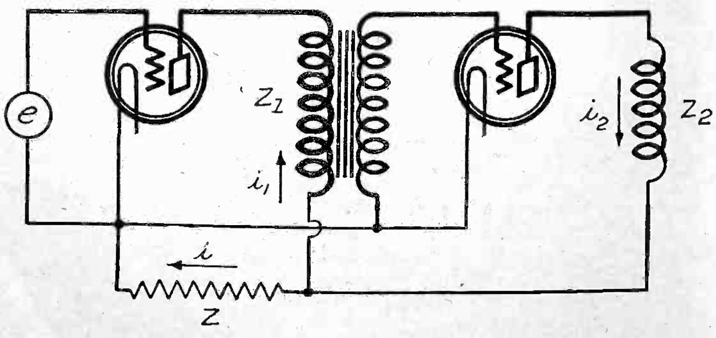


FIG. 54
IN THIS TWO-TUBE AMPLIFIER THE TRANSFORMER IS CONNECTED SO THAT THE SECOND CURRENT IS IN OPPOSITE PHASE TO THE FIRST, RESULTING IN INSTABILITY WHEN THE COMMON IMPEDANCE Z IS HIGH.

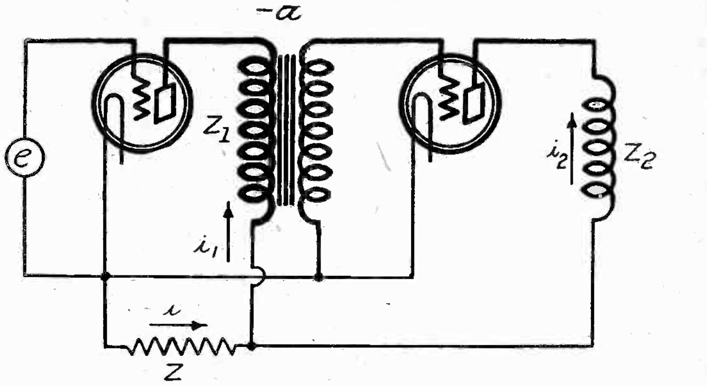


FIG. 55
IN THIS AMPLIFIER THE TRANSFORMER IS CONNECTED SO THAT THE TWO PLATE CURRENTS ARE IN PHASE, RESULTING IN STABILITY WHEN THE COMMON IMPEDANCE Z IS HIGH.

When there is an inductance in the plate circuit of the last tube, such as that of a loudspeaker winding, there is a change in the behavior of the circuit. The fourth plate current is retarded by an angle depending on the frequency. When this retardation amounts to a certain value the sum of the second current and the component of the fourth in phase with it is equal to the sum of two odd-numbered currents. At that frequency the common impedance has no effect in increasing or decreasing the amplification. For all higher frequencies the component of the fourth current in phase with the second is so small that the two odd-numbered currents determine the direction of i. Hence for the higher frequencies this four-tube circuit is unstable, provided that the load on the final tube contains inductance. This change from stability to instability might occur at any frequency, depending on the circuit constants, but often it occurs around 1,000 cycles per second.

This does not necessarily mean that the four-tube circuit will oscillate at the higher frequencies, but it means that for frequencies higher than the change-over frequency the amplification will be increased by the feedback through Z. A four-tube circuit like that shown in Fig. 52 might oscillate around 10,000 cycles, unless there are condensers across Z.

If the circuits in Figs. 50, 51 and 52 are impedance-coupled instead of resistance-coupled, they behave in general just as if the coupler is resistance. However, the behavior is more complex and the frequency regions of stability and instability are not as definite.

In these direct-coupled circuit diagrams the stopping condensers and grid leaks were omitted for the sake of simplicity. When they are used, as they are in nearly all practical circuits, the behavior of the circuits is approximately the same as when they are not. However, there are many marked differences, particularly at the low frequencies.

The difference can best be explained with the aid of a diagram, such as is shown in Fig. 53, which includes only one coupler. C is the stopping condenser, R the grid leak, R1 the plate load resistor, $i1$ the plate signal current through R1, j the signal current through the condenser and grid leak, and i is the current through the common impedance.

The first thing to be observed is that the total plate current is broken up into two parts, $i1$ and j, and that only one of these flows through the common impedance. It appears, therefore, that the grid leak and condenser circuit makes the circuit a little bit more stable, and that the stabilization depends on the magnitude of j compared with that of $i1$. This magnitude in turn depends on the relative values of the corresponding impedances. Under most operating conditions j is small compared with $i1$ so that the stabilization effect is not great. However, this suggests a method of stabilization of

OF STABILITY LED AUDIO AMPLIFIERS

Upon the Behavior Is Explained

and Herman Bernard

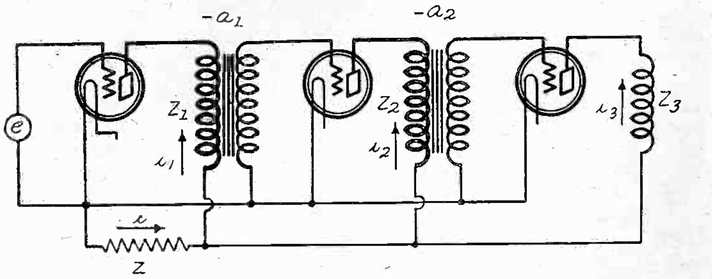


FIG. 56
THIS THREE-TUBE TRANSFORMER COUPLED CIRCUIT IS THE MOST STABLE OF THE FOUR POSSIBLE COMBINATIONS OF THE TWO TRANSFORMERS. BOTH TRANSFORMERS ARE CONNECTED TO REVERSE THE PHASE.

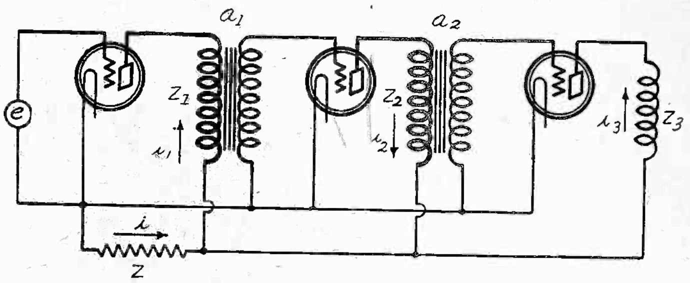


FIG. 57
IN THIS THREE-TUBE AMPLIFIER THE TRANSFORMERS ARE CONNECTED SO AS TO MAINTAIN THE PHASE, RESULTING IN CURRENT PHASE RELATIONS AS SHOWN. THE CIRCUIT IS NOMINALLY NEUTRAL BUT ACTUALLY STABLE.

a circuit that is oscillatory at low frequencies. This will be discussed later.

The condenser and leak have another influence on the behavior of the circuit, one which is of greater importance. At low frequencies the condenser offers a very high impedance to currents, and the voltage drop across the condenser will be comparable to that across the grid leak R. Only the drop across R is impressed on the grid of the second tube. Hence at low frequencies the amplification will be reduced by C. This reduction in some instances may stabilize a circuit that is oscillatory at low frequencies, for no circuit can oscillate unless there is a high amplification in it. The lower the frequency the lower the amplification for any given values of C and R.

The condenser and the leak also change the phase of the signal, so that the same simple relationships among the directions of the plate currents existing in the circuits in Figs. 50, 51 and 52 will no longer obtain. The phase will be advanced by the condenser and leak by a certain angle, depending on the frequency and the time constant of the condenser and the leak. The time constant, it should be stated, is the product of the capacity of the condenser in farads and the grid leak resistance in ohms. It is measured in seconds. At high frequencies phase shift is negligible and therefore at these there is little change in the circuit. At low frequencies the shift is considerable and the circuit changes its behavior accordingly.

The phase shift introduced by the condensers and the grid leaks in a circuit is such as to make a three-tube circuit like that in Fig. 51 stable at the very low frequencies and a four-tube circuit like that in Fig. 52 oscillatory. The oscillation in the four-tube circuit might occur at a frequency below 20 cycles per second, and in some instances as low as one cycle in 10 seconds.

This very slow frequency oscillation is the most difficult to deal with because condensers are valueless for by-passing.

It should be stated here that the time constant of the stopping condenser and grid leak should be as large as possible. The larger it is, the more nearly will the circuit behave as if the condenser were not present, that is, it will behave as a circuit of the type shown in Figs. 50, 51 and 52. No detrimental effects on the amplification of the high frequencies will occur, notwithstanding the prevalent fallacy that the time constant should be small in order to amplify the high frequencies.

Since the time constant is the product of the capacity of the condenser and the resistance of the leak, it is clear that it may be increased by increasing either. In a circuit that oscillates at a low frequency it is often desirable to make the time constant small in order to reduce the amplification to a point where oscillation cannot be sustained. This is a makeshift, but a most welcome one in some instances.

There are certain limitations to the changes in the values of the condenser and the grid leak. If the grid leak is made small, the condenser remaining constant, the amplification will be reduced at all frequencies. The quality, however, remains almost unchanged. If the condenser be reduced, the resistance remaining constant, the amplification will be reduced chiefly on the low frequencies. This might be disirable when the object is to reduce oscillation on a low frequency without affecting the quality in the audible range. If the resistance be made very large it may cease to function as a leak. The tube will block, not because the grid goes negative as is commonly said, but because it goes positive. There are positively charged conductors all around the grid and the leakage from these through the insulation may be greater than the leakage through the grid leak.

A time constant of about .02 second is suitable for high quality broadcast reception, which may be obtained by using a condenser of .01 mfd. and a leak of 2 megohms, or a condenser of .02 mfd. and a leak of 1.0 megohm. The lower value leak resistance should be used where the grid is surrounded by the higher positive voltages, or where the signal level is the greater.

In view of the fact that the phase shifts introduced by the stopping condensers and grid leaks a circuit like that in Fig. 52 having grid leaks and condensers can be expected to oscillate at a very low frequency or at a very high. The oscillation at the high is usually prevented by condensers across the plate voltage supply. At the low frequencies any condenser placed across the common impedance is usually quite ineffective.

Direct coupled amplifiers are not the only circuits subject to oscillation as a result of feedback through the common impedance. Transformer-coupled circuits are almost equally subject to the trouble, particularly those which are efficient on the low frequencies.

In Fig. 54 is a two-tube transformer coupled amplifier in which Z_1 is the impedance of the primary of the transformer, a the ratio of turns, Z_2 the impedance of the load on the second tube, and Z is the common impedance. As before i_1 and i_2 are the alternating components of the two plate currents and i is the net current in the common impedance. The ratio a may be either positive or

(Continued on next page.)

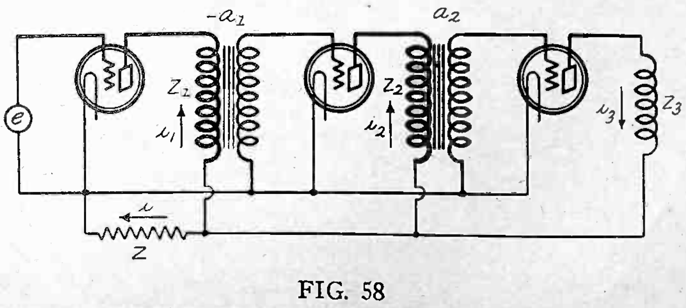


FIG. 58
THIS CIRCUIT IS UNSTABLE WHEN Z IS LARGE. THE FIRST TRANSFORMER REVERSES THE PHASE, THE SECOND MAINTAINS IT.

WORST INSTABILITY

Arises from Phase Relationships

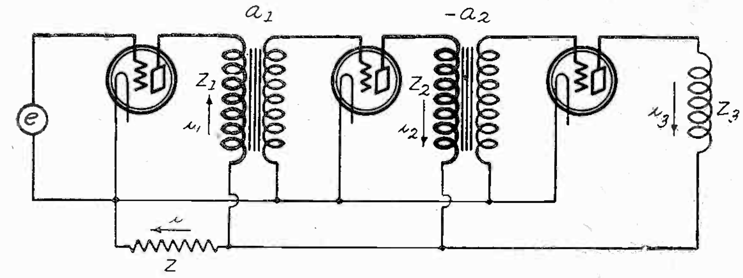


FIG. 59

THIS IS THE MOST UNSTABLE OF THE FOUR POSSIBLE CONNECTIONS OF THE TWO TRANSFORMERS. THE FIRST TRANSFORMER MAINTAINS THE PHASE, THE SECOND REVERSES IT.

(Continued from preceding page.)

negative according to whether it does or does not reverse the phase of the signal.

The arrows in Fig. 54 shows the case when *a* is positive because the currents are in opposite directions in the two plate circuits, and this single reversal of phase has been introduced by the second tube. In this case the current *i* through Z is determined by the second current.

Now if the transformer-coupled circuit were like the direct coupled, this amplifier would be stable. However, this is not the case, for the feedback is in such direction as to increase the amplification. When *i2* encounters the common impedance at the junction of Z1 and Z2, it divides, part going up through the primary of the transformer and part through Z. Since the part of *i2* that flows through Z1 flows up, it is in phase with *i1*, and consequently the input to the second tube is greater than it would be if Z were not present. One might say that the common impedance causes the second current to back up until it is forced to seek an outlet through Z1 and the tube.

Another way of looking at this feedback is to consider the total effective voltage drop in the plate circuit of the first tube. The drop *i*Z is in opposite direction to the drop *i*1Z1. Hence the greater the feedback *i*Z the lower the drop in the plate circuit of the first tube. If the drop in the common impedance is great enough, the total drop in the plate circuit of the first tube will be negative, which means that oscillations will be sustained.

In Fig. 55 are shown the directions of the currents in the circuit when the ratio of the transformer is negative, that is, when the transformer is connected so that it reverses the phase of the signal. There are now two phase reversals, one by the transformer and one by the second tube, so that the phase of the second plate current is the same as that of the first. Naturally, the current in the common impedance Z is in the same direction as the two plate currents.

Now the second plate current tends to reduce the current in the first tube. The second tube "draws" current from the transformer primary as well as from the common impedance.

Looking at the phenomenon from the viewpoint of voltage drop in the plate circuit of the first tube, it is clear that the greater the second current the greater is the drop in the plate circuit of the first tube. There can be no reduction in this drop by the second current as long as the two plate currents are in phase. Hence the greater the feedback the greater the stability of the circuit.

The connection shown in Fig. 55 is the one more frequently used, as it has been found by experiment that it gives the more satisfactory operation. When there is no common impedance, there should be no difference between the two.

It is not to be supposed that one of these circuits is unstable and the other is stable under all circumstances. It would be true for all frequencies if the impedance Z1 were equal to impedance Z2, which is rarely the case. The first impedance is usually very large and the second comparatively low. Moreover, the phase shifts introduced by the two impedances are different. So in general there will be a frequency region in which the circuit in Fig. 54 is stable and another in which the circuit in Fig. 55 is unstable. However, the circuit in Fig. 55 is more stable than the other over a greater frequency band, and it is particularly more stable at the low frequencies.

When two transformers in a three-tube circuit are used, there are four possible connections of the transformers, resulting in essentially four different circuits. Two of these are relatively stable and two of them unstable.

The most stable of the four is the one obtained when the ratios of the two transformers are negative, making all the plate currents in phase in the common impedance. This case is shown in Fig. 56. This circuit is not only the most stable, but also the weakest amplifier, for the feedback reduces the amplification considerably.

The circuit next in order of stability is the one in which both transformer ratios are positive, which is illustrated in Fig. 57. Note that the first and the third plate currents are in phase in the common impedance and that the second current is opposed. The second current is much smaller than the sum of the other two, so that the current in the common impedance flows in the same direction as the third. It is clear that the greater the feedback the more stable is the circuit. It is also clear that this circuit cannot be so stable as the circuit in Fig. 56, because *i2* reduces the reverse feedback.

Next comes the circuit shown in Fig. 58, in which the ratio *a*1 of the first transformer is negative and the ratio *a2* is positive. The third current flows against the other two in the common impedance. Being greater than the sum of the other two, it determines the direction of the current in Z. This circuit is unstable because the last current reduces the voltage drops in the plate circuits of the first two tubes, or the common impedance backs current up through the primaries of both transformers.

The most unstable circuit is shown in Fig. 59. The ratio of the first transformer is positive and that of the second is negative. As will be seen, the plate currents in the two second tubes combine and feed back into the first.

While the four circuits have been listed in the order of stability, there is really very little difference between the two circuits in Figs. 58 and 59, if the tubes and the transformers are the same. In considering the overall effect on the amplification of the feedback, it is necessary to consider feedback from one tube to the one preceding, as well as the feedback from the last to the first.

If we assign a weight of unity to a feed-back from one tube to the preceding when it tends to produce oscillation and minus unity when it tends to reduce the amplification, and two units when the feedback skips a tube, giving the two units a positive or negative sign according to the direction of the feedback, we find that the circuit in Fig. 56 has a weight of —4, the circuit in Fig 57 a weight of 0, and the circuits in Figs. 58 and 59, plus 2 units each. On this basis of judgment there is no difference between the instabilities of the two circuits in Figs. 58 and 59. A feedback of —4 for the circuit in Fig. 56 indicates a high order of stability. The circuit in Fig. 57, according to this basis of judgment, is neither stable nor unstable, but neutral. It would seem, then, that the connection represented by this circuit is the most desirable as a compromise between stability and maintenance of amplification. Yet the connection in Fig. 56 is most common.

While the weight method of estimating the feedback leads to the conclusion that the circuit in Fig. 57 is neutral, the statement previously made that the circuit is stable is valid, because the last current is larger than the second and the feedback produced by the third should have been given a greater weight.

Just as the retardation of the plate current in the last tube by the reactance of the load impedance changed the behavior of the resistance-coupled circuits, so the reactances of the various plate circuits in transformer-coupled circuits change the behavior. However, it is the relative retardations that counts rather than the absolute values. If the retardation at every frequency in all the plate circuits is the same, any circuit acts just as a resistance-coupled circuit as far as the feedback is concerned. Of course, in general, it can not be assumed that the retardations are the same, for there are many different impedances and constants, all of which contribute to the retardation.

Therefore, a transformer-coupled circuit cannot be treated as simply as can a resistance-coupled circuit. It is not possible to predict in just what frequency regions a given circuit will be stable or unstable. At low frequencies, however, where oscillation is most difficult to control, the behavior is essentially as indicated by the circuits in Figs. 54 to 59.

[The series of articles on "Power Amplifiers," of which the above is the tenth instalment, has won a hearty response from readers who appreciate this masterful exposition of knotty problems. It is advisable to get each copy of Radio World *containing previous instalments and follow the discussion henceforth from week to week. The previous dates are June 1st, 8th, 15th, 22d, 29th, July 6th, 13th, 20th and 27th.—Editor.]*

240 BIAS DETECTOR

It Is Fed by 222 Operated at Full Gain

By Herman Bernard

Managing Editor

[Preliminary discussion of a 4-tube circuit design, the construction of which will be described later, was published last week in the July 27th issue. Two 222 tubes are used at full gain. The detector is a 240 and the output tube a 112A. The circuit is for battery operation, or for A battery filament heating and B eliminator plate supply. The circuit draws about 17 milliamperes plate current, using a maximum of 135 volts. Not only is its operation economical, but it is expected the cost of the parts, including decorated steel cabinet, will be about $20. Herewith the second instalment is published. More details will appear next week, issue of August 10th.—Editor.]

* * *

FINALLY there is the output tube, a 112A, ample both in amplification constant and power-handling capacity at the rated voltages. The maximum undistorted power output is 30 milliwatts, which assures absence of overload at the highest input desirable for any home. While 30 is comparatively low, when viewed in connection with numbers running into the hundreds and thousands, it is still a fact that no greater maximum undistorted power output is necessary for the operation of a home receiver. Nearly all receivers exceed 30 by far, in the handling capacity of the last audio stage, but the actual requirement is exceeded many-fold, often hundred-fold.

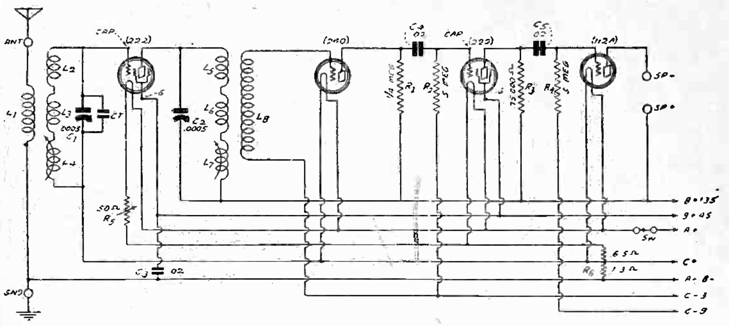
The receiver shown in Fig. 1 affords ample volume for the home, and if the last stage should be overloaded, due to some special circumstance, like proximity to a powerful broadcaster, the volume control should be used to reduce the signal level at the receiver input, for the remaining volume will be more than ample.

Requires Few Parts

The parts required for the receiver are few. All the parts, including a steel cabinet, conservatively decorated, and also including subpanel with sockets affixed, plus both coils, the tuning condensers, resistors and other capacities, probably will cost about $20. And yet the performance of the receiver will be a revelation to many—its pure tone being utterly thrilling, and its sensitivity far beyond the expectation of anyone who has not experimented soundly with the screen grid tube.

The physical layout of the parts is compact indeed, yet there is sufficient room on the subpanel, and spacing of parts where separation adequate is desirable. And the receiver tunes from below the lowest broadcast wavelength to a little above the highest.

The detector tube is a high mu 240, operated as a negative grid bias detector. The optimum operating point under the prescribed conditions of 0.25 meg. in the plate circuit and 135 plate volts applied, is 3 volts negative grid for detection. In the diagram the minimum bias voltage is just that, as C plus is taken from filament minus.



THE FOUR-TUBE CIRCUIT THAT PROVIDES SUFFICIENT SELECTIVITY, GOOD SENSITIVITY AND TONE QUALITY SECOND TO NONE.

240 Great for Power Detection

The 240 is the one tube that affords grid bias detection without any semblance of critical adjustment. One might say it will detect all over the map. Many who have tried grid bias detection, fine though it is, have given it up, because they could not get detection, just amplification, evidenced by absence of signals and presence of squeals. But the 240 is not such an example and nobody should have the least trouble obtaining fine detection. Besides, it is advisable from considerations of tone quality to use power detection. Sensitivity to radio frequencies can be just as high as with the leak-condenser method, while the audio frequency response is wonderful. No deviation from the choice of the 240 as the grid biased should be considered for this circuit.

From the detector the rectified current and voltage are fed to the second screen grid tube, used as first audio frequency amplifier. Two main considerations are present: (a) attainment of stability, i. e., absence of audio-frequency oscillation evidenced by motorboating, screeching, howling, etc., and (b) high amplification. The tone quality will be excellent automatically, if the audio oscillation is avoided, because of the relatively flat characteristic of resistance-coupled audio. Excellent stability was attained with constants of the values stated in the diagram.

Right or Wrong?

(*See questions on page 7*)

1.—Right. The mutual conductance given with tubes gives the number of microamperes the plate current will change for a change of one volt in the grid bias.

2.—Right. That is how the equality of the two currents is defined.

3.—Wrong. The DC meter measures the average current, which is less than the heating value of the current.

4.—Right. It measures the peak value if the calibration was in terms of peak values. However, it is more customary to calibrate such meters in terms of root mean square values.

5.—Right. It can be used to measure almost any high voltage in this manner. The higher the amplification factor of the tube the higher the voltages that can be measured with ordinary voltmeters.

6.—Wrong. While this property of sound makes it unessential to amplify the lowest notes, it does not make it undesirable. If the low notes are present in "their own right" the low notes will have a more pleasing quality than if the low notes come through as difference frequencies of the higher harmonics. It is this peculiarity of sound which saved radio in the early days of bad circuits.

7.—Wrong. The tuned circuit responds to only one frequency. While it responds to some extent to frequencies close to the resonant frequency, it does not respond to the harmonics of this frequency. Hence it tunes out the distortion.

8.—Right. They remain in the output. If they did not the amplifier would be inoperative, for the first odd harmonic is the signal.

9.—Wrong. The upper and lower frequency limits depend much on the intensity of the sound. The limits are farthest apart for a certain intensity, narrowing down both as the intensity increases and decreases.

10.—Wrong. The distortion may be much less in a two-stage amplifier than in a one-stage. The reason for this is that the wave form distortion in one tube as nearly offset by the distortion in the next tube. Hence amplifiers should contain an even number of tubes. When the circuit is direct coupled the frequency distortion will also be less for the even circuit.

WHAT A C VOLTAG

TO RECTI

Resistance of Tube
Difference—Fil
Affect Re

By Capt. P

Con

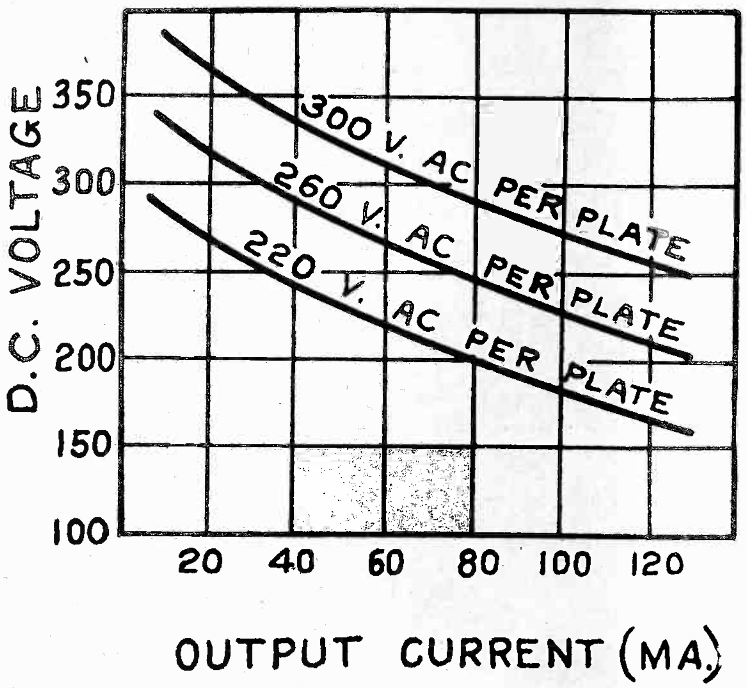


FIG. 1

REGULATION CURVES FOR THREE DIFFERENT AC INPUT VOLTAGES OF A 280 TYPE RECTIFIER AND POWER TRANSFORMER.

WHEN designing B supply units the question as to what the AC voltage across the secondary of the power transformer should be to get a specified DC voltage at the output always arises. The answer to this question is found in the regulation of the device, and the regulation of the circuit depends on the resistance in the secondary of the power transformer, the resistance of the rectifier tube itself, and on the resistance in the filter chokes. To some extent it also depends on the capacity of the first condenser across the line, that is, the condenser next to the rectifier tube.

Of these factors the resistance of the tube has the greatest influence, and as a first approximation it may be assumed that the regulation depends on this resistance alone. This assumes that the resistance of the tube is large in comparison with the sum of the other resistances, exclusive of the resistance in the voltage divider and the load.

The resistance of the tube does not remain constant but depends on the voltage swing and on the current drain. For large currents the resistance is less than for small currents, and therefore it is to be expected that the regulation is a little better for high currents. This is borne out by experimental regulation curves, as shown in Fig. 1. These curves include the effect of the resistance of the power transformer as well as that of the tube, but the resistance of the transformer is constant, so that the bending of the curves is due to the lowering of the resistance of the tube. A constant resistance would give straight line regulation curves.

A B supply cannot be designed intelligently without the aid of regulation curves for the tube which is to be used, because without such curves it is impossible to tell what the output voltage will be for a given current drain and AC input voltage.

Suppose it is required to design a B supply that will deliver 80 milliamperes and maintain a DC voltage of 300 volts across the voltage divider. What should the AC voltage per plate be? Referring to the regulation curves in Fig. 1 we note that when the AC voltage per plate of the rectifier tube (280) is 300 r.m.s., and the DC voltage across the first condenser is about 290 volts when the current drain is 80 milliamperes. Obviously 300 volts per plate are not enough, especially as there will be some additional voltage drop in the filter chokes.

When the voltage per plate is 260 volts r.m.s. the DC voltage across the output of the tube at 80 milliamperes is 245 volts. If 40 volts per plate changes the output voltage 45 volts, how much change is required to change the voltage 10 volts? Approximately 9 volts. That is, the voltage per plate should be 309 volts.

This does not take into account the voltage drop in the resistance of the filter chokes. Suppose the resistance of each of the two chokes is 500 ohms, so that the total resistance in the filter is 1,000 ohms. Since the current is 80 milliamperes, the drop in the chokes
will be 80 volts. In this case then we have to assume that the v
age across the first condenser is 380 volts instead of 300. We fo
from the curves that 40 volts per plate changed the output volt
45 volts. Now we have to determine how much the voltage
plate should be to change the output voltage 90 volts. Using
straight proportion we find that the change should be 80 vo
Therefore the voltage per plate on the rectifier tube should be
volts, effective value.

Use of Low Resistance Chokes

Now choke coils having 500 ohms resistance are not suitable
a B supply draining as much as 80 milliamperes, for the drop
them is excessive. Not only is it wasteful of power, but the re
lation will be poor and the operation of the circuit will be unsa
factory.

Suppose we use heavy-duty chokes having a resistance of o
150 ohms each. Then the total resistance will be 300 ohms, a
the drop in them will be 24 volts. Since the voltage across
voltage divider is to be 300 volts, the voltage across the first co
denser must be 324 volts. What should the voltage per plate n
be to give this output voltage? Applying the proportion we fou
previously we have 40:45::X:34. That is, the voltage should
increased above 300 volts by X = 30 volts. Hence the voltage
each plate should be 330 volts.

It may be that voltage regulation curves of the tube alone
available. In that case the drop in the power transformer seco
dary also must be allowed for. This is done in exactly the same w
as making allowance for the drop in the choke coils.

If the voltage regulation of the tube itself is known, it is p
sible to specify the resistances of the secondary of the power tra
former and of the choke coils as well as the effective voltage acr
the secondary to get the desired DC voltage across the voltage
vider for any desired current drain. This raises the question as
where the curves may be obtained.

Taking Voltage Regulation Curves

One way is to get them from the manufacturers of the rectif
tubes. Another way is to take them on the tubes just as the man
facturers do.

In Fig. 2 is shown a circuit suitable for taking curves. Tra
former T1 supplies the filament current for the rectifier tube. T
current is adjusted to normal by means of rheostat Rh1 in t
primary, indicated by voltmeter AC3. This should read 5 vo
throughout the tests. The AC voltage for the plate of the rectifi
tube is supplied by transformer T2. The voltage is adjusted
desired values by means of rheostat Rh2 in the primary, and t
secondary voltage is measured by means of voltmeter AC2. T
rheostat should be adjustable over a wide range so that a conside
able range of AC voltage may be obtained across the seconda
A power clarostat, 25 to 500 ohms, is suitable for Rh2. The se
ondary winding should be accurately center tapped so that ea
plate gets one-half of the voltage indicated by AC2. The D
output voltage is measured by means of voltmeter V1. The curre
drain is varied either by varying the resistance R or a resistan
connected in parallel with it. This variable resistor also can be
power clarostat, 0-30,000 ohms.

SHOULD BE APPLIED

ER PLATES

anges With Current and Secondary ation, Too

V. O'Rourke

Editor

The current drain is measured by means of milliampere A. Voltmeter VI should preferably be one of high resistance. If it is of low resistance and draws considerable current, the negative terminal of the meter should be connected so that the milliampere includes the current taken by the voltmeter, or the milliammeter should be moved to the left of the point where the voltmeter is connected.

In taking a voltage regulation curve the rheostat Rh2 should be adjusted until voltmeter AC2 indicates a suitable value, say 600 volts. Keep the voltage at this value by continued readjustment. Then the output resistance should be varied so as to obtain various current drains. The readings on V1 corresponding to the readings on V1 should be recorded and entered in a regulation curve such as the top one in Fig. 1. The resulting curve gives the regulation of the tube alone at an AC voltage of 300 volts per plate.

When this curve has been obtained, rheostat Rh2 should be readjusted until AC2 reads some other desired value, say 500 volts, and the process repeated. The resulting regulation curve is that for the tube alone at 250 volts AC per plate. Several such curves should be taken on the same tube, varying the current drain from about 10 milliamperes up to 125, or up to the safe limit of the tube in question. The curves should be taken at equal AC voltage differences to make interpolation easy when the curves are to be used. In the curves in Fig. 1 the voltage difference is 40 volts. This is a convenient value because it is easy to divide the difference so as to get 10-volt differences.

The curves should be plotted on cross section paper divided decimally. This makes reading of the curves a simple matter.

It will be found that the reading of voltmeter AC2 will change slightly when the current is changed. This is due to the voltage drop in the transformer secondary. Hence for each current reading it is necessary to readjust Rh2 to bring the voltage on the plates up to the value at which the regulation is taken.

To determine the regulation of the transformer and the tube, open the circuit so that no current flows, and then adjust the secondary voltage to the desired value, say 300 volts per plate. Repeat the entire process without making any adjustment of the voltage as indicated by AC2 for changes caused by changes in the current drain. The resulting regulation curves will be for the transformer and the tube.

In the same manner the regulation of the complete B supply can be taken, provided in this instance the DC voltmeter be placed in the position of V3. If it is desired to get the regulation of the circuit up to the second choke the DC voltmeter can be put in position of V2.

If it be desired to find the voltage drop in one of the chokes when a given current flows the voltmeter may be connected as shown by V4. This meter, of course, can be connected across either or both chokes.

For the purpose of selecting a power transformer and filter chokes the regulation curves of the tube alone are most useful. When that is known the voltage across the secondary can be specified for given values of resistance in the transformer, in the chokes and for a given current drain. The resistances of the transformer and the chokes are constant and their effect on the regulation of the complete device can be predetermined. Not so the resistance of the tube.

The range of the meters needed depends on the tubes on which the regulation curves are taken. The voltmeter AC3 can be one having a range from zero to 10 volts. This can be used either for 280 or 281 type rectifiers, because the voltage of one is 5 volts and that of the other 7.5 volts.

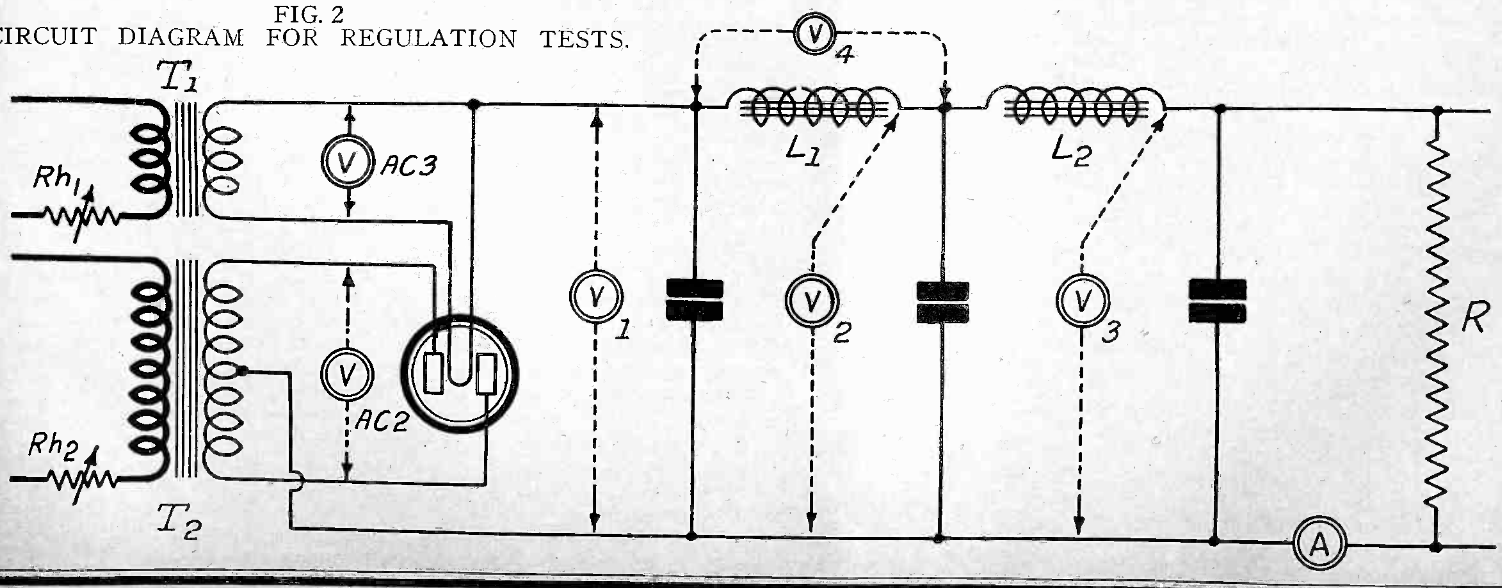
The AC voltmeter AC2 should have a range twice as great as the highest voltage at which regulation curves are to be taken. If a meter of such range is not available it will be necessary to measure the voltage across each half of the secondary separately. In a half wave rectifier this is not possible for there is only one winding, and the voltage may be high. The maximum range of the meter should be about 750 volts.

The DC voltmeter V1 should have a range equal to the peak voltage of the AC wave, that is, 1.41 times the AC voltage applied to each plate, because the DC output voltage will approach this value as the current is reduced to zero. Of course, it is not necessary to approach the zero current reading in all instances, for the regulation near zero is of no interest.

The milliampere A should have a range equal to the maximum current that will be drawn. For 280 tubes this is 125 milliamperes and for two 281 it may go up to 250 milliamperes. A 250 milliamperes meter is suitable for all ordinary B supplies.

The regulation of a complete B battery can be obtained with only a DC voltmeter V3 and a milliammeter A. The AC voltage per plate is fixed by the line voltage and the ratio of the power transformer, as is the voltage across the filament. To take a curve it is only necessary to vary the current drain in definite steps and to note the corresponding readings on the DC voltmeter. However, in taking such a curve it would be desirable to check the primary voltage to make sure that it is of normal value, that is, 110 or 115 as the case may be. Such a curve would be of little aid in designing a B supply, but it would indicate how the voltage in the supply varied with changes in current requirements for the receiver.

FIG. 2
CIRCUIT DIAGRAM FOR REGULATION TESTS.



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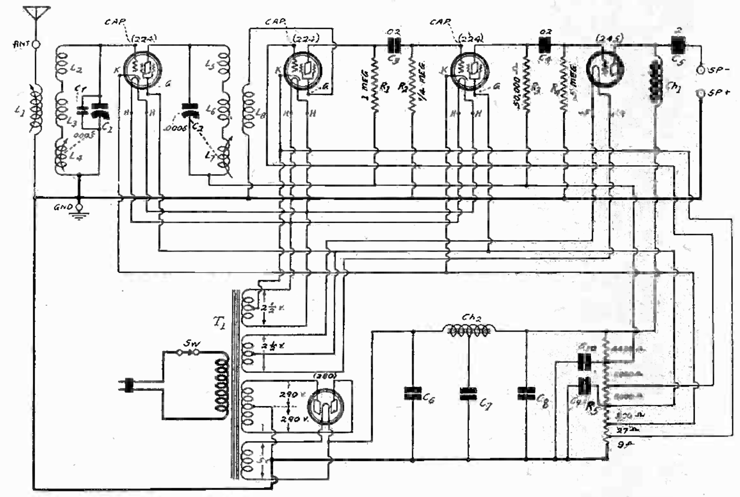


FIG. 774
DIAGRAM OF A FOUR-TUBE AC RECEIVER, WITH 280 RECTIFIER, USING A 224 TUBE AS RADIO AMPLIFIER, A 224 AS A SPACE CHARGE DETECTOR, ANOTHER 224 AS FIRST AUDIO AMPLIFIER, AND A 245 OUTPUT TUBE. THE VOLUME IS LARGE, DUE TO THE HIGH GAIN IN EACH STAGE.

WHAT tube should I use for grid bias detection? Is this form of detection the same as power detection?—J. K. W.

For battery-operated receivers, where the detector plate circuit has a resistor in it, or an impedance coil, the 240 tube is highly suitable. This is a high mu tube, with a working amplification constant of about 31 as an amplifier. For 135 volts applied to the end of the resistor the negative grid bias should be 3 volts, computed from the negative filament of the detector tube. Thus any voltage dropped in a filament resistor in the negative leg of that tube would be deducted from the 3 volts. However, the bias is not critical. For a plate load consisting of the primary of an audio transformer any general purpose tube may be used, but the bias would have to be higher. The 222 may be used with 135 plate volts on a resistor, 6 volts negative bias being supplied. The sensitivity is not so great when general purpose tubes are used as when the 240 or 222 is used with proper load. In AC circuits, the 227 with transformer primary, impedance coil or resistance load may be used as a grid bias detector, and the 224 screen grid tube if the plate load is a resistor or impedance coil. The 227 at 135 volts applied to the plate load would detect well as 10 to 16 volts negative on the grid. The 224 would require a smaller bias under the same plate voltage conditions, with resistive or impedance plate load. Power detection is the name now given to negative grid bias detection, because the detector has a greater undistorted power handling capacity, although not always as sensitive as the leak-condenser method. The 240 and the 224 are excellently sensitive when used this way. The screen grid tubes—222 for battery operation, 224 for AC operation—may be used as a negative grid bias detector in space charge fashion. Instead of connecting the inner grid as the control grid, this being the cap on the tube, to the input coil, the inner grid connects to a positive voltage, about 22 volts, while the outer or screen grid, this being the G post of socket, is connected to the tuning coil. The space charge method requires a lower order of bias, about .5 volt, where the plate resistor is .5 meg., while the plate voltage is 135 to 150 volts. The plate load should be a resistor rather than an impedance coil.

* * *

IN my B supply I have by-pass condensers, some of them quite large; for instance, those connecting from the intermediate B plus taps to ground, and from C plus to ground across the biasing section of the voltage divider. When I put in these large capacities the hum is rather obvious, but when I omit them the hum is negligible. I thought that these condensers served purposes of filtration and that the hum should be less. What do you suggest I do?—D. O. R.

The hum naturally will be greater, because the bypass condensers reduce the effective impedance of the sections across which they are connected, and rid the voltage divider of its natural discrimination against the lower audio frequencies. As the condensers improve the low-note response, they increase the relative audibility of the hum, because the two main hum frequencies for a 60-cycle line are first, 120 cycles, which is the second harmonic, and secondly, the fundamental of 60 cycles, both low frequencies. It is better to support the low note response and tolerate a little more hum, since when a program is being heard the hum is not heard. If you use separate condensers, that is, capacities that haven't a common terminal, then connect the capacities that bypass intermediate B plus voltages, so that one side goes to B plus, the other to C plus. Now you probably have all connected from B plus to B minus. Across the biasing section do not use less than 4 mfd. Also, to prove the practicability of this advice, leave whatever condenser you have, if less than 4 mfd., across the biasing section, and connect one side of a 4 mfd. condensers to ground. Tune in an orchestra. By connecting the other condenser lead to the C plus post for a few seconds, then, removing it, you can compare results. The low notes will be almost absent with the extra capacity omitted, but delightfully present when the extra capacity is included. If a separate resistor is used for biasing the power tube or tubes this advice also holds.

* * *

CAN I use my 0-100 milliammeter as an ohmmeter? I have come to that point in set-building where I desire to measure accurately the resistance of the resistors used.—T. G. C.

Yes, you can use the meter over a large range of resistance values by selection of the proper applied voltages. It is advisable to use a voltmeter to be sure you know the voltage source accurately. Starting with a 1.5-volt dry cell, put a resistor in series with the meter that will provide full-scale deflection. This will be 15 ohms. A 20-ohm or other similar rheostat could be turned until the reading is 100. Easy legibility of readings is easily obtained up to 500 ohms, assuming that the meter reads in steps of 5 milliamperes, while higher resistance can be measured, depending on the accuracy with which you can take readings of less than 5 milliamperes. The 15 ohms may be retained permanently in the circuit for readings from a 1.5-volt source within the approximate range of 0 to 485 ohms, as a protection to the meter. The resistance is the voltage (1.5) divided by the current (reading on the milliammeter). Subtract the 15 ohms from the result to determine the resistance of the measured unit. When higher resistance values are to be measured they should be tested experimentally in the circuit already described, and likely will give no reading. Increase the voltage at the source until a reading is obtained. This method safeguards the meter in the event an estimated high resistance is much less than expected or is shorted. A 100-volt source will give a reading of 100 milliamperes for a resistance of 100,000 ohms, hence affords an easily readable range of from 5,000 ohms to 100,000 ohms. Other ranges can be established in the same way. Be sure to connect the meter with polarity correct.

* * *

CAN good results be obtained from a four-tube AC receiver, plus rectifier tube? I am interested in space charge detection, as I am told it is very voluminous, i.e., sensitive. I would like to use resistance coupling, but am afraid two stages of resistance audio will not provide sufficient volume. If the wavelength range can be extended down to 150 meters or so by using the Bernard tuner method, please give details.—A. J. K.

Excellent results can be obtained from such a circuit, with abundant volume. See Fig. 774. A variable antenna coupling coil is used as volume control, but you may use some other method, if you desire. The values of the resistors in the audio stage are suggestive only. If stability can be retained with a lower detector plate resistor, say .5 meg., and much higher grid leak for R2, say 2 meg. or more, make the substitution. The grid circuit and the plate curcuit of the first tube are separately tuned, and for greater sensitivity separate condensers are shown. L1 has 20 turns on 1¾", L2 and L3 are a total of 40 turns on 2", while L4 is a tickler coil, 20 turns on 1¾", or any existing tickler, in series with the stator winding, the tuning condenser being connected across the total. The coils are panel mounted and the tuning condensers' shafts are joined to the shafts of the moving coils that are in the tuned circuit. L5L6L7 duplicate this arrangement, the pickup coil L8 consisting of 30 turns on 2", adjoining the tuned circuit. No. 24 wire is suitable. C6 and C7 are 2 mfd., 400 volts AC rating, C8 is 4 mfd., same rating, while C9 is 4 mfd. or higher, 200 volt DC rating, and C10 is 2 mfd., same rating. An AC switch, preferably of the snap type, should be used for SW. The power transformer voltages are marked. The high voltage winding need not be 580 total, as shown, as higher AC voltage is permissible.

* * *

MICROPHONIC effects in tubes in my receiver often spoil reception for half a minute at a time, especially if there is any jarring, as when somebody walks across the room. What shall I do?—R. D. W.

Put some sort of physical damper on the tubes, particularly on the detector, as that is the most common offender where microphon-

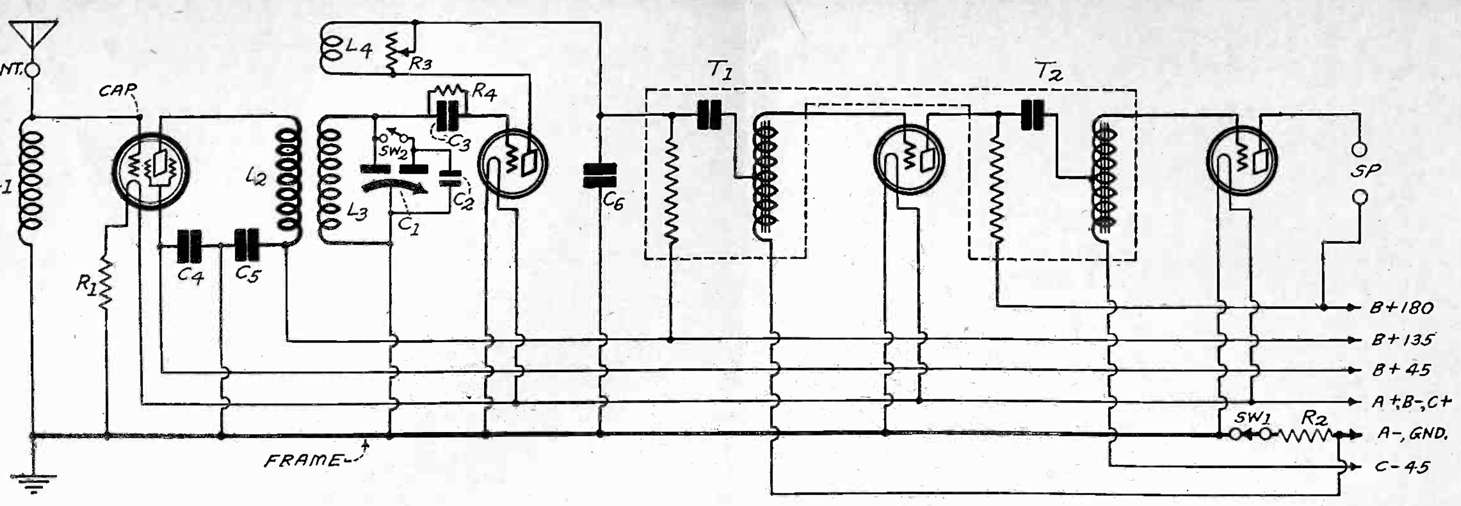


FIG. 775.

THE THRILL BOX, AN OUTSTANDING SHORTWAVE CIRCUIT, USES FOUR TUBES. REGENERATION IS CONTROLLED BY A 3,000-OHM ADJUSTABLE RESISTOR, R6. THE LAST TUBE IN THIS DIAGRAM IS A 171A. SIX PLUG-IN COILS, WITH A CONDENSER SWITCH, SW2, WILL ENABLE TUNING IN FROM 15 TO 530 METERS AT LEAST.

ism is present. Howl arrestors are commercially available. These are heavy caps that, when placed over the tube, greatly reduce the frequency of the tube's natural period of vibration. See that the subpanel, front panel and all parts are tightly secured in your set.

* * *

IT IS a great convenience to dispense with an outdoor aerial, in fact, with any type of aerial, and I am thinking of doing that. I tried various makeshifts, but without result. I got signals, but they were too weak. I did not try a loop as I don't care for loops. They all look unsightly to me. Isn't there some way of dispensing with aerial and ground?—P. J. O'R.

It is always well to use a good outdoor aerial, strung on good insulators to strong posts or masts, the leadin being a continuation of the aerial wire itself, and being brought past the roof coping and into the house from stand-off insulators, so that the leadin will not swing in against the wall. It is feasible to dispense with such an aerial, but some type of aerial has to be used, or you'll hear no signals. One type may be simply a fixed mica condenser connected to the one side of the AC line, external ground connection being omitted (if you have an AC set). Or a mesh wire in a console will provide pickup for any very sensitive set. But it must be remembered that a greatly increased sensitivity in a receiver, over what you have been used to, will be necessary, otherwise the loops, socket antennas, indoor aerials and the like will disappoint you with their very low resultant volume. It is far better to maintain an outdoor aerial, as described, even with a highly sensitive receiver, than to use a meager pickup, as a few feet of wire, or a mesh screen, because persons with very sensitive receivers like to be able to capitalize on that sensitivity in the form of loud, clear reception of far-distant stations. The outdoor antenna helps that result, the makeshift antenna does not. For reception of local stations, with more than enough volume readily obtainable, the lesser types of pickup are adequate with sensitive receivers. A smaller pickup increases the apparent selectivity, but aerial reduction or substitution to improve selectivity is always at the expense of volume and apparent sensitivity. A circuit that is not selective enough can not be remedied by providing less antenna input, except at the expense of volume. Correction of faulty receiver design, in other words, can not be made at the aerial.

* * *

ON short waves is the volume usually good? I am interested in receiving entertainment programs. Many of these are broadcast, I understand. Will I have a good chance of getting them on the National Thrill Box? Can this short wave receiver be used on a B eliminator? How many tubes has it? Can an AC filament Thrill Box be built?—I. S.

Volume is good, but not as great as on broadcast wavelengths, due largely to the lower power used on short waves, the greater distance the signal travels before reaching your aerial, and the special discounting effect of modulation at the high frequencies. Enough programs are broadcast to provide you with entertainment any night. Foreign reception may be expected, also. The Thrill Box is one of the best short-wave circuits so far offered to the public. A B eliminator can be used, but it should be one that has large filter capacity in the filter choke system, otherwise motorboating may result. The Thrill Box has four tubes. They are 222, 200A, 240 and 112A or 171A. The filaments should be battery-heated. The circuit has been tried out with AC tubes, but proved too noisy. This so far has been the general result on AC short wave circuits of all kinds. See Fig. 755.

* * *

USING a coil that has a large primary, 24 turns on 2½" diameter, and the usual secondary, 50 turns on the same diameter, can I have the erstwhile tuned secondary in the plate circuit of a screen grid tube, and use the former primary as the secondary, to couple to the grid of the next tube, which happens to be the detector? The reason I ask is that the ratio is about 2-to-1, primary to secondary, when the coupling is turned about, that is, a step-down ratio, and I was afraid the volume might be altogether too low.—M. D.

That is an entirely practical method. Any radio frequency transformer, with high impedance primary, say 24 turns or more on 2½" diameter, may be turned about as you say, the tuned circuit being in the plate lead of a screen grid tube, and the half-as-large coil in the grid circuit of the next tube. There is indeed a stepdown ratio, but 2-to-1 is not at all serious under the circumstances, because tuning the primary gives about four times as great sensitivity. The smaller pickup coil should be tightly coupled to the tuned winding, however. It is advisable to have the pickup small as described where selectivity is needed. Otherwise you might increase the 24 turns, but you would run into the danger of not covering the whole broadcast tuning range, due to high distributed capacity and other effects.

* * *

IS IT requisite to use the rated screen grid voltages, or may higher or lower voltages be used?—R. E. A.

The rated voltages should not be exceeded. For 135 plate volts on the 222 the screen grid voltage is 45 volts. For 180 volts on the 224 the screen grid voltage is 75 volts. Circuit conditions sometimes favor lower screen grid voltages, in fact, often the volume control is a means of reducing the screen grid voltages from the front panel. In some special instances of squealing sets the rated screen grid voltages may be permanently low, sometimes as low as 10 volts, but this is a concession to poor circuit design.

SCHICKERLING STOCK CORNER CALLED PLOT

Operators in stock of the Schickerling Radio Tube Corporation have been under investigation by the New York State Attorney General's office. An illegal corner in this stock was alleged, and the Attorney General obtained an order from the State Supreme Court, in Brooklyn, N. Y., citing several brokers to give reasons why an injunction should not be issued against them, prohibiting their further operations in this stock.

The corner was alleged to have been developed by the defendants. The stock was listed on the New York Produce Exchange.

The defendants are alleged to have entered into a conspiracy, by representing that the stock issue was 100,000 shares, at the same time arranging to confine the actual issue to 10,000 shares. Thereupon when brokers who relied on the statement that 100,000 shares were available tried to obtain stock they had committed themselves to deliver, there was none to be had.

It is alleged two of the defendants received orders for 50,000 shares at $11 a share and that the tube corporation got only $5 a share. These defendants are said to have issued orders to Stock Exchange and Curb Market brokers to buy more than 13,000 shares, but made delivery impossible even before the buying orders were placed.

* * *

[Readers desiring information regarding the integrity of radio stocks should address Financial Editor, Radio World, *145 West 45th Street, New York City, before they buy. —Editor.]*

Amperite Announces Voltage Regulator

The Radiall Company announces a self-adjusting line voltage control for A. C. receivers. It is constructed in glass bulb form, similar in appearance to the standard radio tube. The resistance unit is enclosed in a bulb filled with an inert gas. The regulating properties of the line Amperite are obtained through the specially developed resistance element. This unit will handle a wide range of current fluctuation, approximately 30 volts, from 95-125 volts, and the resultant voltage remains at a predetermined quantity. Continuous life tests in the Radiall laboratories show a life of 3,000 hours and over, and for practical uses, a liberal life of 2,000 hours at maximum voltage is guaranteed, says the manufacturer. Full data may be had from the Radiall Company, 561 Broadway, New York City. Mention Radio World.

J. H. C.

COGGESHALL APPOINTED

Aso O. Coggeshall, announcer at WGY, Schenectady, N. Y., has been appointed acting studio manager of the station to succeed Kolin D. Hager, who went to a station group.

NEW CORPORATIONS

Radiocoin Corp., Wilmington, Del., Radios—Corporation Trust Co. of America.

Selectric Phonograph and Radio Corp., Wilmington, Del.—Corporation Trust Co. of America.

Rosasco Mfg. Co., Radios—Atty. V. Marrino, 26 Court St., Brooklyn, N. Y.

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 ....

John T. King, 24 Henry Ave., Melrose, Mass.
Guy E. Bonawitz, N. High St., Selinsgrove, Pa.
J. E. Walker, 212 Eugene St., Norwood, Man., Can.
Joseph Holub, 187 Warwick St., Brooklyn, N. Y.
Dr. Arthur Senior, 120 High St., San Fernando, Trinidad, B. W. I.
Oscar Grepke, 2157 Cuyler Ave., Chicago, Ill.
D. W. Neave, 840—14th St., Detroit, Mich.
Gustav Hoffman, 1814 Howe St., Chicago, Ill.
Geo. Toomey, Speers, Sask., Can.
J. F. Sickles, 155 Summer Ave., Newark, N. J.
George Ustimovich, 303 West 120th St., N. Y. City.
Edgar S. Rasmusson, No. Westport Radio Shop, Sanford Road, No. Westport, Mass.
L. R. Hubbard, Prop., 2040 West 70th St., Chicago, Ill.
R. H. Schleiter, Mgr., Freedom Radio Co., 1098 Fourth Ave., Freedom, Pa.
Robert Foote, Heflin, Ala.
Philip Cohen, 104 Jay St., Schenectady, N. Y.
Melvin Derr, 2734 Burlington, Dallas, Tex.
O. J. Hurley, 710 No. 2nd St., Montrose, Colo.
E. B. Carpenter, 106 Poultney Ave., Buffalo, N. Y.
M. E. Zuccarello, 15 Berrien St., Nashville, Tenn.
Jack E. Allen, 410 East Pico St., Los Angeles, Calif.
R. J. Hansel, 2947 W. Cortland St., Chicago, Ill.
E. L. Black, 358 Shepperd Place, Atlanta, Ga.
C. L. Nelson, 1001 Staples St., Corpus Christi, Texas.
A. F. Manuel, 838 West End Ave., New York City.
Jos. J. Heintz, Jr., 1802 West St., Wilmington, Del.
W. J. Wilkie, Box 279, Summerton, S. C.
B. P. Theobald, 7214 Highland Ave., Bywood, Upper Darby, Pa.
C. P. Christon, 1526 N. Felton St., Philadelphia, Pa.
Peter Warholic, 222 Stoddard St., Oneida, N. Y.
H. Ackerman, 1841 65th St., Brooklyn, N. Y.
Leo Freni, 1241 Wolf St., Philadelphia, Pa.
H. N. Morgan, 919 Cherokee Rd., Louisville, Ky.
Edward Marsh, 462 E. Mound St., Columbus, Ohio.
Chas. E. McGrew, 416 N. Maple, Newkirk, Okla.
Frank G. Schafer, R. R. No. 1, Trotwood, Ohio.
Nick Tombers, 3723 Morgan Ave., N., Minneapolis, Minn.
W. W. Kreiner, 117 Riverside Dr., Northampton, Mass.
James Benzie, 304 S. Jefferson Davis Park, New Orleans, La.
H. A. Custer and Sons, Box 503, Texon, Texas
Wm. B. Tournere, 1458 Ridge Way, Los Angeles, Calif.
G. W. Sterkey, 703 Henry Clay Ave., New Orleans, La.
Robert B. Davis, 8 Howard St., Haverhill, Mass.
Joseph Casey, Box 1 Melrose, Mass.
Ted B. Fowler, No. 50, N. Pennsy Ave., Morrisville, Pa.
G. F. Walton, 2808 Church St., Norfolk, Va.
H. A. Beck, 130 N. 2nd St., Allentown, Pa.
J. Wm. Lanckton, 3148 Park Ave., Detroit, Mich.
Edgar Jackson, 26 Park-Vale Ave., Allston, Mass.
Karl L. Hans, Box 1876, Luke Field, Honolulu, T. H.
W. Heaps, Eudowood, Towson, Md.
R. M. Graves, 26 River St., Wakefield, R. I.
L. A. Adair, 3711 Normandy, Dallas, Tex.
John Zenaz, 5746 W. 22 Pl., Apt. 101, Cicero, Ill.
E. A. Fitzgibbons, 230 No. Meadow St., Watertown, N. Y.
Milton Strong, Jr., East Hampton, Conn.
I. A. Hanover, Apt. 24, 3001 W. 29th St., Coney Island, N. Y.
R. C. Betteridge, 29 Richmond Place, Akron, Ohio
Louis Puzio, 100 Wood St., Garfield, N. J.
L. David Hanna, 196 Fulton Ave., Toronto, Ont., Can.
Frank Capaccio, 113 Stockton Ave., Walton, N. Y.
Paul Sokol, 367 Homestead St., Akron, Ohio.
Raymond Van Becelaere, 4480 Radnor, Detroit, Mich.
Harry E. Hall, 1050 Westmont St., Darby, Pa.

LICENSE SALES IN LAW TANGLE, RULING ASKED

WASHINGTON.

The Federal Radio Commission received a communication from its general counsel, B. M. Webster, suggesting that a general order be formulated, defining the policy of the Commission in regard to the sale of station licenses, due to absence of definitive regulations in the Radio Law itself.

A part of section 12 of this law deals with sales. In the opinion submitted to the Commission Mr. Webster said:

"A study of the debates and committee reports leading up to the present Radio Act discloses that Congress disapproved the practice of selling licenses and frequencies because it might lead to the creation of vested rights in a particular channel. However, this disapproval did not extend to the sale of the station itself.

"The assignment provision of section 12 is an express consent to such action.

Difference Explained

"There is thus indicated a clear line of differentiation between the sale of a license and the sale of a station. It is one thing to sell an existing station operating under a license, in which case the owner of control changes, but the operation of the same station goes on. It is quite another thing to talk of assigning a license and at the same time propose the establishment of an entirely new station under new ownership. Practically nothing exists which is subject to assignment in such a case except some indefinite and intangible right to broadcast, unrecognized by the law.

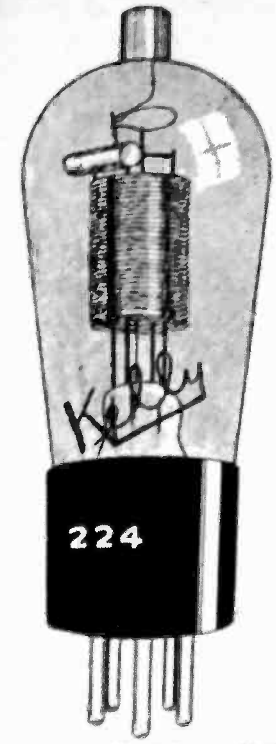
"Considering the statute as a whole and bearing in mind the evils which it seeks to correct, it seems that the purposes to be served by this portion of Section 12 are as follows: (1) to prevent development of the theory of property rights in the use of a frequency or in the right to communicate by radio. (2) To prevent the making of any profit based upon the sale of a license. (3) To prevent the acquisition of a station by ineligible applicants through purchase rather than by license application. (4) to prevent the operation of stations by persons not qualified to operate them under the standard prescribed by Congress.

Licensee Must Be In Control

The Radio Act does not require that a licensee hold legal title to the radio apparatus. Clearly, however, he must be the one in possession in order to control completely both the apparatus and its use. By this is meant, that he must have such control over the station apparatus and facilities as will render him amenable to civil and criminal responsibility in the operation of the station. A person may thus be a proper licensee if he is operating apparatus borrowed, rented or otherwise possessed by him."

Concerning a lease Mr. Webster said:

"A lease which is so drawn as to constitute a mere sale of time, which allows the lessor to retain control of the use or operation of the station, to continue financially responsible for the debts of the station, and to continue its management is not objectionable. On the other hand, a lease which puts into the hands of a lessee the station management, which the Commission in issuing a license has placed in the hands of the lessor licensee in accordance with the standard of public interest, would, in effect, be an assignment of license and therefore void."



224 *AC-SG Tube*, $3.00

Leaders—224 and 245!

What These Marvelous Tubes Do

The Radio Trade Show in Chicago established the 224 AC Screen Grid Tube and the 245 AC Power Tube, both new, as by far the leading tubes for 1930. The master designers of circuits have chosen these tubes, the 224 for radio frequency amplification, the 245 for output tube. They merely confirmed what experimenters already had established—extreme sensitivity, great distance and fine stability are possible with the 224, while maintaining needle-point selectivity.

The 224 is capable of RF amplification of a higher order than engineers are able to capitalize in full. The tube can easily be worked at a gain of 60, as compared with 8 for the 201A.

Indirect heating is used. The filament, called heater, requires 2.5 volts and draws 1.75 ampere. The plate voltage should be 180, the screen grid voltage (G post of socket) 75 volts. The control grid connection is made to the cap at top of tube. The cathode is the electron emitter. Negative bias, 1.5 volts. Type of socket required: UY (five-prong).

Ordinary coils may be used with this tube by doubling the number of turns on the primary.

If still greater amplification is desired a larger primary may be used, and if still greater selectivity is desired, the primary may be reduced, but should have at least one-third more turns than for ordinary tubes.

"Look for the Green Box"

The 245 has a low filament voltage, 2.5 volts, at a relatively high current, 1.25 ampere. This eliminates the objectionable hum. The tube requires only 250 volts on the plate to be able to handle about as great undistorted power as the 210 does at 350 volts. A single 245 output tube will handle, without overload, the largest input to a last stage as would be required in any home. It works well into a dynamic speaker, or, by filtering the output, into a magnetic speaker. In push-pull two 245s give superb tone at doubled power handling capacity. The 250 requires 50 volts negative bias at 250 volts on the plate and draws 32 milliamperes under those conditions. The direct filament heating method is used. Type of socket, UX (*four*-prong).

There never was a power tube so excellently suited to home use—one **that handles such large** input without strain, yet which operates on a plate voltage now regarded as in the "medium" class. Use this power tube and know supreme performance. *245 Tube, Price* $2.25

OTHER SPECIAL PURPOSE TUBES

222 Screen Grid, for battery or AC eliminator operation; 3.3 volt filament, @ .132 ampere; 135 volts plate 22 to 45 volts screen grid; negative bias 1.5 volts..$3.50

240 high mu tube, for detector or audio circuits, where a resistor or impedance coil is in the plate circuit; amplification factor, 31. Filament 5 volts, @ .25 ampere; plate 135 to 180 volts, negative bias 1.3 to 3 volts..$1.25

280 full-wave rectifier, 125 mils at 300 volts or less; 5-volt filament @ 1.25 amperes $1.75

281 half-way rectifier, 7.5-volt filament............$3.50

227 detector and amplifier for AC circuits, indirect heating type; 2.5 volts filament @ 1.75 amperes; 90 to 180 volts plate, negative bias 1.5 to 6 volts; excellent for power detection $1.50

226 AC amplifier; 1.5 volts filament @ 1.05 amperes; 90 to 150 plate volts; negative bias 2.5 to 4.5 volts..$0.95

112A output tube for battery or AC operation; filament 5 volts @ .25 ampere; 135 plate volts; 9 volts negative bias $0.95

171A power tube for battery or AC operation; 5 volts filament @ .25 ampere; 180 plate volts @ 40 volts negative bias $0.95

250 power tube, 7.5-volt filament @ 1.25 amperes; 450 plate volts; 80 volts negative bias $6.00

210 power tube $4.50

GENERAL PURPOSE TUBES

201A, 5-volt filament @ .25 ampere; 45 to 135 volts on plate, 5-volt positive for detector to 4.5 negative bias, for amplifier $0.65

199, 3.3-volt filament @ .06 ampere; 45 to 90 volts on plate; 3.3-volt positive bias for detector, to 4.5 negative for amplifier..$1.25

PUSH-PULL PAIRS

The 250, 245, 171A and 112A are sold in matched pairs for push-pull, insuring balanced, symmetrical circuits. Order MP 250, MP 245, MP 171A or MP 112A. The matched tubes are of equal mutual conductance. They are boxed together and bear "Matched Pair" identification stickers. No extra charge for matching.

Kelly Tube Co., 8718 Ridge Boulevard, Brooklyn, N. Y.

Gentlemen: Please send me the following tubes:

Quantity	Type	Quantity	Type	Quantity	Type
☐	224	☐	222	☐	280
☐	245	☐	201A	☐	281
☐	226	☐	240	☐	250
☐	227	☐	199	☐	210
☐	112A	☐	171A	☐	MP.

If ordering C.O.D. put a cross here ☐

If enclosing remittance with order put a cross here ☐

On prepaid orders we pay cartage. On C.O.D. orders you pay cartage plus post office money-order fee.

Name ....

Address ....

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

Kelly

RADIO TUBES

The New

THORDARSON

R-245 POWER COMPACT

was selected for the Push-Pull B, described by Harvey Sampson in RADIO WORLD, July 27th.

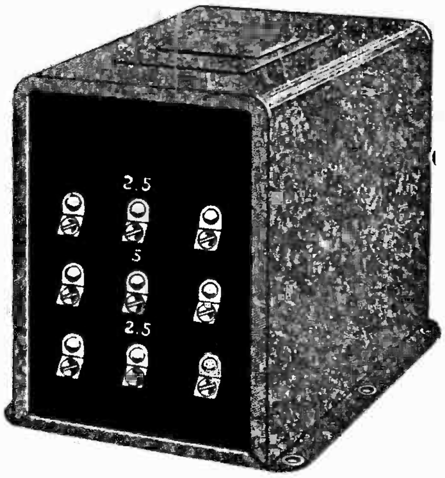
Now Available at All Good Dealers

FREE—Send for SD115, Complete Data on Push-Pull Power Amplifier and Plate Supply.

THORDARSON
ELECTRIC MFG. CO.
500 W. Huron St., Chicago, Ill., or

Ben J. Aplin
Sales Representative
30 Church Street, New York City

Filament Transformer



The heater type tube draws 1.75 ampere at 2.5 volts. If several such tubes are used a heavy-duty filament transformer is necessary. The top 2.5-volt winding of this filament transformer easily carries **NINE AMPERES**, or enough current for five heater type tubes. The bottom 2.5-volt winding stands four amperes, or enough current to heat **TWO MORE** such tubes, a total of **SEVEN TUBES!** The power tube, if of the 5-volt type, may be heated from the 5-volt central winding. 5-volt power tubes in push-pull may be heated from this winding.

All three windings are tapped at the exact electrical center. This precision location, made with the aid of an impedance bridge, accounts for absence of hum otherwise caused by the last tube when heated directly with AC. The heater type tubes are *indirectly* heated by AC, since the filament that glows is fed by AC but communicates heat to the cathode or electron emitter.

The heater type tube is represented by the *227*, excellent as radio amplifier and audio amplifier, and the exclusive type of AC detector tube. Also the new AC screen grid tubes, with the same filament voltage and current, are of the heater type.

The transformer is beautifully finished in crackled glossy black, with bakelite front, and comes equipped with 52-inch AC cable with plug. Six riveted mounting holes for baseboard or subpanel. Size, 3¾ in. high, 2⅝ in. wide, 3 in. deep. Shipping weight, 6 lbs.

Cat. F226A, for 50-to-60 cycles, 105-to-120 volts AC, Net Price $6.00

Guaranty Radio Goods Co.

145 West 45th St.

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
No. 339—For reading DC voltages, 0-100 volts, 2.25
No. 342—For reading DC voltages, 0-150 volts, 2.25
No. 340—For reading DC voltages, double reading, 0-8 volts, 0-100 volts.......................... 1.50

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Just East of Broadway

All Parts

for

MB-29

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

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

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HAVE AN EXPERT PUT YOUR SPEAKER IN SHAPE!

If your present speaker, 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.

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.

RADIO WORLD, 145 W. 45th St., N. Y. City.
(Just East of Broadway)

☐ 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.

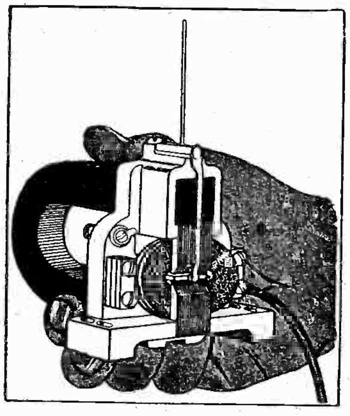
☐ Enclosed please find $5.25 for both the aluminum subpanel, etc., and the drilled Bakelite front panel of the AC model.

Name ....

Address ....

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

FREE!



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Radio World for one year (52 numbers, one each week) will keep you abreast of latest circuits and news. Act now. Offer revocable without notice.

☐ If renewal put cross here.

Radio World, 145 West 45th St., N. Y. City.
Enclosed please find $6 for one year's subscription for Radio World (52 numbers). Send your "superb unit" free.

Name ....

Address ....

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

New Diamond

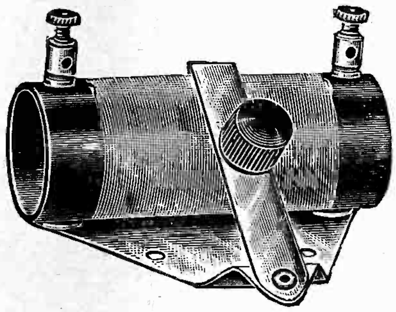
PARTS FOR BATTERY MODEL DIAMOND

C1—Aerovox .0005 moulded fixed	.25
C2—Hammarlund .0005 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

GUARANTY RADIO GOODS CO.
145 WEST 45th STREET
(Just East of Broadway)
NEW YORK CITY

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.

GUARANTY RADIO GOODS CO.
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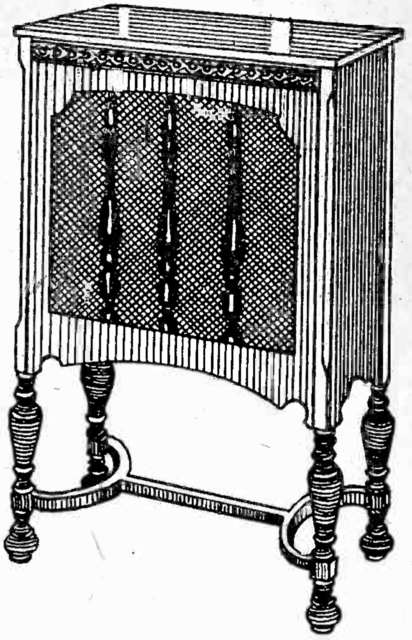
ARISTOCRAT FLOOR SPEAKER

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.

Acoustical Engineering Associates
143 WEST 45th STREET
NEW YORK CITY
(Just East of Broadway)

All Parts for

PUSH-PULL DIAMOND

Mershon Electrolytic Condensers, four in one Copper Container

8-8-18-18 mfd. List price, $9.60 — **$5.76** Net

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

Filament Transformer, 2½, 5, 2½ v., net	$6.00
Power Transformer, 2½, 5, 2½, 300, 300 v., net	10.00
S M Unichoke 331, net	4.80

Guaranty Radio Goods Co.
145 West 45th Street
New York City
(Just East of Broadway)

FILL OUT AND MAIL NOW

SUBSCRIPTION BLANK

RADIO WORLD

RADIO WORLD

145 West 45th Street, New York City
(Just East of Broadway)

Please send me RADIO WORLD for .... months, for which please find enclosed

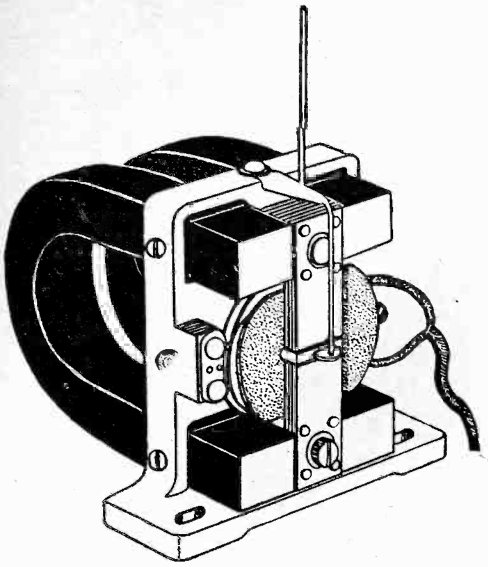
SUBSCRIPTION RATES:

Single Copy	$ .15
Three Months	1.50
Six Months	3.00
One Year, 52 Issues	6.00

Add $1.00 a Year for Foreign Postage; 50c for Canadian Postage.

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.

Acoustical Engineering Associates
143 West 45th Street
New York City
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NATIONAL

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

Latest Model National Velvet-B, Type 3580, in handsome crackle finish black metal casing, for use with sets up to and including six tubes. Input 105-120 volts AC, 50 to 60 cycles. Output, 180 volts maximum at 35 milliamperes. Three variable output intermediate voltages. (Det., RF, AF). Eliminator has excellent filter system to eliminate hum, including 30 henry choke and 18 mfd. Mershon condenser. No motorboating!
(Eliminator Licensed under patents of the Radio Corporation of America and associated companies.)

Guaranty Radio Goods Co.
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NEW Morecroft

"Elements of Radio Communication," by Prof. John H. Morecroft, of the Engineering Department of Columbia University, is the latest book on radio by this outstanding authority.

This book is entirely new and contains matter which never before has been published. It is written in plain language so that every radio novice can understand it, yet it is a complete course in the elements of radio.

It contains 266 pages, 170 illustrations and a complete index. Price $3.00.

RADIO WORLD
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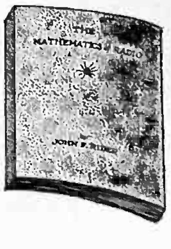
By JOHN F. RIDER

"The Mathematics of Radio"

The Latest Book on This Important Subject

Price $2.00



Here is the first radio book that covers the field between the beginner and the college professor.

It is the first practical interpretation of radio technique and is written in a practical manner for the practical man. It is non-technical, yet it is not written for the veriest beginner although he, too, may obtain much valuable assistance and information.

It is the first book in which the latest data are converted into actual practical examples, examples which apply to your tubes, receiver, amplifier, eliminator.

128 pages. 8½x11". 119 illustrations. Printed and bound in a flexible cover.

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OHM'S LAW: IR drop, DC and AC circuits, peak and effective AC voltages.

RESISTANCES: Basis for resistance variation, atomic structure, temperature coefficient, calculation of resistance variation, expression of ampere, volt and Ohm fractions, application of voltage drop, plate circuits, filament circuits, filament resistances, grid bias resistances. Parallel, series, wattage rating, maximum permissible current flow, distribution of current, calculations of resistance in parallel, in series, C bias resistances in filament circuits, in B eliminators.

DC FILAMENT CIRCUITS: Calculation of resistances.

AC FILAMENT CIRCUITS: Transformers, wattage rating, distribution of output voltages, voltage reducing resistances, line voltage reduction.

CAPACITIES: Calculation of capacity, dielectric constant, condensers in parallel, condensers in series, voltage of condensers in parallel, in series, utility of parallel condensers, series condensers.

VOLTAGE DIVIDER SYSTEMS FOR B ELIMINATORS: Calculation of voltage divider resistances, types of voltage dividers, selection of resistances, wattage rating of resistances.

INDUCTANCES: Air core and iron core, types of air core inductances, unit of inductance, calculation of inductance.

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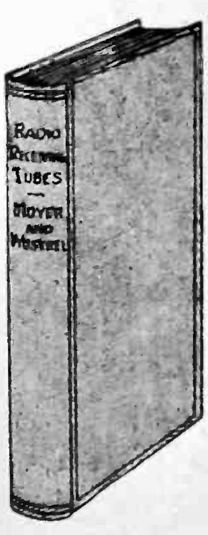

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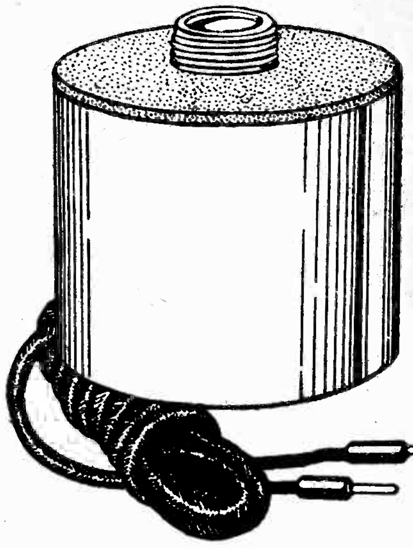

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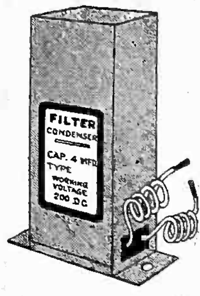
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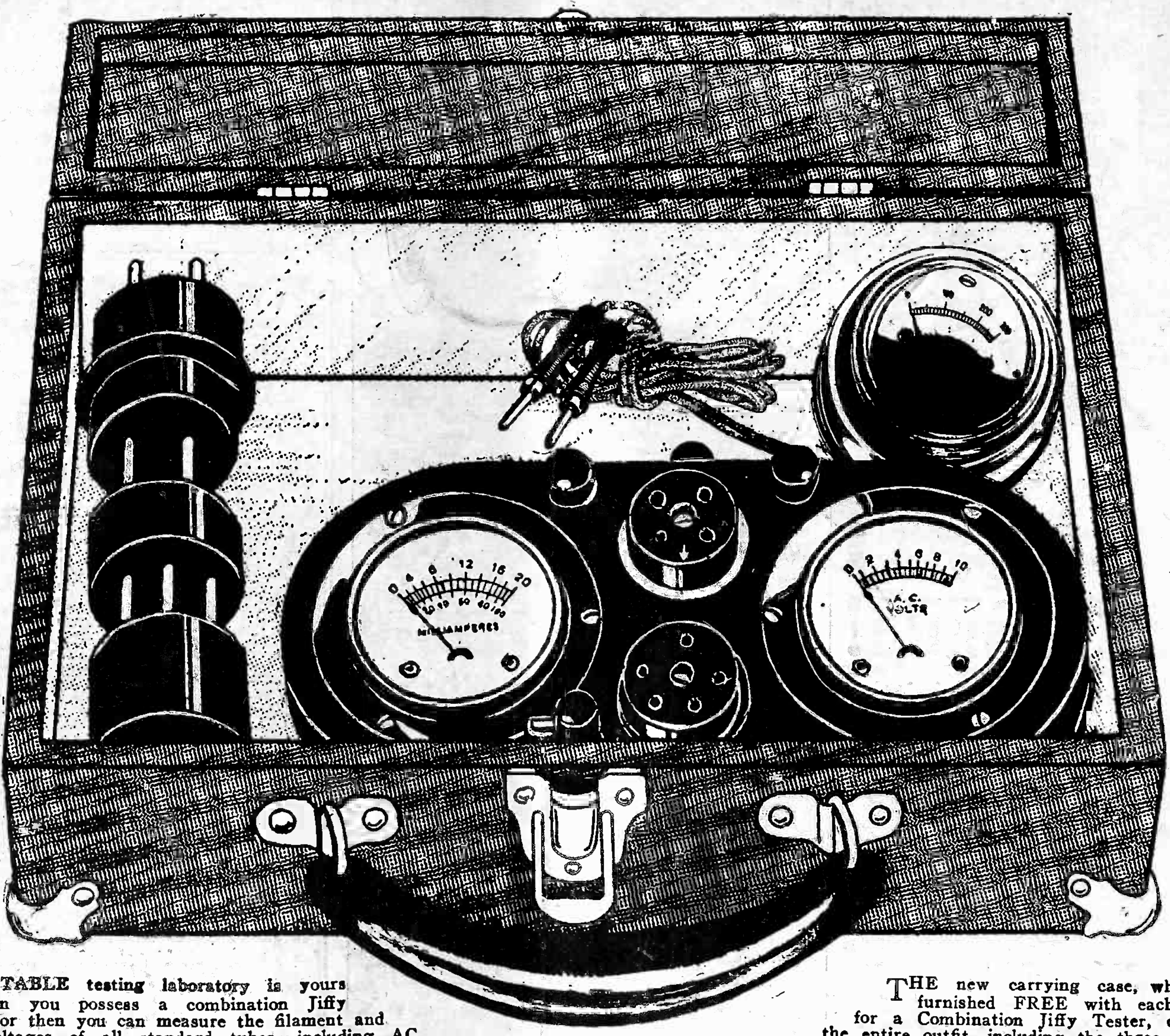
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