STATIONS BY FREQUENCY AND WAVE

24

AUGUST 17th, 1929 **15 CENTS**

RADIO WORLD

REG. U.S. PAT. OFF.

The First and Only National Radio Weekly

387th Consecutive Issue—EIGHTH YEAR

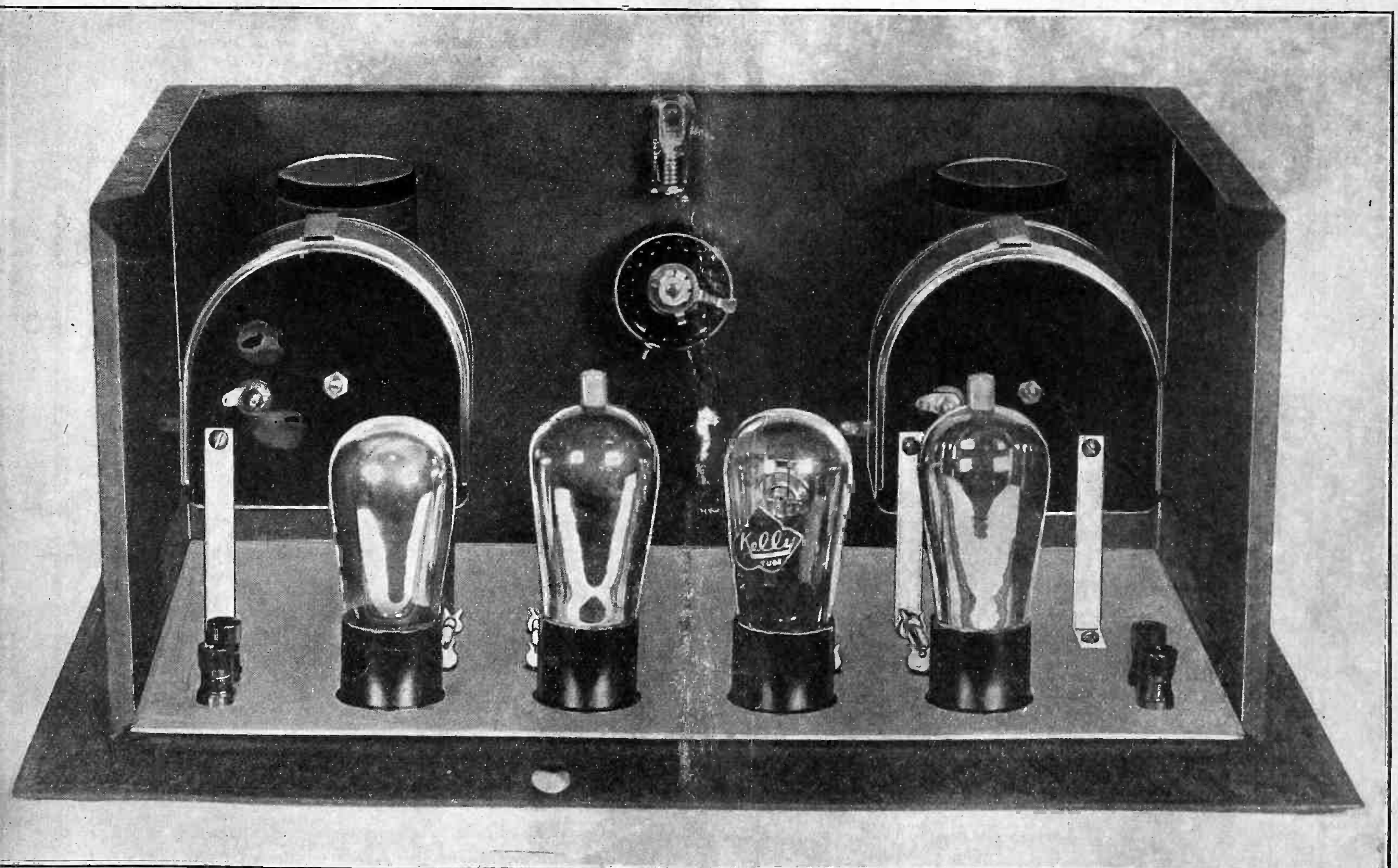
How to Compute Voltage Divider Resistance

An Audio Meter

Your Ingenuity Tested in Volume Control Poser

Tables of Tube Characteristics

HB COMPACT, *Battery Model*

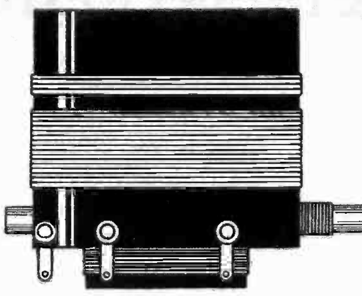


Rear View of Exceptional 4-Tube Set Using Two 222 Tubes, One 240 and One 112A. **See pages 3, 4 and 5.**

RADIO WORLD, owned and published by Hennessy Radio Publications Corporation, 145 West 45th Street, New York, N. Y. Roland Burke Hennessy, President and Treasurer, 145 West 45th Street, N. Y.; Herman Bernard, Secretary, 145 West 45th Street, New York, N. Y.

A NEW IDEA IN COILS!

The Bernard Tuner Works Screen Grid Tubes Up to the Hilt!

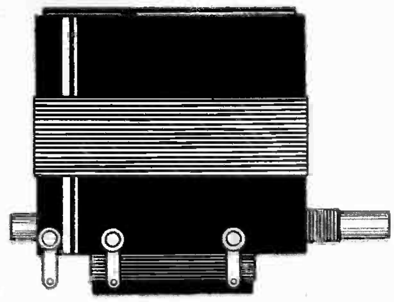


Cat. No. BT5A—$2.50
FOR .0005 MFD. CONDENSERS
Bernard Tuner for antenna coupling, the primary being fixed and the secondary tuned. This coil is used as input to the first screen grid radio frequency tube. The double-action tuning method invented by Herman Bernard is employed. Adjust an equalizing condenser across the tuning condenser so that exactly the same dial settings prevail through all circuits. This equalizer, 90 mmfd., once set, is left thus.
Cat. No. BT3A for .00035 mfd. $2.55

FOR the first time in radio a coil has been designed that permits working the screen grid tube up to the enormous amplification level that theory long promised but practice long denied.

The secret lies in tuning the plate circuit of the screen grid tube, and still covering the entire broadcast band. Herman Bernard, noted radio engineer, invented the solution—a tuned coil consisting of a fixed and a rotating winding in series, the moving coil turned by the same dial that turns the tuning condenser. An insulated link physically unites condenser shaft and moving coil. Thus when the condenser plates are entirely in mesh the moving coil is set for maximum inductance, that is, it aids the other part of the tuned winding. As the condenser is turned to lower capacity setting the moving coil aids less and less, until at the middle of the dial it acts as if fixed. From then on the moving coil bucks the fixed winding, greatly reducing the total effective inductance, and thus nullifying the effect of the high starting capacity.

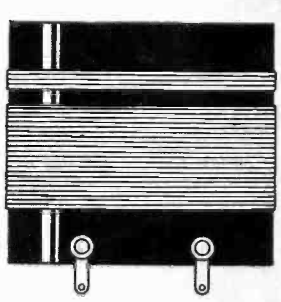
The Bernard Tuner is a two-winding coil for interstage coupling, working out of a screen grid tube, 222 or 224, and into any type tube. The tuned primary has coupled to it a still larger inductance, so that a step-up voltage is obtained, thus greatly increasing an already enormous amplification! This is Cat. No. BT5B for .0005 mfd., BT3B for .00035 mfd. Use BT5A or BT3A for antenna coupler, tuning the secondary, with an equalizing condenser across the antenna tuning condenser, so that the high minimum capacity of the tube's output will be duplicated at the input.



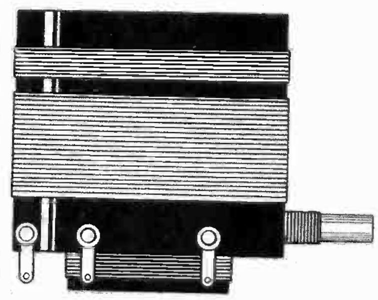
Cat. No. BT5B—$2.50
FOR .0005 MFD. CONDENSERS
Bernard Tuner for working out of a screen grid tube, consists of a rotary coil in series with a fixed coil, the two constituting a tuned primary, for tuning the combined rotary and fixed windings to exceed the broadcast band of wavelengths. The condenser shaft and rotary coil shaft are physically coupled so one motion turns both. Develops the highest possible amplification from the screen grid tube.
Cat. BT3A for .00035 mfd. $2.55

The Diamond Pair

Since 1925 the Diamond of the Air has been an outstanding circuit. It has undergone few changes. When power tubes and screen grid tubes appeared these were included. When AC operation became practical, the model was described for such use. Whether battery-operated or AC-operated, the Diamond of the Air is a dependable and satisfactory circuit. It uses a screen grid RF stage, tickled detector and two stages of transformer coupled audio. The same coils are used for both models, battery or AC. The secondaries are tuned. They are matched with fine precision, to permit ganged tuning.



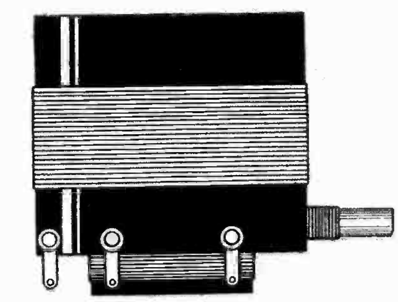
Cat. No. RF5—$0.75
FOR .0005 MFD. CONDENSER
Antenna coil for any standard circuit, and one of the two coils constituting the Diamond Pair. The secondary is carefully wound to match the inductance of the companion coil's secondary, so equality of tuning prevails.
Cat. No. A3 for .00035 ...$0.08



Cat. No. SGT5—$1.25
FOR .0005 MFD. CONDENSER
Interstage 3-circuit coil for any hookup where an untuned primary is in the plate circuit of a screen grid tube. This primary has a large impedance (generous number of turns), so as to afford good amplification. Used in the Diamond of the Air.
SGT3 for .00035 mfd. $1.30

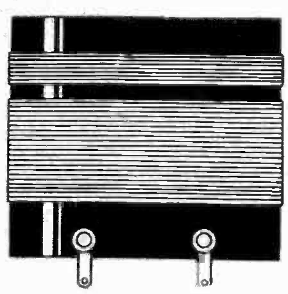
The Diamond Pair of coils for .0005 mfd. tuning are Cat. Nos. RF5 and SG5. A circuit of excellent stability, extremely high selectivity and good sensitivity, the Diamond of the Air should be built with coils that permit full capitalization of the virtues of the circuit. Not only is the number of turns correct for this circuit on each coil, but the spacing between aperiodic primary and tuned secondary is exactly right. Note that the 3-circuit coil SGT5 (or SGT3) has a high impedance primary. This means good amplification from the screen grid tube, obtained in a manner that guarantees selectivity attainment.

ANTENNA COUPLER



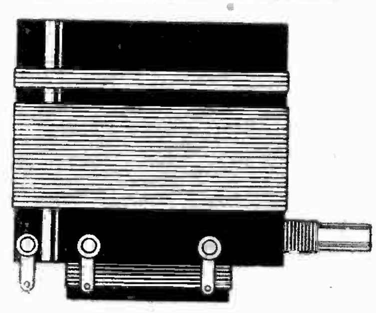
Cat. No. VA5—$1.10
FOR .0005 MFD. CONDENSER
Moving primary and fixed secondary, for antenna coupling, adjustable from a knob at the front panel, thus providing volume control.
Cat. No. VA3 for .00035 mfd. $1.15

SG TRANSFORMER



Cat. No. SGS5—$0.75
FOR .0005 MFD. CONDENSER
Interstage radio frequency transformer, to work out of a screen grid tube, where the generous-sized primary is in the untuned plate circuit.
Cat. No. SGS3 for .00035 mfd. $0.80

STANDARD TUNER



Cat. No. T5—$1.25
FOR .0005 MFD. CONDENSER
Standard three-circuit tuner, for antenna stage, or interstage coupling where primary is in the plate circuit of any tube except a screen grid. Provides abundant selectivity and gives smooth tickler action.
Cat. T3 for .00035 mfd. $1.30

SCREEN GRID COIL COMPANY, 143 West 45th St., New York, N. Y.
Just East of Broadway

Enclosed please find $.............. for which please ship at once, parcel post prepaid, the following coils:

Quantity	Cat. No.	Price	Quantity	Cat. No.	Price	Quantity	Cat. No.	Price	Quantity	Cat. No.	Price
☐	BT5A	@$2.50	☐	RF5	@$0.75	☐	VA5	@$1.10	☐	SGSF	@$0.75
☐	BT3A	@$2.55	☐	RF3	@$0.80	☐	VA3	@$1.15	☐	SGS3	@$0.80
☐	BT5B	@$2.50	☐	SGT5	@$1.25	☐	T5	@$1.25	☐	FL4	@$0.35
☐	BT3B	@$2.55	☐	SGT3	@$1.30	☐	T3	@$1.30	☐	EQ90	@$0.35

NAME ....

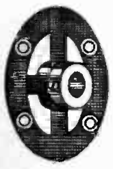
ADDRESS ....

CITY.............................. STATE..............................

5-DAY MONEY-BACK GUARANTEE!

Insulated Link

A flexible coupling device to unite two independent ¼" shafts for single dial operation of a tuning condenser and a Bernard Tuner. If the condenser has shaft protruding from the rear, then the condenser may be panel-mounted and the coil shaft coupled by the link to either extension shaft of the condenser. If the condenser has no shaft protruding at rear, mount the Bernard Tuner on the front panel. It has shaft protruding at rear for coupling by the link to the condenser's front shaft. To make sure of insulated protection do not force the receptacles of the link together when mounting.



Data on Construction

The coils are wound by machine on a bakelite form 2½" wide, and the tuned windings have identical inductance for a given capacity condenser, i. e., .0005 mfd. or .00035 mfd. Full coverage of the wave band is assured. The wire is silk insulated.

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

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

[Note: Those desiring the 90 mmfd. equalizing condenser for use with the antenna model Bernard Tuner, BT5A or BT3A, should order EQ90 at $0.35.]

SCREEN GRID COIL COMPANY
143 West 45th Street, New York City

"UNINTERRUPTED READER INTEREST" EVERY WEEK — EVERY YEAR

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Latest Circuits and News

EIGHTH YEAR

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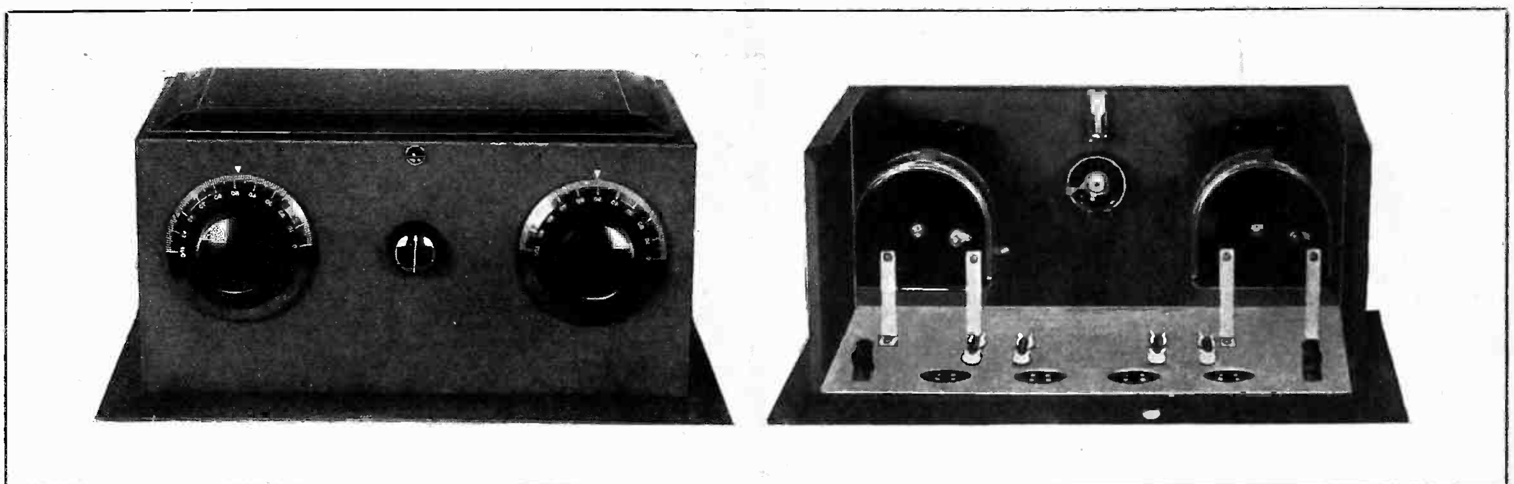
(Just East of Broadway)
Telephone, BRYant 0558 and 0559

THE HB COMPACT

Four Tubes Do a Great Deal Indeed

By Herman Bernard

Managing Editor



FIGS. 1 AND 2

TWO SEPARATE DIALS ARE USED TO TUNE THE HB COMPACT, FOR GREATER SENSITIVITY. THE REAR VIEW SHOWS THE TUNING CONDENSERS MOUNTED BEHIND THE COILS, WHICH ARE ON THE FRONT PANEL.

[*Publication of some preliminary articles, giving advance information about the HB Compact, in battery and AC-operated forms, brought such an avalanche of demands that publication of the constructional data begin at once, that the battery model is described, beginning this week. The AC model will be discussed constructionally as soon as the present battery-model series is completed. The two circuits have been tested with exceptional thoroughness by disinterested laboratories and pronounced most remarkable. In this encomium* RADIO WORLD'S *editor wholeheartedly joins, and considers it a privilege to be able to serve* RADIO WORLD'S *large family of readers by presenting Herman Bernard's masterpieces in economical circuits. The fact there are only two tuned circuits, and only four tubes all told, in the battery model, need deter nobody, as it is scarcely possible that greater gain ever has been established in a stable circuit than is provided by the HB Compact, in battery or AC form.—Editor.*]

OPPORTUNITY is now presented to home-builders of receivers, custom-set builders and the like, to construct the truly amazing HB Compact, a four-tube circuit that scales new heights.

The first outline of the circuit was published in RADIO WORLD, issue of July 27th, on the theory that readers would appreciate some preliminary information. As a new system of tuning was to be introduced, it was supposed that readers would like that fully explained to them in advance. Some idea of the performance of the receiver was given, too.

The August 3d issue contained more information along the same lines. Both of these discussions concerned the battery-operated model, which uses a screen grid radio frequency amplifier, a 240 tube as negative bias detector, a screen grid tube as first audio amplifier, and a 112A as the output tube, the audio channel being resistance-coupled.

The day after the July 27th issue appeared on the newsstands I received 142 letters, inquiring about various aspects of the circuit, many of the writers asking point-blank whether the circuit was all that I said it was, or whether I said it was all that it wasn't. Stung in previous adventures in circuits—not my circuits, thank goodness—these doubters certainly had good reason to be cautious.

More and More Inquiries

The second day 167 more letters arrived, and before the end of that week the total mail on the subject of the Bernard Tuner and the HB Compact had passed 500, and at this writing 1,068 letters require an answer, and as it is impossible to send an individual reply to each inquirer, the alternative is to start publishing the constructional article on the battery model HB Compact three weeks in advance of the date of issue for which it was intended.

To accomplish that happy result it was necessary for the editor of RADIO WORLD to send me a telegram, which reached me while I was canoeing on a lake in upper New York State, in the midst of a blissful vacation, which perforce had to be thus coldly interrupted, so that decent attention might be paid

(*Continued on next page*)

Dubious Answered

Some Wondered if Circuit Worked at All

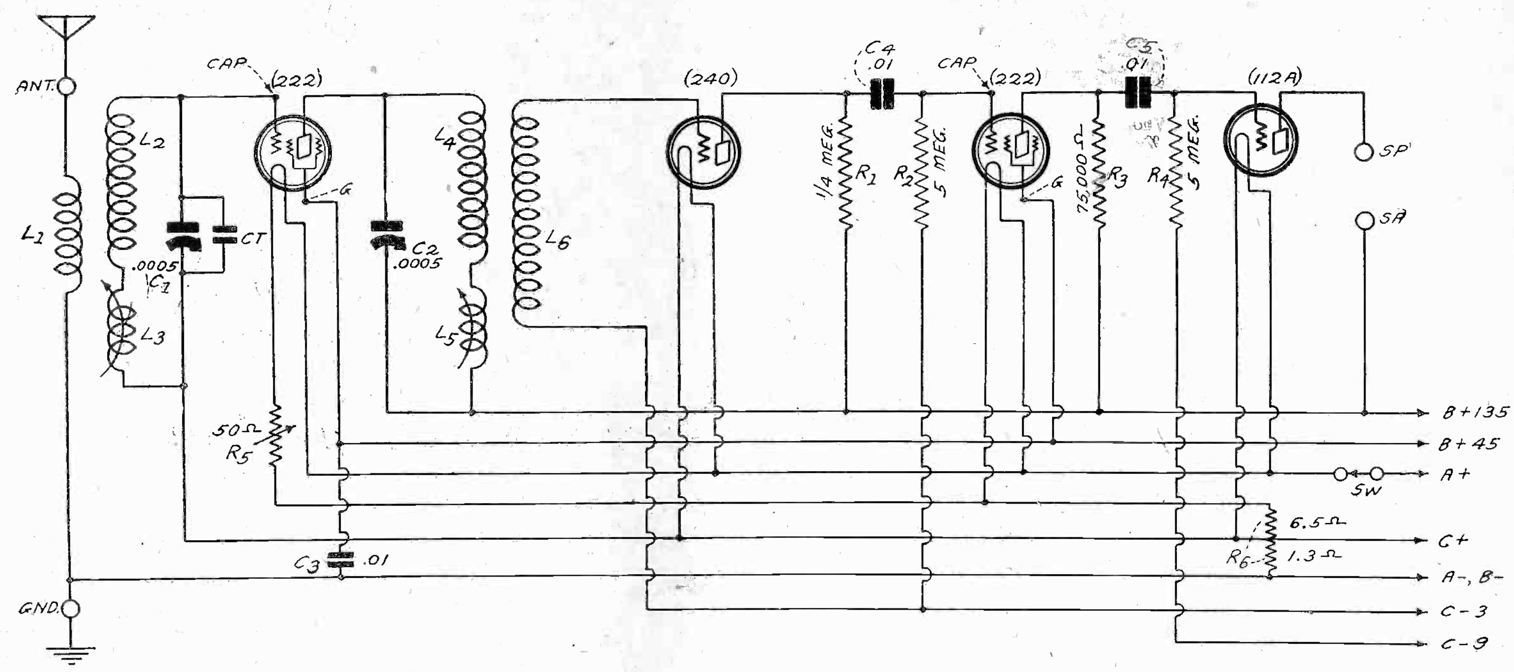


FIG. 3

THE CIRCUIT DIAGRAM IN SCHEMATIC FORM. IF A 6-VOLT PILOT LIGHT IS USED, CONNECT IT DIRECTLY ACROSS A+ AND A—, USING THE SET SIDE OF THE SWITCH AS A+. NOTE THE SCREEN GRID TUBE'S PRIMARY IS TUNED. THERE IS A STEP-UP RATIO TO THE DETECTOR INPUT.

to the 1,068 who sent in encouraging or other letters, and the untabulated majority who did not write in on the subject, but whose interest was awakened nevertheless.

I was all for going ahead with the good vacation, I may as well confess, as the fishing was excellent, the breezes cool by day and by night, and a friendly moon winked me to sleep under tall pines each frigid evening, while I knew from reports of recent arrivals at that glorious lake that New York City was sweltering day and night. A second telegram was not only more persuasive, but I might say more persistent, and after I had no choice left I decided that it wasn't doing the right thing by one's constituency to be sunning one's self on a placid lake or mooning away the cool night hours under skies blinking with stars, when the vote was apparently 1,069 to 1 against it.

Much Stepping on Gas

So I got busy anew with the circuit, which needed just a touch or two here and there, and started writing this piece of literature, so that there might be no delay in the confirmation of every assertion I made concerning this most remarkable circuit.

Sizzling activity was not confined to my own immediate case. The National Company at that time had in its laboratory, for final engineering detail work, their models of Bernard Tuners, both for antenna coil and interstage coupling, and they had to be convinced that speed was necessary. The National Company is, as you know, a high-class engineering concern, and it will not sacrifice quality to expediency, so the production models of these coils, as made by National Company, can not be expected to be available simultaneously with the publication of this first article of the series, although the time between such publication and delivery of National coils need not be expected to be long.

The other company working on Bernard tuners, of lower price, and which work well and are also heartily recommended by me, although they are not in the de luxe class of the National coils, was the Screen Grid Coil Company. This concern had started earlier and was therefore able to get into production, under the impetus given by several coaxing conferences and a few telegrams, hence the Screen Grid Coil Company's products are now available.

Use the Steel Cabinet

The aluminum subpanels had to be expedited, special brackets provided for mounting the condensers behind the coils, and other physical problems solved, but those worries are over and it is now possible to capitalize on this fine circuit by building the receiver, and at a very low cost, indeed.

It is suggested that the circuit be built into the special steel cabinet, which comes already drilled, including the holes for the condensers, rheostat and pilot light, and which is provided likewise with an insulating device, so that no matter what make of coil is used, including home-made coils, the tuned primary circuit of the screen grid tube will not be shorted by the grounded steel cabinet. This grounding arises from the fact that a grounded aluminum subpanel is used, and the subpanel is fastened by machine screws and nuts to the flange on inside of the steel cabinet. Both the subpanel and the cabinet are drilled consonantly, so that affixing the screws and nuts is the only work necessary to perfect the attachment of one to the other.

Tuning the primary circuit is certainly a wonderful asset, because it enables obtaining highest amplification from the screen grid tube. As is well known, the screen grid tube's plate circuit should have a high impedance load. As radio frequencies the best solution is to tune that circuit, for at resonance the impedance is infinite. Then couple to the next stage, in

LIST OF PARTS

L1L2L3—One Bernard Tuner for antenna circuit, for .0005 mfd. tuning (BTS5 of National Co., or BT5A of Screen Grid Coil Co.).
L4L5L6—One Bernard Tuner for screen grid interstage coupling, for .0005 mfd. tuning (BTP5 of National Co., or BT5B of Screen Grid Coil Co.).
C1, C2—Two .0005 mfd. tuning condensers.
CT—One Hammarlund 90 mmfd. equalizing condenser.
C3, C4, C5—Three .01 mfd. mica fixed condensers.
R1—One Lynch .25 meg. metallized resistor.
R2, R4—Two Lynch 5.0 meg. metallized resistors.
R3—One Lynch .75 meg. metallized resistor.
R5, SW—One 75-ohm rheostat with switch attached.
R6—Two resistors, one 1.3 ohms, the other 6.5 ohms.
Ant., Grid., Sp.—, Sp.+. Four binding posts.
One drilled steel cabinet 7" high, 9½" front to back, 15" wide.
Two dials with pointers.
One pilot light bracket with lamp.
One 7-lead battery cable.
One 9½x15" satin finish aluminum subpanel with sockets affixed, and supplied with insulated bushings supporting bracket, and four resistor clips.
Two insulated links (flexible couplers).
Four brackets to support tuning condensers.
Three 45-volt B batteries.
Two 4½-volt C batteries.
One 6-volt A battery.
Four Kelly tubes: two 222, one 240, one 112A.

COILS EXPLAINED

Moving Segment Must Be Rightly Placed

this instance the detector, by a step-up ratio of secondary to primary, and you increase the gain at least four times. Thus is an already enormous gain converted into something that is so utterly astonishing in volume and sensitivity that nobody except a person who had actually tuned this circuit himself would ever suspect that such accomplishment with such few tubes was at all possible.

Theory has always led us on, for the screen grid tube could produce more thrilling arithmetic and algebra than any other tube on the market, regardless of price. When amplification was under consideration the number ran into so many figures that not all the digits could be confined to a single line of the usual width of writing paper, 8½", no matter if you wrote small and crowded the digits. But how to accomplish in practice what was luringly promised by theory was another matter. Of course, tune the primary. This was done last year in the Screen Grid Universal, a very sensitive receiver, but in the second tuned circuit some of the wavelengths in the broadcast spectrum were wiped out of the frequency tuning range, because of the high minimum capacity, if a step-up ratio to the detector were used. The only solution then was to reduce the number of turns on the secondary until the minimum capacity was low enough not to deprive the tuning condenser of its requisite effective ratio of minimum to maximum capacity.

The minimum capacity, developed elsewhere in the same tuned circuit, acted purely as a parallel capacity across the second tuning condenser. If turns were removed from the coil to reach lowest wavelengths, otherwise missed, then high wavelengths could not be tuned in, if the step-up ratio was maintained. The circuit aroused great interest, for its sensitivity brought admiring comment from multitudes of builders, and they did not worry about missing out on low wavelengths that they were not particularly interested in, anyway.

Uses New Tuning System

The present circuit covers the entire broadcast spectrum, even though a step-up ratio is maintained from tuned primary in the screen grid plate circuit, to the grid circuit of the detector tube. This is done by using a tuning system that I invented, whereby a moving coil and a fixed coil are connected in series, and the tuning condenser connected across the extreme ends. The shaft of the tuning condenser is united with the shaft of the moving coil by a flexible insulated coupler or link, and the turning of the dial actuates both coil and condenser simultaneously.

When two coils are mutually coupled they may be aiding or opposing each other. If aiding, the effective inductance increases; if opposing, it decreases. Therefore the moving coils in this system of tuning must be placed so that when the plates of the tuning condensers are completely in mesh the moving coil aides the fixed coil with which it is in series.

The rest of the action is automatic. As the dial is turned to the middle of its scale the condenser plates become more and more unmeshed, and automatically the moving coil adds less and less inductance. When the middle of the scale is reached the moving coil is at right angles to the fixed coil. This is zero coupling between the two. The effect is little different at this moment than if the moving coil were a fixed one. Now, as the condenser is turned toward minimum capacity setting the moving coil starts to buck the fixed winding. The nearer to minimum capacity the condenser is turned the greater the bucking effect. This bucking rises to considerable height, so that, were it not for the high minimum capacity the circuit arrangement affords, the lowest broadcast wavelength, or highest frequency, would be tuned in at 35 on the dial, and at 5 on the dial 150 meters would be tuned in. However, this feature of sub-broadcast range can not be used in the present circuit, as the object of introducing the Bernard tuners here is to guarantee coverage of the broadcast spectrum, which requires something to overcome the effect of the high starting capacity.

Doubly Effective Tuning

The variometer tuning effect added to the condenser tuning effect, whereby both effects are in the same direction, amply extend the tuning ratio, so that even with 100 mmfd. starting capacity, the full wave band may be tuned in nevertheless. This is due to lowered effective inductance at low capacity settings and raised effective inductance at higher capacity settings, with the middle of the dial as the reference point.

It is respectfully submitted that this system of tuning never was even broached heretofore, and not only is an original contribution to the methods of tuning, but is one fraught with diverse possibilities of use. The bucking at higher frequencies, in respect to the reference point, introduces a resistance that varies with frequency, and in the right direction, so that a self-stabilizing tendency is developed. This advantage is actually utilized in the HB Compact, hence the absence of any grid suppressor or other quieting device, even though the entire circuit is confined in probably the smallest practical space.

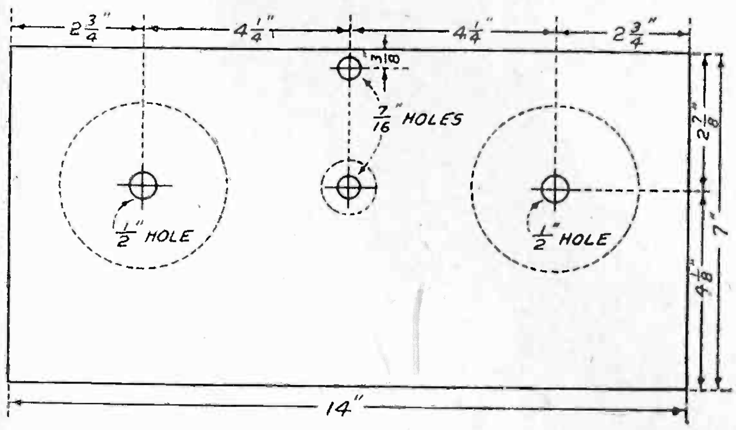


FIG. 4
TEMPLATE FOR DRILLING A 7x14" FRONT PANEL IN THE EVENT THE PRESCRIBED STEEL CABINET, OF WHICH THE FRONT PANEL IS A PART, IS NOT USED. HOLES FOR AFFIXING THE FRONT PANEL TO THE SUBPANEL AND FOR INSERTING DIAL POINTERS WOULD HAVE TO BE PROVIDED.

Intimate Details on Coils

Since the system of tuning is such a distinct novelty, and as the coils made by the two companies differ somewhat, it is well to go more deeply into the coil features.

A great deal of trouble will be encountered if the moving coils are not properly connected in circuit. Naturally, if at maximum capacity setting of the tuning condensers a bucking conditon exists, then an aiding condition will accompany the dial settings for higher frequencies than the reference point (middle of the dial). This is exactly the opposite of what is intended.

The situation becomes exasperating if both coils are reversed, that is, are working in the wrong direction, unless one is advised as to the remedy. If both are working wrong, then the consistency of the error will no doubt pall upon those doubters who wrote me wondering whether there was anything at all to the system of tuning. But the solution is easy. Simply reverse the connections of the moving coil, so that the end that previously went to the condenser goes instead to the same terminal of the fixed part of the tuned winding, and the free end now goes to the condenser, or, simpler yet, loosen the moving coil's setscrew, and turn the moving coil 180 degrees around. Now if you compare the correct position of the moving coil in one circuit with the incorrect position in the other circuit you will find that the dial readings have changed considerably. Now 500 meters will come in around 80 on the dial, the right way, instead of 'way up around 95 or more. Also the low waves will be received higher up on the dial. Only the correct position of the moving coil will tune in 545 meters.

Some Pointers

Here are some pointers:

(1) Place the moving coil randomly parallel to the fixed winding when the condenser plates are totally in mesh. Tune in a high wavelength station, preferably over 450 meters, and a low wavelength station, preferably under 250 meters. Then with plates again fully in mesh, reverse the moving coil, either by a turn of 180 degrees or by physical reversal of leads, and compare the dial settings for the two stations. The correct connection or position is the one that gives the higher capacity setting for the low wavelength station and the lower capacity setting for the high wavelength station.

(2) By visual inspection, the correct connection may be obtained by noting the direction of the windings of the moving

Both Dials Track

That Makes DX Easier to Bring In

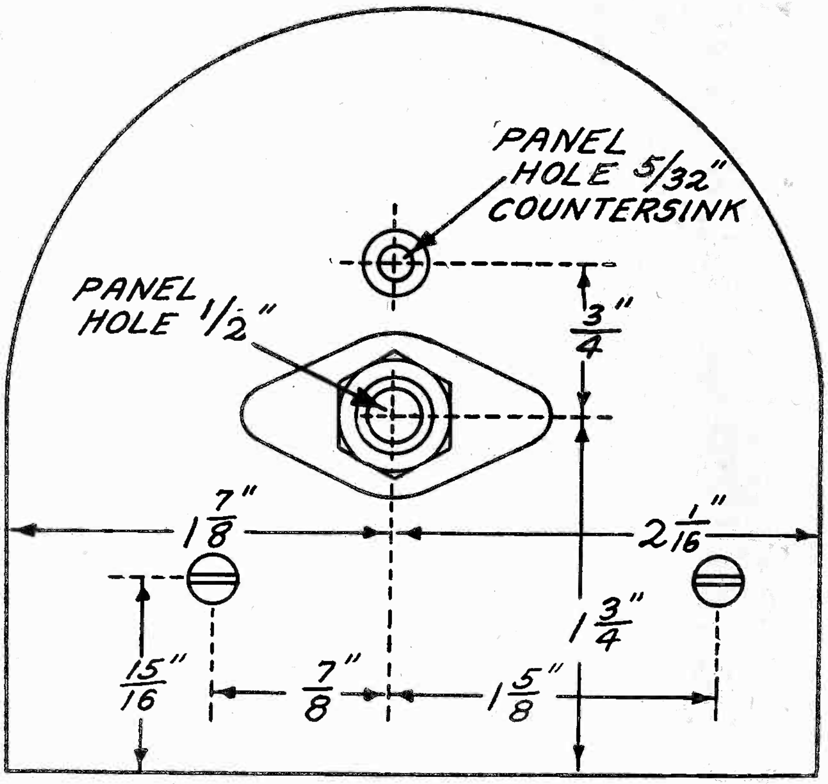


FIG. 5
TEMPLATE FOR MOUNTING THE TUNING CONDENSERS TO THE SUBPANEL BY MEANS OF BRACKETS. THE TWO LOWER HOLES ARE USED. THE SINGLE HOLE MOUNT MAY BE BRACKETED FOR GREATER RIGIDITY.

coil and fixed coil in series with it, and seeing that the windings are in the same direction when the condenser plates are fully enmeshed, or in the opposite direction when the condenser plates are fully "out," and that corresponding terminals of fixed and moving coils are connected, either top to top or bottom to bottom.

Commercial Coil Features

The coils made by the National Company have the moving coil terminate, for connection to the rotor of the second tuning condenser, C2, at a fixture used in conjunction with the support of the tickler. The outlet is through a long lug. Therefore the connection between moving coil and fixed coil in series with it is made as a part of the manufacture of the coil. In this instance the physical reversal of windings can not be made, but the moving coil may be turned around 180 degrees to get it right if it is wrong at first.

The coils made by the Screen Grid Coil Company may be turned around, as suggested, or the leads may be reversed, as explained, since the constructor has to make the connection between the moving and fixed parts of the winding, at the binding posts.

While considerable details have been given about this feature of possible mixup of position, there is no real problem, as a mere statement of what the dial settings should be with given condensers will be a complete guide to success. The condensers used in the laboratory model were of the dust-proof type, with a front and back shield, and worked excellently. The dial settings will be given in a subsequent instalment of this series. But construction of the receiver may be confidently begun without these dial settings, particularly as builders may use various makes of condensers, and it will not be possible to give the settings for all makes.

Analysis of RF Side

The radio frequency side of the circuit is seen to consist of an antenna coil, with a fixed winding for the aerial-ground connection, and a combination fixed-variable winding for the tuned secondary. Notice that the secondary is tuned in this instance, not the primary.

The high minimum capacity across the subsequent tuned circuit, C2, L4L5L6, is not present in the first tuned circuit, C1, L1L2L3, because the parallel minimum distributed capacities of two large coils are not present nor is the high-amplification condition that helps produce high minimum capacity. To make the tuning equal, so that dials will track absolutely, the high starting capacity of the second circuit must be improvised in the first circuit. This is done by connecting an equalizing condenser of 90 mmfd. or higher capacity across the first tuning condenser, C1, and setting it so that its capacity equals that of the distributed capacity of the next tuned circuit. Once the adjustment is made, preferably at a wavelength under 300 meters, it need not be changed thereafter.

The equalizing condenser is not a trimmer, in the sense of being used for control from the panel of any tuning inequalities, for each stage here is separately tuned, and if any inequalities cropped up, a slight adjustment of the first tuning condenser dial would apply the remedy.

Why Tracking Is Valuable

It is advantageous to have the dials track nicely, because then you have a great help to reception of distant stations. If you know that the dial setting of one condenser is necessarily the dial setting of the other condenser, when you log one dial you've logged both dials. Otherwise one circuit will develop freak dial settings, wholly unmatched by the other circuit, and distant reception becomes indeed elusive. However, in the present instance dial tracking is assured, particularly as there is a high starting capacity in both circuits, and any slight capacity variation due to freakish effects is a negligible percentage of total capacity in the circuit, no matter how little capacity is contributed by the tuning condenser. Assume 50 mmfd. as a minimum, due to setting the equalizer at that capacity. Then the different capacity effects due to use of aerials of different lengths and heights, and of grounds of equally different effects, is of no importance, because representing only a minor percentage of the minimum capacity in the circuit.

The capacity effect of different sized aerials is reflected in the secondary only on a reduced scale, and even at worst does not nearly equal the actual capacity difference between antenna and ground.

The coils made by both companies make possible the attainment of splendid results. The National Company's coils are BTS5 for antenna coil for .0005 mfd. tuning, BTP5 for the interstage coil for the same tuning capacity. The Screen Grid Coil Company's pair for .0005 mfd. are BT5A for antenna coil and BT5B for the interstage coil.

The main differences between the two makes of coils have been set forth. There are two other points of variance. The National Company's coils are on a 2" outside diameter, with tickler about an inch down, while the Screen Grid Coil Company's inductances are on a 2½" diameter, with tickler so near the top that when the moving coil turns around part of its form extends beyond the level of the fixed form's rim.

The other point of difference is that the National Company's coils, if fastened to the front panel, without insulation, cause the "low" end of the tuned winding to be at the same potential as that of the steel cabinet, which is ground. The other company's coils are not metallically or other than merely physically connected to the front panel, because the tickler shaft is independent of the electrical circuit. For the National coil for interstage coupling an insulating device is needed, so that the ground potential does not reach the high B voltage on the coil.

Of course if a bakelite or hard rubber front panel is used these points have no bearing, as the front panel is the insulator.

If the tuning condenser is placed on the front panel, instead of the coil, the Screen Grid Company's model and the National Company's model both require insulating the shaft and mounting holes, because otherwise the condenser rotor puts the high B voltage at ground potential, thus shorts the B supply. This is true even though flexible insulated links be used to unite condenser shaft and coil shaft. The front cover illustration aids a visualization of these conditions.

Details for constructing the coils were published in the July 27th, August 3d and August 10th issues, except that it is advisable to use a step-up ratio, say 1½ to 1, no matter which type coil is followed. Conversion of existing three-circuit coils was explained also.

Next week fresh details on construction of the circuit will be published.

[Other illustration on front cover]

WHY SHIELDING?

Multi-Stage RF Channels Squeal Otherwise

By James H. Carroll

Contributing Editor

SHIELDING is not a new principle. It was known to the ancients also, the knights of the Middle Ages used to shield their bodies in battle for much the same reason that we shield receivers, viz., to preserve from dissipation the flow of life currents. Some radio genius, therefore, probably got the idea from a suit of armor hanging on his ancestral walls. However, the idea is a sound one.

When radio shielding started, a comparatively short time ago, it began, more or less as a fad. It was crudely performed in some instances and wrongly in others.

With the screen-grid tube in multi-stage amplification shielding has become doubly necessary.

Shielding is not an intricate operation by any means and any fan will find it easy to shield his circuit and will obtain great pleasure and thrill in building the new shielded circuits. Making cans and shields has become a necessary complement of the parts business, and cans for tubes, and shielding compartments for coils and condensers, are now readily available for fan use. An enterprising New York dealer, Blan the radio man, went so far as to establish recently a department for this special purpose, making aluminum compartments and boxes to order in any wanted size, as well as carrying a large stock of standard sizes.

A striking example of a beautifully and most scientifically shielded job is the new MB29, designed by James Millen and Prof. Glen H. Browning.

Cans Barriers to Magnetic Forces

Shielding has become a most important part of the modern receiver so as to prevent feedback. The passage of an electric current through a conductor, such as a wire, causes the setting up of magnetic lines of force, thus creating a magnetic field. In the case of a wire-wound coil, the magnetic field is large. The field thus set up is not confined to the coil area, but forms a circle of infinite diameter.

In coils of the solenoid type, the field is most intense along the axis of the coil.

In coils of the doughnut type, really of toroidal form, which is a solenoid bent in ring form, the stray flux line are more confined, as the coil has no free ends. It will readily be apparent that if any of these coils are placed in the receiver and are not spaced sufficiently apart, the free fields will interlink so that the radio frequency currents in one coil will set up interfering currents in another coil, producing stray coupling. The set becomes unstable.

Shielding, to be effective, must be thorough. Even a small opening or crack will upset the effect.

The high gain and fine results of the Hammarlund-Roberts Master Hi-Q 29 are due largely to effective shielding. It is well to bear this in mind for faultily constructed shields of poor materials are worse than no shielding at all, because introducing a loss without any compensating gain.

Fans who desire to shield a receiver not designed in the modern way for shielding will find it a difficult, ineffectual task, and the most practical thing to do is to tear down the receiver and redesign it for the protective shielding, as the proper layout of parts is most important. For instance, in the old-style radio frequency sets the tubes were not placed directly behind their coils and condesers, as in today's practice. Instead they were placed beside the condenser inductance unit, being staggered with the audio frequency valves, making it practically impossible properly to place a shielding can.

Most Efficient Methods of Shielding

Aluminum, tin and copper are used for shielding, aluminum being most commonly used on account of lightness. It is a much better shield than tin.

Theoretically shielding would not be necessary if the inductances could be so widely spaced so that their fields could not substantially interlink.

In laying out the shielded receiver, the units should be considered in turn and the cans should be made to fit them, but not too closely. There should be 1 inch or 2 inches between can and coil.

It will be generally found that the set will wire easiest if the jacks used are mounted on the panel, under the sub-panel so that they project into the sub-panel box. It should be remembered that every tube should have a can or compartment of its own, especially the screen-grid and detector tubes. These tube cans are on the market in sizes and shapes to suit every taste and every need. Shielding should invariably be connected to the ground binding post of the set. All parts should be insulated, wherever necessary, with bushings, radio tape, spaghetti or blocks of hard rubber.

If practical, the rotors of all the condensers should be grounded on the boxes and this may be accomplished in the case of a leak-condenser detector circuit by returning the grid coil to A+ but having the tuning condenser go to A minus, with a 1 mfd. condenser from A+ to A—.

Wires that have to be drawn through shielding walls should be covered with a good grade of spaghetti or other insulating tubing and the hole in the shield must be clean-cut, with no burs.

Complete shields may be bought, that is, cans, built up as well as cans in knockdown form.

In soldering on copper shields, the copper surface should be clean and bright before the solder is applied, the iron well tinned and very hot, as the large copper surface dissipates heat rapidly. Very little flux should be used and the remaining traces should be carefully removed with alcohol after the soldering is completed. You can not solder to aluminum, so fasten lugs to insulated bushings.

Right or Wrong?

(1)—The hum in the output of a tube operated with AC on the filament varies with the plate current flowing.

(2)—An unbalance of the grid return with respect to the mid-point of the filament does not change the hum component in the plate circuit of a tube operated with AC directly on the filament.

(3)—There is no advantage in connecting the mid-point of the heater in a 227 type tube to the cathode or to a negative voltage.

(4)—A screen grid tube cannot oscillate because its grid-to-plate capacity is negligible.

(5)—The amplification factor of a tube is a constant independent of the voltages applied.

(6)—The amplification factor can be measured with a voltmeter and a milliammeter.

(7)—A vacuum tube voltmeter cannot be constructed without the use of very sensitive instruments.

(8)—The highest power output from a tube is obtained when the plate load resistance is equal to the internal resistance of the tube.

(9)—The amplification factor of a tube decreases as the plate coupling resistance is increased, the voltage in the plate circuit remaining constant.

(10)—The power required to operate a complete radio receiver installation can be estimated closely by summing up the AC and DC power dissipations in the receiver and the voltage supply circuits.

(1)—Right. The hum component increases as the plate current decreases. However, there is a current for which the hum is a minimum.

(2)—Wrong. The grid return must be made accurately to the electrical center of the filament, or there will be a considerable hum component, in many instances much greater than the signal itself.

(3)—Wrong. Sometimes a disagreeable hum can be entirely eliminated by connecting the mid-point of the heater to the cathode, or to a point of lower potential.

(4)—Wrong. It is true that the grid-to-plate capacity is negligible at audio frequencies, and even at broadcast frequencies, but it is not at higher radio frequencies. And the tube oscillates readily due to feedback from one circuit element to another.

(5)—Wrong. While it is true that the factor is practically constant over the usual operating range, it decreases rapidly for low effective plate voltages.

(6)—Right. It can be done very easily and with only a few readings. It is only necessary to observe how much change is required in the grid voltage to offset a given change in the plate voltage, keeping the plate current constant.

(7)—Wrong. Good results can be obtained with any ordinary instruments used for testing receivers.

(8)—Right. The greatest power is obtained from any electric source when the load resistance is equal to the internal resistance of that device. However, the greatest *undistorted* output is obtained from a tube when the load resistance is twice the internal resistance.

(9)—Right. In some instances at least, judging from the course of the grid voltage, plate current curve, the amplification factor decreases to zero.

(10)—Right. No more power is taken from the line than is used by the radio set, so that if all the power dissipation in the receiver and its voltage supply are summed up the result is the power taken from the line.

A TUBE IN AN A
SINGLE 227 SERVI

Same Valve Is Automatic Volume Contro
and Grid of Next, and Is V

By Herbe

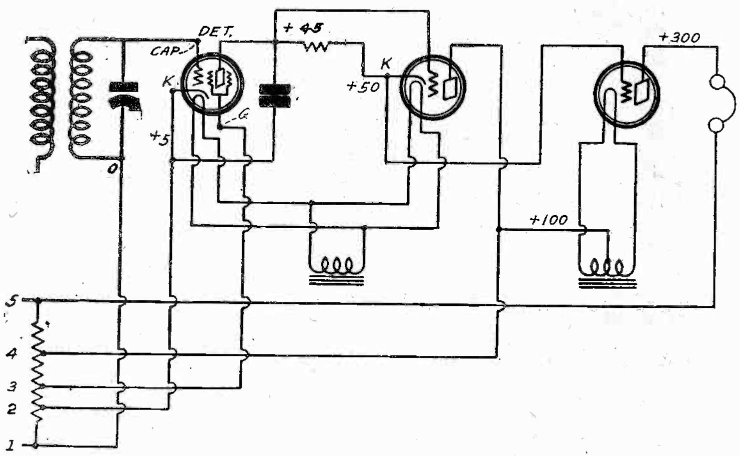


FIG. 1
A 224 DETECTOR, WITH A 227 AS AUTOMATIC VOLUME CONTROL RESISTOR, PLATE LOAD ON DETECTOR AND GRID LOAD ON OUTPUT TUBE, AS WELL AS VARYING BIASER OF THE POWER TUBE

WHILE radio frequencies of considerable intensity are deemed advisable if the automatic volume control is to be actuated from the RF current, no special regard need be paid to signal level if the control is located in the audio frequency amplifier. The intensity will be sufficient in the first audio stage, and indeed this may be the only audio stage, since circuits of such design are becoming popular. Considerable radio frequency amplification is necessary to render practical the single stage of audio.

In Fig. 1 is shown an experimental design originated by Ulmar Umph in which a vacuum tube is used as an automatic volume control, with the assistance of an external biasing resistor. This circuit shows the detector as a 224 tube, with a biasing resistor for the 227 connected to the detector plate, and the load on the plate circuit consisting of the plate-to-cathode resistance of the 227.

The grid of the 227 is returned to the plate of the detector so that the negative bias on the load tube is the voltage drop in the external resistor. This drop changes with changing values of plate current, hence changes the bias. The more plate current flowing, the greater the voltage drop across the external resistor and the greater the bias and consequent plate load. Increased bias increases the plate-to-filament resistance of any tube. In the case of the 227 the plate-to-cathode resistance is affected.

Serves Another Purpose

Another novelty in this circuit is that the plate-to-cathode resistance is not only the load on the plate circuit of the detector, but is also the grid load on the output tube, a 245. This double use is made possible by proper arrangement of the voltages. If 200 volts are to be applied to the last tube then a total of 300 volts would be necessary, so that 200 would be dropped in the output tube, about 50 in the common grid-plate circuits of the volume control tube and the output tube, and about 50 in the detector tube. This 50-volt external drop is used not only for the purposes of the detector plate but also for negative bias of the power tube.

If the position (1) on the voltage divider is taken as the reference point, then point (2) will be higher by a few volts, enough to bias the detector tube negatively for detection purposes at an applied voltage of 100, and this normally would be about 5 volts, if the screen voltage is around 22½, represented by point (3). Assuming 1 milliampere plate current in the volume control tube, the external resistor next to the detector plate would be 5,000 ohms to produce a negative bias of 5 volts at that current. The plate of the volume control tube goes directly to the voltage divider, to point (4), which is 100 volts higher than the reference point. The 10 volts used for the two previously mentioned biases need not be considered now in the computation.

The cathode-to-plate resistance of the volume control tube is assumed to be about the same as the resistance of the plate circuit of the detector tube, to make the statement of the voltage distribution simpler.

Now ,the power tube has its filament midtap connected to plus 100 volts and its plate to plus 300 volts, so its plate voltage is 200, while the grid return is to plus 50 volts, so the grid bias is 50 volts negative. This is not the rated bias for 200 plate volts, but for 250 plate volts, as the voltages are illustrative only.

Third Use

Not only is the plate-to-cathode resistance of the volume control tube used twice at the same time, as plate load and grid load, but the voltage drop in that resistance is used three times, because it furnishes the negative bias for the last audio tube.

So the external resistor that biases the volume control tube, increasing the bias with increased signal level, tends to level out the volume where it is above the required amount, since higher bias produces lower amplification. The corresponding change in the plate resistance of the volume control tube, as affected by bias, is made to change the bias on the last audio tube as well. This is apparent when one considers that the cathode-to-plate

G. E. and Westinghous

In the March, 1929, issue of "Proceedings of Radio Engineers" G. L. Beers, Westinghouse Electric and Manufacturing Company, Pittsburgh, and W. L. Carlson, General Electric Company, Schenectady, published a paper on "Recent Developments in Super-Heterodyne Receivers," in which they disclosed a simple automatic volume control. In this control a single tube, associated with the second detector, was used for controlling the grid on the intermediate frequency amplifiers. The range of the control was approximately up to 100,000 microvolts per meter. Other features in the receiver were band selectors in the intermediate frequency level, obtained by means of tuned windings inductively coupled, and a high intermediate frequency.

In a discussion of this paper in the August, 1929, issue of "Proceedings," Dr. Frederick K. Vreeland asserts that it is preferable to obtain the selectivity in the radio frequency channel by means of band pass filters of the directly coupled type, such as he described in an earlier paper in "Proceedings," claiming that it is difficult to obtain a flat top characteristic over a 20 kc. band when the width of the band is 11 percent. of the carrier, and that it is relatively easier to obtain the desired square-top transmission band at radio frequency where the 20 kc. band is only 3.3 percent. of the carrier.

Mr. Beers, one of the authors of the article discussed by Dr. Vreeland, answers by claiming a decided superiority in obtaining the selection in the intermediate frequency on the ground that if the selection is done at the constant intermediate frequency the response

ROIT, NEW USE: S THREE PURPOSES

Coupling Resistor in Plate of One Circuit ying Biasing Resistor of 245

E. Hayden

resistance of the 227 is the biasing resistor for the output tube. Again, higher volume is trimmed down for the same reasons, and besides the safety factor of increased bias accompanying increased volume tends to prevent overload in this second position.

As for the aspects of detection by the grid bias method, the modulation is upward, as contrasted with downward modulation of the leak-condenser method of detection. With the negative grid bias or so-called power detector, any increase in volume increases the plate current. In a leak-condenser detector the plate current drops as the volume goes up. Hence the external biasing resistor in the present circuit is able to function in the right direction.

Two Points to Consider

There are two points well worthy of investigation: first, whether the impossibility of using a bypass condenser across the power tube's biasing resistor causes tone value to suffer, and second, whether the increased plate resistance of the volume control tube causes the amplification to increase at a faster pace than the increased bias tends to make the amplification decrease.

Why not bypass condenser can be used across the biasing resistor of the power tube circuit is obvious when one recalls that that very resistor is the only coupling and is across the line. It alone unites the detector stage to the output tube, and a condenser of the usual capacity for bypassing, say, 4 mfd., would bypass a nearly all of the signal!

As for the effect of the increased resistance increasing the amplification faster than the increase in bias decreases the amplification, this could happen, if the volume control tube were a high mu tube, such as the 224 for instance, but when it is a 227 it is not likely that the amplification will go up in any degree that would noticeably offset the decrease occasioned by the higher bias.

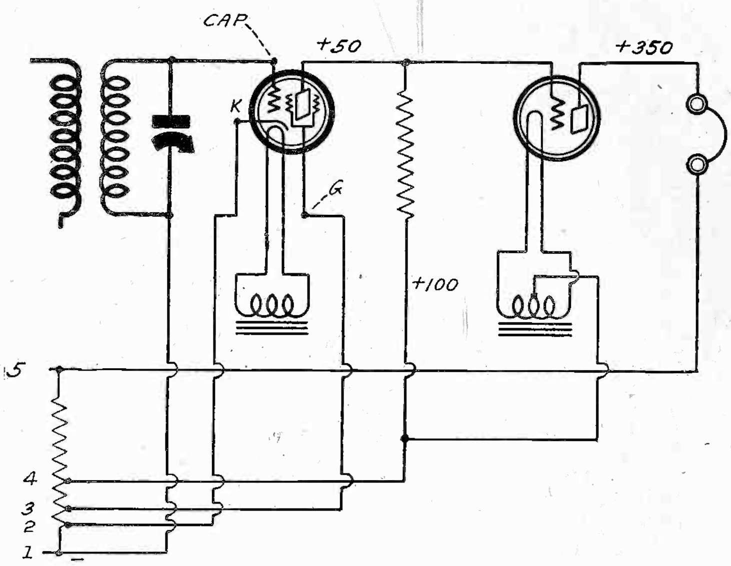


FIG. 2
SIMPLIFIED GENERAL PLAN OF THE CIRCUIT.

Aids Amplification

One danger that exists in the use of a volume control tube, especially in a circuit such as the one now under discussion, is that it might turn out to be anti-regenerative, so that it is an amplification killer at every signal volume, including weak signals as well as strong ones. The present design has no effect on weak signals, but is reduces strong ones to the steady desired volume level. The volume control tube does not produce negative feedback or other damping effects, but tends to aid the amplification.

Fig. 2 shows the same general circuit, with a simple resistor representing the volume control tube, but with the external biasing resistor omitted. In Fig 2 the usual action of a resistor is embodied, and no volume control results. But a tube is not a usual type of resistor. It is a highly special one, whereby its resistance varies with variations of operation. Thus an increase in plate voltage decreases the plate resistance, while an increase in negative bias, with unchanged plate voltage, increases the plate resistance.

The circuit in Fig. 1 shows the use of a vacuum tube's property of being a resistor of varying resistance values through automatic change of the bias applied to the volume control-coupling tube. While the 227 is hooked up in amplifier fashion, it is neither an amplifier nor a detector, but a resistor of instantaneous sensitivity, that changes its resistance in a manner that the hookup capitalizes.

* * *

[*The circuit operation as described in the foregoing article, and several of the conclusions stated in the text, are utterly fallacious. While more than an elementary knowledge of radio may be necessary to determine the mistakes, many of our readers possess the required technical background. Letters discussing the circuit and the article, and pointing out the mistakes, are invited. Address Technical Editor, Radio World, 145 West 45th Street, New York, N. Y.—Editor.*]

Engineers Again Clash

will be uniform throughout the broadcast band. But if the selection is done at radio frequency, the response will vary throughout the broadcast band. At 1,500 kc. the tuning will be three times as broad as at 550 kc. He further states that it is desirable that the responsive curve be slightly rounded at top, rather than flat or hollow, so broadcast listeners will be able to tune the receiver accurately without the aid of instruments. If the response curve has a hollow at the top, with peaks at the sides, the broadcast listener will tune to one of the peaks, and thus lose the higher frequencies in the side bands which the system was designed to preserve.

Dr. Vreeland also said that an automatic volume control operating by changing the plate voltage is superior to one in which the grid voltage is varied because there is less wave form distortion. In answer Mr. Beers says that wave form distortion occurs both when the control operates on the grid voltage and on the plate voltage.

Dr. Vreeland also states that his automatic volume control maintains a constant audio output level regardless of the degree of modulation of the incoming signal, and yet variations in the sound intensity of the music or speech which are produced by changes in the percent. modulation are rendered with their true relative strength. Mr. Beers challenges this assertion in view of Dr. Vreeland's claim that his automatic control has quick response and slow recovery. Mr. Beers asserts that faithful response is impossible if the volume control has these characteristics.

How to Determine

or Plate

Missing Quantity S

Degree of

By J. E. Anderson a

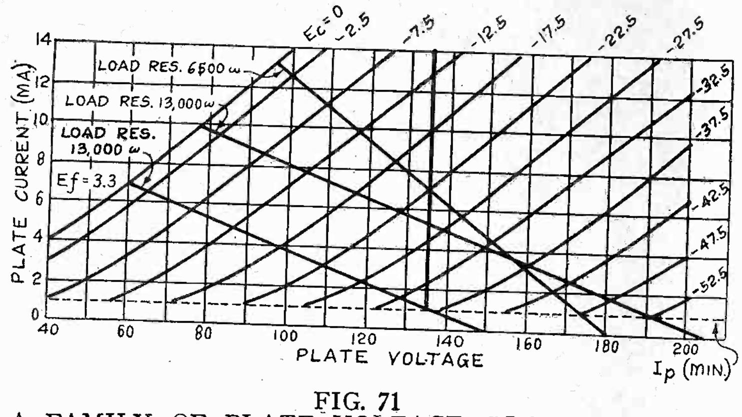


FIG. 71
A FAMILY OF PLATE VOLTAGE, PLATE CURRENT CURVES FOR THE 220 LOW POWER OUTPUT TUBE, WITH THREE LOAD LINES, ONE FOR A RESISTANCE EQUAL TO THE PLATE RESISTANCE AND TWO FOR A RESISTANCE TWICE THE PLATE RESISTANCE.

[The following article is one of the series on "Power Amplifiers," begun in the June 1st issue, and published each week since then. Next week another interesting instalment will be published.—Editor.]

With these limitations in mind we can determine from the curves the voltage amplification, the maximum output voltage, and the necessary bias for any given plate load resistance.

The load line for the .3 meghom resistance crosses the —.5 volt curve at 73 volts on the plate, and it crosses the current limiting line at 165 volts on the plate. The difference between these two plate voltages, namely, 92 volts, is twice the amplitude of the signal voltage drop across the resistor when the tube is loaded up to the limit under the conditions stated. Thus the amplitude of the voltage drop is 46 volts, and the effective value is 32.5 volts.

This change in the output voltage was produced by a change in the grid voltage from —.5 to —5 volts. The difference, 4.5 volts, is twice the signal amplitude impressed on the grid. The amplitude is therefore 2.25 volts. Since this grid voltage change produced an output voltage amplitude of 46, the amplification is 46/2.25, or 20.4.

The necessary bias is half way between the two extreme grid voltages, or it is —.5 plus —2.25, that is, —2.75 volts. In practice it would be made —3 volts, but this would limit the signal amplitude to 2 volts, which in turn would limit the output voltage amplitude to 40.8 volts. Even this voltage is sufficient to load up a 171A power tube.

Some improvement may be effected by increasing the plate load resistance, without increasing the plate battery voltage. When this is done, it is permissible to allow a lower minimum plate current. By increasing the load resistance the amplitude of the input voltage can be increased a little, and at the same time the amplification will be increased. When the higher plate load resistance is used, the wave form distortion will be less, but the frequency distortion will be slightly greater. The high audio notes will not be amplified so much due to the greater effect of the plate to grid capacity of the tube when the load resistance is high.

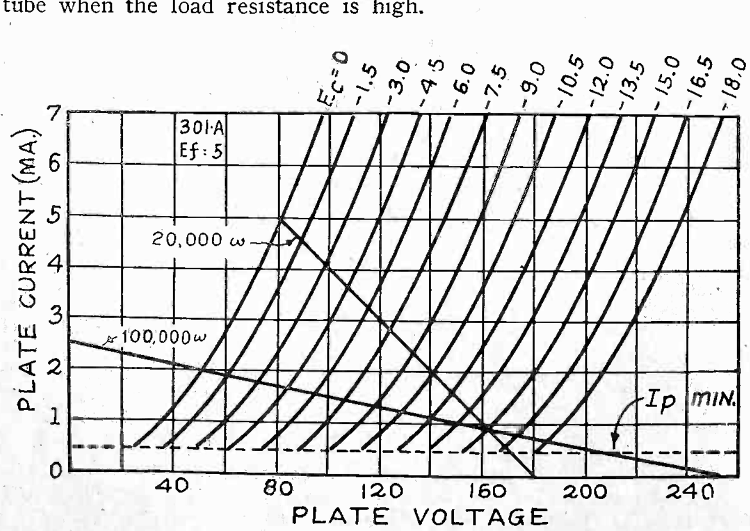


FIG. 72
A FAMILY OF PLATE VOLTAGE, PLATE CURRENT CURVES FOR THE 301A TUBE, WITH TWO LOAD LINES, ONE FOR RESISTANCE COUPLING AND ONE FOR POWER AMPLIFICATION.

If it is desired to obtain a greater output voltage, enough, for example, to load up a 250 power tube, or to minimize the wave form distortion, a much higher plate battery voltage can be used. If the higher plate battery voltage be combined with a higher load resistance, both a very high amplification and a high output can be obtained. Consider the longer dotted line, for example. The battery voltage is 300 volts and the plate load resistance is one-half megohm. This line crosses the —.5 volt bias line at 80 volts and the plate and it crosses the minimum current line at 275 volts. Thus the amplitude of the maximum signal voltage in the plate resistance is 97.5 volts, more than sufficient to load up a 250 power tube.

The grid voltage when the current is minimum is about —8.5 volts, obtained by extending the family of curves. Hence the maximum grid swing is 8 volts, and the amplification is 195/8, or 24.4 times. The necessary grid bias is the signal amplitude on the grid plus the minimum of —.5 volts. That is, the bias should be —4.5 volts. As will be observed from the curves, when the plate battery voltage is 300 volts, the resistance of the plate load is half megohm and the grid bias is 4.5 volts, the effective plate voltage at the operating point is slightly over 180. volts, and the plate current is slightly more than .2 milliampere. Thus it is perfectly safe to operate the tube under these conditions.

While it is not often necessary to operate a resistance coupled amplifier at such high plate voltages, it is sometimes convenient to do so in order to simplify the wiring of the receiver.

While the 220 tube is not capable of delivering much energy to the loudspeaker, it is usually regarded as a power tube because it has been designed for use as the last tube in a receiver employing tubes of the 99 type in the stages ahead.

For those wishing to compute the power output and the amplification a family of plate voltage, plate current curves is reproduced in Fig. 71. Three load lines are drawn across the curves, one for a load resistance of 6,500 ohms, which is approximately equal to the internal plate resistance of the tube, and two load lines for 13,000 ohms, which is about twice the value of the internal resistance.

The 6,500-ohm load line assumes that the plate battery voltage is 180 volts, and the two 13,000-ohm lines assume plate battery voltages of 150 and 205 volts. The minimum permissible plate current is taken as one milliampere, indicated by the dotted line parallel to the plate voltage axis. During operation the grid voltage should not be so great as to force the plate current below this line, and it should at no time approach the line for zero bias closer than one-half volt.

When the battery voltage is 150 volts and the load resistance is 13,000 ohms, the plate current reaches the permissible minimum when the voltage on the plate is 136 volts, at a grid voltage of 36.5 volts. The grid voltage swing is therefore 36 volts, which will produce a swing in the plate load of 74 volts. The corresponding amplitudes are 18 and 37 volts. The amplification is therefore 2.0. The grid bias should be 18.5 volts. The steady plate current at this bias is nearly 4 milliamperes. It should be noted that this is the current when the load is a pure resistance. When the plate current flows through a choke coil of low resistance, the current will be considerably higher. The power output, however, must be calculated on the basis of pure resistance load.

Consider the 180-volt, 6,500-ohm line. It reaches the minimum current line at a grid voltage of —47.5 volts, where the plate voltage is 174 volts. The double amplitude of the grid voltage is therefore 47 volts, while the corresponding plate voltage amplitude is 77 volts. The voltage amplification is 1.64. Thus the amplification is considerably lower with lower plate load resistance.

The grid bias should be one-half 47 plus the .5 allowance made to prevent current, or 24 volts. At this bias the steady plate current is about 6.3 milliamperes. As before, this is the current when the load is a pure resistance, and not when the plate is fed through a choke coil.

GRID BIAS VALUE VOLTAGE

...plied with Good ...ccuracy

...Herman Bernard

The 205 volt, 13,000-ohm line crosses the line of minimum current at a grid voltage of —52.5. This, then, allows a double amplitude grid voltage of 52 volts. The required bias would be 26.5 volts, at which the plate current, under resistance load conditions, is 5.2 milliamperes and the effective plate voltage is 135 volts. This is nearly the conditions on which the tube is rated as a power amplifier. But if such high plate battery voltage is used, the steady plate current will be considerably higher than that indicated by the load line.

And if this high voltage is not used, the power output will be considerably less than the rated power.

When the grid voltage varies from —.5 to —52.5 on the third load line considered, the plate voltage varies from 78 to 192 volts. The double amplitudes, therefore, are 52 and 114 volts, making the voltage amplification 2.2. This compares with 2 for the same load and 150 volts in the plate circuit. Thus the higher plate voltage results in a slightly greater amplification as well as greater output.

The computation of output power from these curves, or from those of any other tube, is easily done. The power is the product of the effective values of plate voltage and the corresponding effective value of the plate current. The peak value of the plate current is one-half the value of the difference between the plate currents at the two grid voltage extremes, and the peak value of the voltage is one half the difference between the corresponding plate voltages. The power is one half of the product of these two peak values.

Let us take the 205-volt, 13,000-ohm line in Fig. 71 as an example. We found that the plate voltage varied between 78 and 192 volts. One half the difference is 57 volts. We also note that the current at —.5 grid is 9.8 milliamperes and that it is 1 milliampere at —52.5 volts on the grid. One half the difference is 4.4 milliamperes. The product of the peak values of current and voltage is 4.4x57, one half of which is 125.4, which is the power output in milliwatts. The rated value is 110 milliwatts. To get an output of 125.4 milliwatts the amplitude of the signal voltage on the grid must be 23.5 volts.

The 301A tube is used frequently as an output tube, and quite often as a voltage amplifier in resistance coupled circuits. Hence a family of plate voltage, plate current curves for this tube is reproduced in Fig. 72. Two load lines are drawn across the family of curves, corresponding to the two functions of the tube. One is for a pure resistance load of 100,000 ohms and a plate battery voltage of 250 volts and the other for a pure resistance load of 20,000 ohms and a plate battery voltage of 180 volts.

We shall assume as before that the signal voltage never approaches the zero bias line closer than one half volt and that the minimum plate current is one half milliampere. For resistance coupling this minimum may be larger than necessary and for loudspeaker load it may be lower than it should. However, it is a good average for illustrative purposes.

The 100,000-ohm line crosses the minimum current line at 208 volts on the plate and a grid bias of 21 volts. It reaches the —.5-volt bias line, not drawn, at a current of 1.9 milliamperes and a plate voltage of 53 volts. Hence a grid voltage change of 20.5 volts produces a change in the voltage across the plate resistor of 208—53=155 volts, making the voltage amplification 7.6. This is very close to the amplification factor of the tube, which is 8.

The power output in this case is of no interest. The grid bias required is one half of 20.5 plus .5, or 10.75 volts. It is seldom necessary to use such high plate battery and grid bias voltages on the tube, for only the 250 tube, when operated at full capacity, needs as great a signal amplitude as the voltage across the plate resistance in this instance, that is, 77.5 volts. That tube requires 84 volts. So if the tube is to be used for feeding this power tube directly the high voltage in the plate circuit of the 301A is needed and at the same time the bias should be about 11 volts. The plate coupling resistance could also be doubled to good effect.

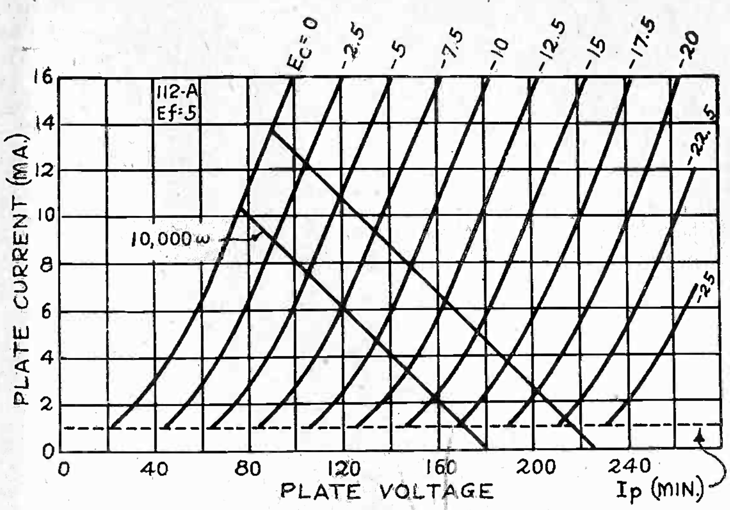


FIG. 73
A FAMILY OF PLATE VOLTAGE, PLATE CURRENT CURVES FOR THE 112A POWER TUBE WITH TWO LOAD LINES 10,000 OHMS, ONE FOR 180 VOLTS IN THE PLATE CIRCUIT AND THE OTHER FOR 225 VOLTS.

Refer now to the 180-volt, 20,000-ohm load line. It crosses the line of minimum current at 170 volts where the grid voltage is —17 volts. The possible voltage swing is 16.5 volts, requiring a bias of 8.75 volts. The maximum current is 4.8 milliamperes and the corresponding minimum plate voltage is 84 volts. Hence we have the power output ⅛ (170—84) (4.8—.5) =46.2 milliwatts. The tube is rated at 55 milliwatts when the plate voltage is 135 volts.

The voltage amplification of the tube is obtained by dividing the double voltage swing, 86 volts in this case, by the double grid voltage amplitude which produces it. This was found to be 16.5 volts. Hence the voltage amplification is 5.2.

The first in the series of tubes which could really be called a power tube was the 112A, for that tube had a maximum undistorted output sufficiently large to operate a loudspeaker with good volume and enjoyable quality, provided the other parts of the circuit did not spoil the quality.

A family of plate voltage, plate current curves for this tube is given in Fig. 73. Two load lines are drawn across the curves, both for 10,000 ohms, which is approximately twice the internal resistance of the tube. One of the lines assumes that the voltage in the plate circuit is 180 volts and the other that it is 225. The minimum current is assumed to be 1 milliampere, indicated as before by a dotted line parallel to the plate voltage axis.

Referring to the 180-volt line in Fig. 73 we note that it crosses the minimum current line at 170 volts, where the grid voltage is —17.5 volts. Now for the sake of simplicity let us assume that the grid voltage may go to just zero, neglecting the effect of the grid current. The line crosses the curve for zero bias at 70 volts on plate, where the plate current is 10.25 milliamperes. We have then for the power ⅛ (170—70) (10.25—1), or 116 milliwatts. The needed bias would be one half of 17.5, or 8.75 volts.

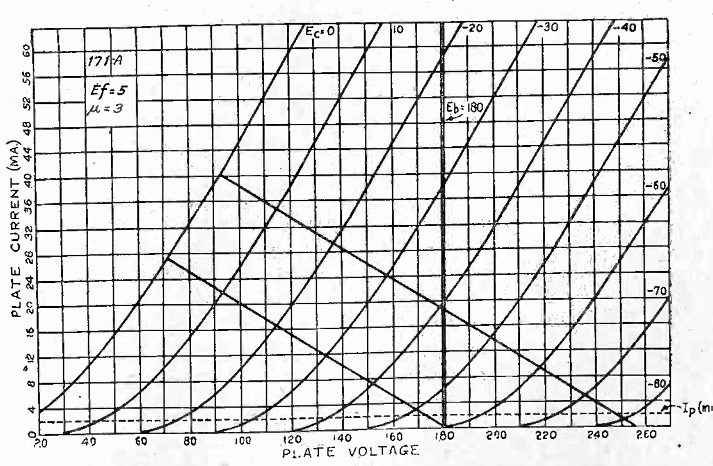


FIG. 74
A FAMILY OF PLATE VOLTAGE, PLATE CURRENT CURVES FOR A 171A POWER TUBES WITH TWO LOAD LINES FOR 4,000 OHMS, ONE WHEN THE VOLTAGE IN THE PLATE CIRCUIT IS 180 VOLTS AND THE OTHER WHEN IT IS 255 VOLTS.

WHAT RESISTANC
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Solution of Common
So Any One Can

By J. I

Tec

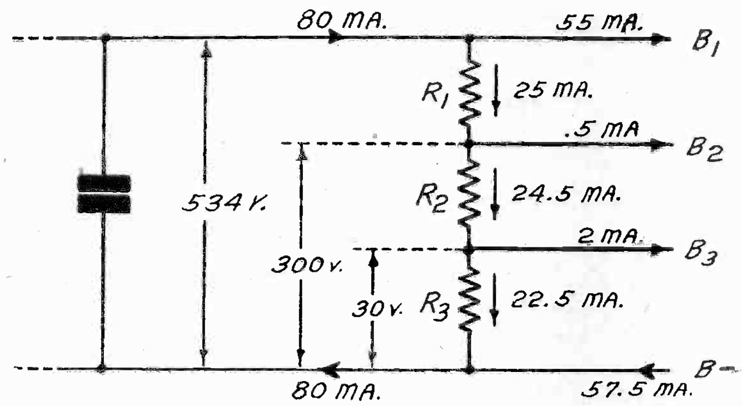

FIG. 1
CIRCUIT ILLUSTRATING THE METHOD OF SOLVING A SIMPLE VOLTAGE DIVIDER PROBLEM.

HARDLY a day passes without some radio fan writing for information on the values of resistors in voltage dividers. A typical question asked is: "I wish to build a B battery eliminator which will give voltages of 45, 90, 135 and 180 volts at the taps. I plan to use this eliminator on different receivers. What should the values of the resistors in the voltage divider be?"

The only answer that can be given to questions of this type is that the resistors should have any values whatever. In answer to a question of this type it is only possible to give the value of one of the resistors, and that value is entirely arbitrary. If a thousand different resistors be placed in a grab bag and a blindfolded persons picks out one of them at random, that will be a correct resistor to use. It may not be the very best value that could be chosen for any particular job, but it is the best value that can be chosen in the light of the information supplied in the question. Moreover, this particular resistance picked out at random can be placed in any desired position in the voltage divider. This position, too, can be selected by the grab bag method.

There is as much definiteness in the question as there is in the following: How fast should an automobile travel to get from somewhere to somewhere else in some time or other. Nobody would think of asking such a question of an automotive engineer and expect to get an answer, but many radio fans don't hesitate to ask indefinite questions and expect definite answers.

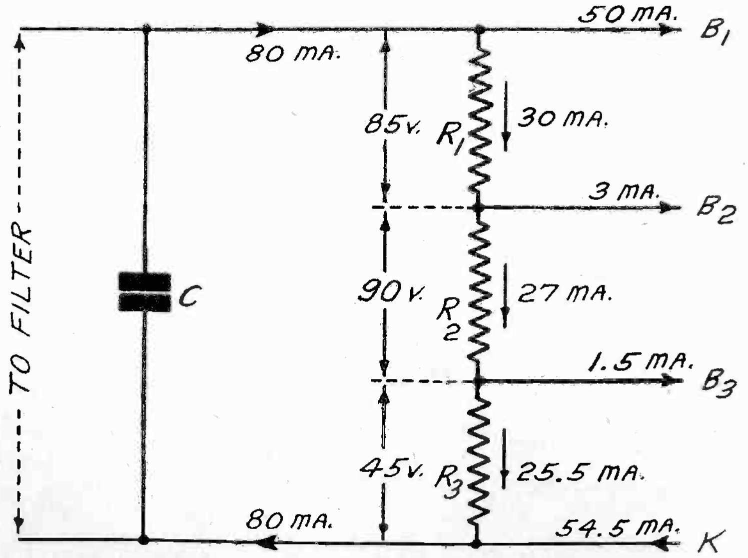

FIG. 2
THE SOLUTION OF A VOLTAGE DIVIDER PROBLEM SIMILAR TO THAT IN FIG. 1.

It is not sufficient to know the voltage between any two taps on the voltage divider. It is also necessary to know the current flowing in the resistance between the two taps. Since this current will not be the same for any two sets, or for any two different adjustments of the various voltages in the same set, it is obviously impossible to determine the value of any one resistor, for the value will not be the same under different conditions.

Any one of the resistances in the voltage divider can be chosen at random, for it is perfectly arbitrary. But when that resistance has been chosen, the values of the others must bear certain relationships to this one, and this relationship depends on the current distribution in the voltage divider network as well as on the voltage distribution.

In any case the product of the resistance between two voltage taps and the current flowing in that resistance is equal to the voltage between the two taps, the current being expressed in amperes and the resistance in ohms. This is simply Ohm's law, which is general.

Factors Governing the Choice

The choice of the arbitrary resistance in the voltage divider depends on the desired value of the bleeder current. If this current is made large, that is, if the arbitrary resistance is made small, the problem is much simplified, for approximate solutions may be given which are correct for all practical purposes. For example, if the bleeder current is of the order of 50 milliamperes and the currents taken from some of the taps is of the order of one milliampere, no great error can be committed if the small currents are neglected entirely and the assumption made that the bleeder current alone flows through certain sections of the voltage divider.

Of course the bleeder current cannot be chosen too large, for if it is the output voltage will be low, a heavy drain will be imposed on the rectifier tube and the filter chokes and the operation of the receiver will be unsatisfactory.

We shall solve a few typical voltage divider problems to illustrate the method of procedure in arriving at reasonable resistance values.

Fig. 1 is a simple case. It is assumed that the maximum current which can be drawn from the rectifier without overloading the filter chokes is 80 milliamperes. The rectifier tube imposes no additional limitations, for any one of the common rectifiers will handle more than 80 milliamperes.

It is also assumed that a single 250 power tube is connected to the highest voltage tap and that this tube is operated at the maximum plate and grid voltages. Further, it is assumed that two AC screen grid tubes are operated in resistance coupled circuits with 300 volts in the plate circuits and 30 volts on the screens, the resistances in the plate circuits being 250,000 ohms. The grid bias values for all the tubes are supposed to be provided for by drops in individual resistances.

Under these conditions the current distribution is approximately as follows: 55 milliamperes to tap B1, .5 milliampere to tap B2, 2 milliamperes to tap B3. Therefore the total current taken by the amplifier is 57.5 milliamperes. Since the current drawn from the filter cannot exceed 80 milliamperes, the bleeder current may be 22.5 milliamperes, and that value is selected. Ordinarily this would be a very small bleeder current, but it is large compared with the currents taken from the two taps B2 and B3. Hence it is large enough.

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Through the lowest resistance R3 the bleeder current alone flows. Through R2 the current is 24.5 milliamperes, since the current diverted into Tap B3 also flows in this section. In the upper resistance R1 the current is 25 milliamperes, since that resistor carries the current in R2 plus the current diverted by tap B2. We now have sufficient information for solving the problem completely.

The voltage drop in R1 is 534 less 300 volts, or 234 volts. Since the current in this section is 25 milliamperes, the value of R1 must be 234/.025 ohms, or 9,360 ohms. The voltage drop in R2 is 300 less 30, or 270 volts, and since the current is 24.5 milliamperes, the resistance of R2 must be 270/.0245, or 11,020 ohms. The drop in R3 is 30 volts and the current is 22.5 milliamperes. Hence the value of R3 is 30/.0225, or 1,333 ohms. It is the resistance of R3 which was selected arbitrarily in this case and it was done when the bleeder current was selected as 22.5 milliamperes. The values of the other two followed as a consequence of this selection and of the current and voltage distributions.

Fig. 2 illustrates a similar problem. To the B1 tap plate return leads of two 171A tubes and those of other tubes drawing a total of 50 milliamperes. Tap B2 draws only 3 milliamperes and B3 only half as much as that. B2 supplies one tube at a voltage of 135 and B3 serves a detector and a radio frequency amplifier at 45 volts.

As in the preceding example, it is assumed that the maximum current that can be drawn from the filter and rectifier is 80 milliamperes. Since the total current drawn by the tubes is 54.5 milliamperes, 25.5 milliamperes can be used for bleeder current.

Grid bias voltages are supposed to be taken from voltage drops in the individual stages. Since the power tubes require a bias of 40 volts and a plate voltage of 180, the total voltage drop across the voltage divider must be 220 volts. Hence we have the three voltages 45, 90 and 85 volts across the resistors R3, R2 and R1, respectively.

Both the voltage drop and the current in each resistance section are now known and to find the resistance values it is only necessary to apply Ohm's law. The resistances are: R1, 2,833 ohms; R2, 3,333 ohms, and R3, 1,765 ohms.

More Complex Case

In Fig. 3 is a slightly more complex example, in which the bias is derived from voltage drops in the voltage divider. K is the return from the cathodes, ordinarily labeled B minus. The entire current drawn by the set returns to the voltage divider through this lead, and this current amounts to 47 milliampes. The distribution of this current is 32 milliamperes to B1, to which the plate return of a 245 tube is connected, 10 milliamperes to B2, to which the plate returns of two 224 screen grid tubes and the plate return of a detector tube are connected. B3 takes 5 milliamperes, the screen grid current of the two 224 tubes and the plate current of an audio amplifier operated at a plate voltage of 75 volts.

The total drop across the voltage divider is 300 volts, divided by K so that 250 volts are on the plate of the lower tube and 50 volts on the grid. A bias of 1.5 volts is allowed for the screen grid tubes and the audio amplifier. The detector grid is returned to K so that no extra voltage tap is required for this. The voltage drops in the various resistance sections are as indicated.

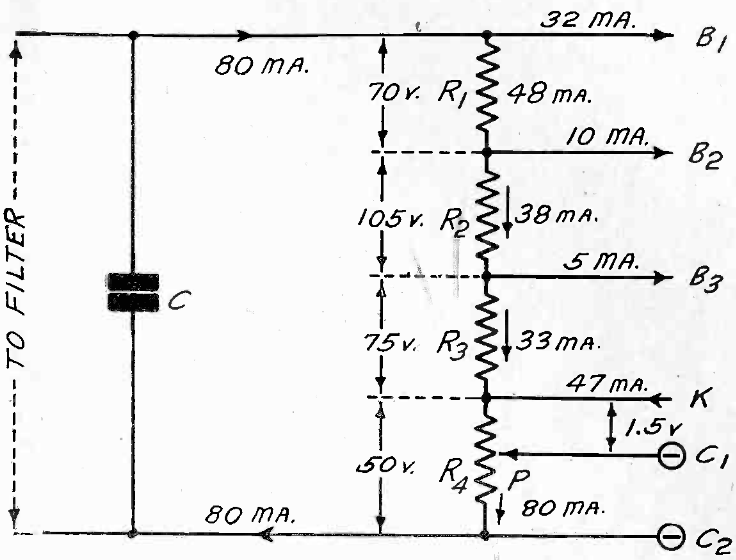

FIG. 3

WHEN DETERMINING THE RESISTORS TO BE USED IN A VOLTAGE DIVIDER IT IS NECESSARY TO REMEMBER THAT THE PLATE CURRENTS RETURN TO THE VOLTAGE DIVIDER WHERE THE CATHODES ARE CONNECTED.

As in the two previous cases it is assumed that the total current delivered by the rectifier-filter is 80 milliamperes. Since the set draws a total of 47 milliamperes, the bleeder current is 33 milliamperes. This value is consistent with the currents drawn by the voltage taps B2 and B3. It is large enough so that small changes in the currents drawn by these two taps will not change the voltage distribution appreciably.

The value of R3 is fixed by the assumption that the bleeder current is 33 milliamperes and by the condition that the voltage drop in it is 75 volts. We have R3 equals 75/.033, or 2,273 ohms. R2 draws 5 milliamperes more than R3, since B3 diverts this amount, and as the voltage drop between B2 and B3 is 105 volts, R2 equals 105/.0438, or 2,763 ohms.

The drop in R1 is 70 volts and the current through it is 48 milliamperes. Therefore R1 equals 70/.048, or 1,458 ohms.

(*Continued on next page*)

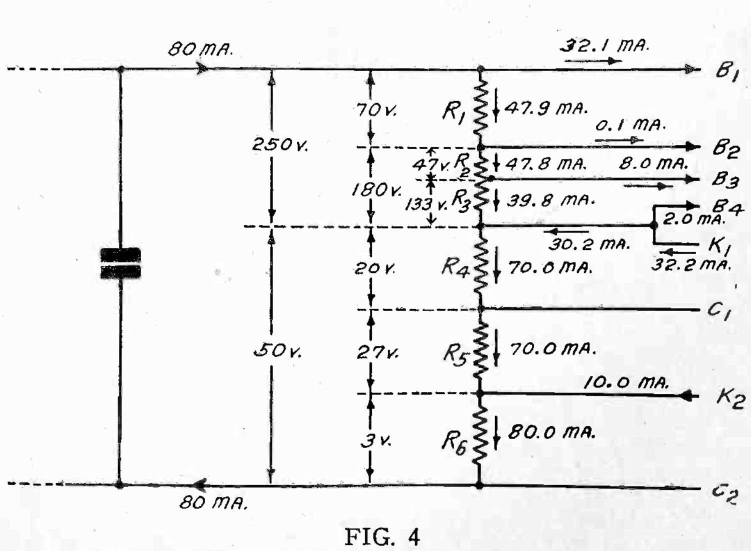

FIG. 4

THIS ILLUSTRATES THE SOLUTION OF A VOLTAGE DIVIDER PROBLEM IN WHICH THE CATHODES ARE CONNECTED TO TWO DIFFERENT POINTS.

AN AUDIO METER

Monochord Measures Useful Frequencies

THE August issue of "Proceedings of the Institute of Radio Engineers" is replete with papers of technical and general interest.

Carl R. Englund and Arthur B. Crawford, of the Bell Laboratories, contribute a paper on "The Mutual Impedance Between Adjacent Antennas." The simple theory for the computation of reflecting or multibranch antenna systems is sketched, which is followed by a thorough discussion of the experimental procedure for measuring the mutual impedance between two antennas.

K. Kruger and H. Plendl, Division for Radio and Electrical Engineering, German Experimental Institute for Aeronautics, Berlin, Germany, contribute a paper on "The Propagation of Low Power Short Waves in the 1000-Kilometer Range." The paper is a report of a series of experiments carried out between two ground stations, and between an airplane and a ground station, to determine whether it is possible to obtain with relatively low power reliable short wave communication over distances of 500 kilometers or more. It contains a complete list of the equipment used, a description of the procedure of the experiments and an account of the results obtained.

J. C. Schelleng, Bell Telephone Laboratories, New York, contributes "Further Note on the Ionization in the Upper Atmosphere." It is mathematical in nature.

"An Electromagnetic Monochord for the Measurement of Audio Frequencies" is the title of a short paper contributed by J. H. Owen Harries, Frinton-on-Sea, Essex, England. The monochord is a steel wire stretched between two rigid supports, like a piano string, and set into vibration by an electromagnet, or loudspeaker unit. If the string is excited by a current of a frequency corresponding to one of the harmonics of natural vibration of the string, then the string will vibrate vigorously. A standing wave-pattern will appear on the string with one more node than the number of harmonics of vibration, counting the ends of the string as nodes. The monochord can be calibrated at its fundamental against a known frequency, such as that of a standard tuning form. Harmonic frequencies are then known by counting the nodes.

The principle of the method and the instrument will be appreciated by students of physics who have performed Melde's experiment in sound. The steel wire vibrates in the same way as the string in this classic experiment.

Mr. Harries gives complete instructions on how to make the instrument, as well as how to use it. The cost of the instrument is negligible, and any radio experimenter can make it for himself after having read the article.

A steel wire 5 feet long and 1/16 inch in diameter, suitably stretched, gives a fundamental of approximately 32 cycles, and it can be used to measure the first eight harmonics, that is, up to a frequency of middle C. A wire 16 inches in length and 1/32 inch in diameter, when suitably stretched, has a fundamental of 261 cycles, and this wire can be used for measuring the first 18 harmonics, or up to 4,698 cycles.

Sylvan Harris, Engineering Laboratory, Kolster Radio Corporation, Newark, N. J., shows in a brief paper how to get an empirical equation for the grid current, grid voltage characteristic of a detector tube, and how, by differentiation, to obtain the detection coefficient. The equation yields results which agree closely with experimental data for small values of grid current. The equation is of the form $(ig - io) = a(eg)^m$, where ig is the grid current, eg the grid voltage, and io, ^{m}, and a are constants to be determined from three different values of grid current and the equation.

Dr. John H. Dellinger, formerly chief engineer for the Federal Radio Commission and now again chief of the radio laboratory of the Bureau of Standards, discusses "Engineering Aspects of the Work of the Federal Radio Commission." He recounts the many technical difficulties confronting the Commission, both in the broadcast band of frequencies and in the higher frequency bands.

Dr. Lewis M. Hull, Radio Frequency Laboratories, Inc., Boonton, N. J., deals with "Some Characteristics of Modern Radio Receivers and Their Relation to Broadcast Regulation." These characteristics are divided into five classes, as follows: (1) discrimination between channels; (2) discrimination within channels; (3) uniformity of reception in all channels; (4) uniformity of reception within a channel; (5) range of reception. The conclusions are based on experimental studies of a large number of broadcast receivers which have been sold commercially, and others which will be sold during the present year.

VOLTAGE DIVIDER PROBLEM SOLVED

(*Continued from preceding page*)

The total drop in R4 is 50 volts, the required bias on the power tube. The current in this resistor is the total current drawn by the circuit because the current that had been diverted by the tubes returns to the voltage divider at the junction of R3 and R4 and thus joins to bleeder current. Hence the current in R4 is 80 milliamperes. Therefore R4 equals 50/.08, or 625 ohms.

No current flows in the lead to C1. Hence the position of P, the slider, is put at 1.5 volts below K as determined by the fact that the current is 80 milliamperes. Since the drop is to be 1.5 volts the position of P is 1.5/.08, or 18.75 ohms down from K. This completes the solution of this problem. If it is desirable to add another grid voltage tap on R4, its position can be determined in the same way as that of P. The current will not change except as the altered bias will change the plate current. This change is negligible.

Fig. 4 illustrates a still more complex case, arising in certain AC operated receivers. In this all the cathodes are not returned to the same point but to two different places on the voltage divider. One cathode return, K1, is at the same point as one of the plate returns, namely, B4. The current and voltage distributions in this case were taken from an actual example. A point of interest in this case is that 2 milliamperes flow from the voltage divider to B4 and that 32.1 milliamperes flow from K1 in the opposite direction. The algebraic sum of these two currents is 30.2 milliamperes in the direction of the voltage divider. The 32.2 milliamperes returned to the voltage divider at K1 are the plate currents diverted at B1 and B2. The 2 milliamperes flowing to B4 ultimately appear at K2, where also the current diverted by B3 returns to the voltage divider.

While this voltage divider appears to be very complex, it was adopted in order to simplify the receiver design, as well as to stabilize the receiver served by the B supply.

The resistors in Fig. 4 have the following values: R1, 1,461 ohms; R2, 983 ohms; R3, 3,342 ohms; R4, 286 ohms; R5, 386 ohms, and R6, 37.5 ohms.

The procedure to follow in solving any voltage divider problem is as follows:

Determine the total current that the receiver or amplifier will require when operating normally. Select a rectifier and filter which will handle considerably more than this current so that there will be sufficient current for the bleeder. Determine the total voltage drop across the voltage divider. Draw a schematic of the voltage divider providing taps for all the different plate and grid voltages as well as one or more for cathode returns. Determine the voltage drops required across the resistor sections to provide the necessary plate and grid voltages for all the tubes. The plate voltages are measured from the cathode connection, K, for the tube or tubes in question.

Next determine what the current drawn by each plate tap is. This is done by taking the normal plate currents for the plate and grid voltages in question and adding up the currents required by all the tubes on any tap. Where there is only one K connection as much current should flow to the voltage divider through this connection as is diverted by all the plate taps. When there are two or more cathode taps the sum of the currents flowing to the voltage divider through the K connections should equal the sum of all the currents diverted by the plate connections.

When the bleeder current is known, and its value may be selected almost at will, and when the currents flowing in all the taps are known, the current in each sectoin of the voltage divider can be computed by simple addition or subtraction. Similarly the voltage drop in each section can be determined. And when both the current and the voltage drop in any resistor is known, the value of the resistance can be determined by the application of Ohm's law. The voltage drop in volts is simply divided by the current expressed in amperes.

There is no voltage divider problem so complex that it cannot be solved in a few minutes in this manner. There is no voltage divider problem so simple that it can be solved at all unless the current flowing is known.

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Space Charge Detector

WHAT is the purpose of using a screen grid tube as a space charge detector?—I. H.

The object is to reduce the space charge, increase the electron flow from filament to plate, and to increase the mutual conductance. It is useful only in specially-designed circuits.

* * *

The Isolating Condenser

IS the value of the coupling condenser in a resistance-coupled audio amplifier critical?—H. G.

The condenser is not a coupling condenser, but an isolating condenser, to make possible the use of the circuit. With the condenser out, the grid of the succeeding tube would have the positive plate potential of the preceding tube applied to it. The grid of course should be negative. The condenser isolates the grid from the direct current and voltage in the preceding plate circuit. The value of the condenser is not critical. It is well to have the product of the condenser in microfarads and the leak in megohms equal the number .02 as a minimum. Thus with a .01 mfd. condenser a leak of 2 meg. would be suitable. Higher values of leak may be used, or higher values of capacity, if instability does not result.

* * *

Key to Negative Bias

IS the negative grid bias determined on the basis of the voltage effective on the plate, or the applied plate voltage? The drop in the plate load equals the difference, of course, but in some forms of coupling, as resistance and impedance, this drop may be high.—O. H. T.

The total voltage in the plate circuit is the determining factor. This is applied voltage. The DC resistance of the load on the plate circuit may be considered merely as an increase in the plate resistance, just as if the tube were geometrically constructed with a higher plate resistance at a given negative bias and positive plate voltage. In transformer-coupled audio circuits, and in transformer-coupled radio frequency circuits particularly, there is little to be gained in considering the difference between applied and effective voltages, as the drop is small. But in resistance coupling it is not at all unusual to drop half the applied voltage in the plate load, the other half in the plate resistance. This equal drop takes place when the plate resistance and the load resistance are equal. The DC resistance is meant in the foregoing discussion. The drop due to signal voltage, which is an impedance factor, is the same for equal impedances, whether the impedance is a coil or a "pure" resistor. There are controversies surrounding both of foregoing statements (regarding bias and effect of the plate load), but the replies made herein are deemed uncontrovertible. For the equal-drop theory, see the August 10th issue of RADIO WORLD, page 7, where J. E. Anderson answered a critic. Mr. Anderson had stated that Prof. John H. Morecroft, in his book for novices, "Elements of Radio Communication," had fallen into a traditional error in rating the AC drops as being different in different types of loads, and Mr. Anderson's critic sided with the Professor.

* * *

Electrons Not Everything

ARE electrons the basis of all electricity?—H. F.

No.

* * *

Pointers on Volume Controls

IS there any particular preference for a volume control? I should like some pointers on volume controls for battery-operated and AC circuits.—T. D. S.

The volume control should give adequate control of volume without incurring any sacrifice that the receiver is not able to stand. For instance, a variable resistor in the series with the loudspeaker would not be the best volume control by any means, as it affords no method of correcting overload in any of the stages. The general practice therefore is to put the volume control ahead of the detector. It may be an adjustable antenna coil, if the receiver will not oscillate at loose coupling of the coil. There will be a slight detuning effect, so this method is serviceable only in circuits that have the antenna coil separately tuned from the others, or, if ganged in the tuning, where a trimmer on the front panel is additional to the volume control. By the adjustable antenna coil method the selectivity is increased as the volume is decreased, a good plan, because the most trouble with poor selectivity arises where strong signals conflict with weak ones of some other station. A variable resistor is the plate lead of radio frequency tubes is a method that decreases selectivity a little. So does the variable resistor across an antenna fixed primary, or a resistor antenna input. A radio frequency choke coil with a small condenser in series, as an input to a so-called dummy tube, is another good method. About .0001 mfd. is usually sufficient. There should be at least three tuned stages following. For screen grid tubes, a potentiometer across screen B voltage, with a condenser of at least .01 mfd. from screen grid to ground or A plus, and with the slider to screen grid, constitutes a good volume control. This, like the others, is for battery or AC operation. For battery receivers alone a variable resistor in series with a filament leg of the first RF tube, or the first two RF tubes, is good. But in AC sets the filament or heater voltages should not be changed for volume control. Where grid bias detection is use,d with high value of bias and high plate voltage, a potentiometer across the secondary of the first audio transformer is sometimes a good makeshift volume control. Varying the grid bias, by using a potentiometer in the common plate and grid return circuit of AC tubes, is another good method but a bypass condenser is necessary here, too.

* * *

ABC Compact for Push-Pull

REGARDING the compact ABC supply, described in the August 10th and 17th issues, for use with heater type tubes (227 and 224) and 245 audio output, can this be used with the push-pull last-stage audio? What voltage will be obtained?—J. I.

Yes, it can be used that way. A 1,500-ohm 10-watt resistor should be placed across the biasing section, from point (4) to ground. No other changes are necessary. The voltage is 300 volts DC at 80 milliamperes, apportioned approximately as follows: 250 volts for the last audio, 50 volts for the maximum bias. The intermediate biases are obtained from taps in the biasing section. See page 5, column 2, of the August 10th issue, for a discussion of the 1,500-ohm resistor. The obtainable voltages were fully discussed in the two issues, August 10th and August 17th.

* * *

Battery Set Can Equal AC

CAN a wholly satisfactory receiver, battery-powered, be constructed so that it will give performance on a par with AC receivers?—H. J. F.

Certainly. The general rule is that the same results are obtainable more economically, from an operating viewpoint, from an AC receiver, but that the results can be duplicated in any instance by use of batteries. A fine combination is a two-stage screen grid radio amplifier, with grid biased detector, and two stages of transformer-coupled audio, the last stage push-pull. This makes six tubes. The output may be two 171As, for a dynamic speaker, or, if a magnetic speaker is used, two 112As will do nicely, and will draw much less plate current, as B battery wattage consumption is the principal economic consideration.

* * *

Would Switch to AC Now

MY A battery is about all shot and I am therefore considering building an AC receiver. I would like to use few tubes, but obtain good results, unless by using many tubes most exceptional results absolutely can be obtained.—H. G. F.

You may reconstruct your present receiver, or you may build an entirely new receiver. If you desire to use only a few tubes, for excellent results, you may build the 4-tube screen grid Diamond of the Air, AC model. This requires the use of a B supply, and the National Velvet-B, type 3580, is suggested. This works the receiver, with a 171 or 171A output tube. In addition a filament transformer will be required, to heat the 224, two 227 tubes, and power tube. For superlative sensitivity you could build a multi-tube receiver, such as the MB29, which has four tuned circuits, using four 224 tubes, and a 227 power detector. You would have to provide filament and plate voltages as well as audio channel additionally, for the MB29, but these may well be in a push-pull power amplifier.

List of Stations by *Frequency* With Wavelength *Conversion*

[REVISED AND CORRECTED FROM THE RECORDS OF THE FEDERAL RADIO COMMISSION, TO NOON, AUGUST 14TH]

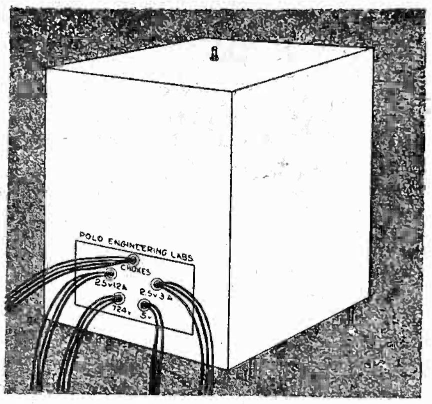
* *Canadian shared*
** *Canadian exclusive*
S-*Studio*

550 KC, 545.1 METERS
WEAN-Providence, R. I.
WGR-Buffalo, N. Y.
WEAO-Columbus, O.
WKRC-Cincinnati, O.
KFUO-Clayton, Mo.
S-St. Louis, Mo.
KSD-St. Louis, Mo.
KFDY-Brookings, S. D.
KFYR-Mismark, N. D.
KTAB-Oakland, Calif.
560 KC, 535.4 METERS
WDGY-Minneapolis, Minn.
WHDI-Minneapolis, Minn.
WIOD-Miami, Fla.
WLIT-Philadelphia
WFI-Philadelphia
KFDM-Beaumont, Tex.
WNOX-Knoxville, Tenn.
WOI-Ames, Iowa
KFEQ-St. Joseph, Mo.
KOAC-Corvallis, Ore.
KLZ-Dupont, Colo.
570 KC, 526 METERS
WNYC-New York, N. Y.
WMCA-Hoboken, N. J.
S-New York, N. Y.
WSYR-Syracuse, N. Y.
WMAC-Cazenovia, N. Y.
WSMK-Dayton, O.
WKBN-Youngstown, O.
WWNC-Asheville, N. C.
KGKO-Wichita Falls, Tex.
WNAX-Yankton, S. D.
WPCC-Chicago, Ill.
WIBO-Desplaines, Ill.
S-Chicago, Ill.
KUOM-Missoula, Mont.
KXA-Seattle, Wash.
KMTR-Hollywood, Cal.
***580 KC, 516.9 METERS**
WTAG-Worcester, Mass.
WOBU-Charleston, W. Va.
WSAZ-Huntington, W. Va.
KGFX-Pierre, S. D.
KSAC-Manhattan, Kans.
WSUI-Iowa City, Iowa
590 KC, 508.2 METERS
WEEI-N. Weymouth, Mass.
WEMC-Berrien Spgs.,Mich.
WCAJ-Lincoln, Nebr.
WOW-Omaha, Nebr.
KHQ-Spokane, Wash.
***600 KC, 499.7 METERS**
WTIC-Hartford, Conn.
WCAC-Storrs, Conn.
WCAO-Baltimore, Md.
WREC-Whitehaven, Tenn.
WOAN-Lawrenceburg,Tenn
WEBW-Beloit, Wis.
KFSD-San Diego, Calif.
KWYO-Laramie, Wyo.
610 KC, 491.5 METERS
WFAN-Philadelphia
WIP-Philadelphia
WDAF-Kansas City, Mo.
WOQ-Kansas City, Mo.
KFRC-San Francisco
620 KC, 483.6 METERS
WLBZ-Bangor, Maine
WDBO-Orlando, Fla.
WDAE-Tampa, Fla.
WJAY-Cleveland, O.
WTMJ-Brookfield, Wis.
KGW-Portland, Ore.
KFAD-Phoenix, Ariz.
***630 KC, 475.9 METERS**
WMAL-Washington, D. C.
WOS-Jefferson City, Mo.
KFRU-Columbia, Mo.
WGBF-Evansville, Ind.
640 KC, 468.5 METERS
WAIU-Columbus, O.
KFI-Los Angeles, Calif.
650 KC, 461.3 METERS
WSM-Nashville, Tenn.
660 KC, 454.3 METERS
WEAF-Bellmore, N. Y.
S-New York City
WAAW-Omaha, Nebr.
670 KC, 447.5 METERS
WMAQ-Addison, Ill.
S-Chicago, Ill.
680 KC, 440.9 METERS
WPTF-Raleigh, N. C.
KPO-San Francisco
****690 KC, 434.5 METERS**
700 KC, 428.3 METERS
WLW-Mason, Ohio
710 KC, 422.3 METERS
WOR-Kearny, N. J.
S-Newark, N. J.
KFVD-Culver City, Calif.
720 KC, 413 METERS
WGN-WLIB-Elgin, Ill.
S-Chicago, Ill.
****730 KC, 413 METERS**
740 KC, 405.2 METERS
WSB-Atlanta, Ga.
KMMJ-Clay Center, Nebr.
750 KC, 399.8 METERS
WJR-Silver Lake, Mich.
S-Detroit, Mich.
760 KC, 394.5 METERS
WJZ-Boundbrook, N. J.
S-New York, N. Y.
WEW-St. Louis, Mo.
KVI-Des Moines, Wash.
S-Tacoma
770 KC, 389.4 METERS
KFAB-Lincoln, Nebr.
WBBM-WJBT-Glenview,
S-Chicago, Ill.
***780 KC, 384.4 METERS**
WBSO-Wellesley, Mass.
WTAR-WPOR-Norfolk, Va.
WMC-Memphis, Tenn.
KELW-Burbank, Calif.
KTM-Santa Monica, Cal.
S-Los Angeles, Calif.
790 KC, 379.5 METERS
WGY-Schenectady, N. Y.
KGO-Oakland, Calif.
800 KC, 374.8 METERS
WBAP-Ft. Forth, Tex.
KTHS-Hot Springs Nat'l
Park, Ark.
810 KC, 370.2 METERS
WPCH-Hoboken, N. J.
S-New York, N. Y.
WCCO—Anoka, Minn.
S-Minneapolis.
820 KC, 365.6 METERS
WHAS-Jeffersontown, Ky.
S-Louisville, Ky.
830 KC, 361.2 METERS
WHDH-Gloucester, Mass.
KOA-Denver, Colo.
****840 KC, 356.9 METERS**
850 KC, 352.7 METERS
KWKH-Kennonwood, La.
WWL-New Orleans, La.
860 KC, 348.6 METERS
WABC-WBOQ-N. Y. City
KFQZ-Hollywood, Calif.
870 KC, 344.6 METERS
WLS-Crete, Ill.
S-Chicago, Ill.
WENR-WBCN-Chicago
***880 KC, 340.7 METERS**
WQAN-Scranton, Pa.
WGBI-Scranton, Pa.
WCOC-Columbus, Miss.
KLX-Oakland, Calif.
KPOF-Denver, Colo.
KFKA-Greeley, Colo.
***890 KC, 336.9 METERS**
WJAR-Providence, R. I.
WKAQ-San Juan, P. R.
WMMN-Fairmont, W. Va.
WMAZ-Macon, Ga.
WGST-Atlanta, Ga.
KGJF-Little Rock, Ark
WILL-Urbana, Ill.
KUSD-Vermillion, S. D.
KFNF-Shenandoah, Iowa
900 KC, 331.1 METERS
WFBL-Syracuse, N. Y.
WMAK-Martinsville, N. Y.
S-Buffalo, N. Y.
WKY-Okla. City, Okla.
WFLA-WSUN-
Clearwater, Fla.
WLBL-Stevens Point, Wis.
KHJ-Los Angeles, Calif.
KSEI-Pocatello, Idaho
KGBU-Ketchikan, Alaska
****910 KC, 329.5 METERS**
920 KC, 325.9 METERS
WWJ-Detroit, Mich.
KPRC-Houston, Tex.
WAAF-Chicago, Ill.
KOMO-Seattle, Wash.
***930 KC, 322.4 METERS**
WIBG-Elkins Park, Pa.
WDBJ-Roanoke, Va.
WBRC-Birmingham, Ala.
KGBZ-York, Nebr.
KMA-Shenandoth, Iowa
KFWM-Oakland, Calif.
KFWI-San Francisco
940 KC, 319.0 METERS
WCSH-Portland, Maine
WFIW-Hopkinsville, Ky.
WHA-Madison, Wis.
KOIN-Sylvan, Ore.
S-Portland, Ore.
KGU-Honolulu, T. H.
KFEL-Denver, Colo.
KFXF-Denver, Colo.
950 KC, 315.6 METERS
WRC-Washington, D. C.
KMBC-Independence, Mo.
WHB-Kansas City, Mo.
KFWB-Hollywood, Calif.
KPSN-Pasadena, Calif.
KGHL-Billings, Mont.
****960 KC, 312.3 METERS**
970 KC, 309.1 METERS
WCFL-Chicago, Ill.
KJR-Seattle, Wash.
980 KC, 305.9 METERS
KDKA-Wilkins Township.
S-Pittsburgh, Pa.
990 KC, 302.8 METERS
WBZ-E. Springfield, Mass.
S-Boston, Mass.
WBZA-Boston, Mass.
1000 KC, 299.8 METERS
WHO-Des Moines, Iowa
WOC-Davenport, Iowa
KPLA-Los Angeles, Calif.
***1010 KC, 296.9 METERS**
WQAO-WPAP-
Cliffside, N. J.
S-New York, N. Y.
WHN-New York, N. Y.
WRNY-Coytesville, N. J.
S-New York, N. Y.
KGGF-Picher, Okla.
WNAD-Norman, Okla.
KQW-San Jose, Calif.
1020 KC, 293.9 METERS
WRAX-Philadelphia.
KYW-KFKX-Chicago.
KYWA-Chicago.
****1030 KC, 291.2 METERS**
1040 KC, 288.3 METERS
WKEN-Grand Island, N.Y.
S-Buffalo, N. Y.
WKAR-E. Lansing, Mich.
WFAA-Dallas, Tex.
KRLD-Dallas, Tex.
1050 KC, 285.5 METERS
KFKB-Milford, Kans.
KNX-Los Angeles, Calif.
S-Hollywood, Calif.
1060 KC, 282.8 METERS
WBAL-Glen Morris, Md.
S-Baltimore, Md.
WTIC-Avon, Conn.
WJAG-Norfolk, Nebr.
KWJJ-Portland, Ore.
1070 KC, 280.2 METERS
WAAT-Jersey City, N. J.
WTAM-Cleveland, Ohio
WEAR-Cleveland, Ohio
WCAZ-Carthage, Ill.
WDZ-Tuscola, Ill.
KJBS-San Francisco
1080 KC, 277.6 METERS
WBT-Charlotte, N. C.
WCBD-Zion, Ill.
WMBI-Chicago, Ill.
1090 KC, 275.1 METERS
KMOX-KFOA-Kirkwood
S-St. Louis, Mo.
1100 KC, 272.6 METERS
WPG-Atlantic City, N. J.
WLWL-Kearny, N. J.
S-New York, N. Y.
KGDM-Stockton, Calif.
1110 KC, 270.1 METERS
WRVA-Richmond, Va.
KSOO-Sioux Falls, S. D.
***1120 KC, 267.7 METERS**
WDEL-Wilmington, Del.
WCOA-Pensacola, Fla.
WTAW-College Sta., Tex.
KUT-Austin, Tex.
WISN-Milwaukee, Wis.
WHAD-Milwaukee, Wis.
KFSG-Los Angeles, Calif.
KRSC-Seattle, Wash.
1130 KC, 265.3 METERS
WJJD-Mooseheart, Ill.
WOV-Secaucus, N. J.
S-New York, N. Y.
KSL-Salt Lake City, Utah.
1140 KC, 263 METERS
WAPI-Birmingham, Ala.
KVOO-Tulsa, Okla.
1150 KC, 260.7 METERS
WHAM-Victor Township
S-Rochester, N. Y.
1160 KC, 258.5 METERS
WWVA-Wheeling, W. Va.
WOWO-Ft. Wayne, Ind.
1170 KC, 256.3 METERS
WCAU-Byberry, Pa.
S-Philadelphia, Pa.
KTNT-Muscatine, Iowa
KEJK-Beverly Hills, Calif.
1180 KC, 254.1 METERS
WDGY-Minneapolis, Minn.
WHDI-Minneapolis, Minn.
WGBS-Astoria, L. I.
S-New York City.
KEX-Portland, Ore.
KOB-State College, N. M.
1190 KC, 252 METERS
WICC-Easton, Conn.
S-Bridgeport, Conn.
WOAI-San Antonio, Tex.
***1200 KC, 249.9 METERS**
WABI-Bangor, Maine.
WNBX-Springfield, Vt.
WEPS-Gloucester, Mass.
WORC-Auburn, Mass.
WIBX-Utica, N. Y.
KGW-Stockton, Calif.
WHBC-Canton, Ohio.
WLAP-Louisville, Ky.
WLBG-Ettrick, Va.
WNBO-Washington, Pa.
WPRC-Harrisburg, Pa.
WKJC-Lancaster, Pa.
WNBW-Carbondale, Pa.
WABZ-New Orleans, La.
WJBW-New Orleans, La.
WBBY-Charleston, S. C.
WBBZ-Ponca City, Okla.
WFBC-Knoxville, Tenn.
WRBL-Columbus, Ga.
KGCU-Mandan, N. D.
WJBC-LaSalle, Ill.
WJBL-Decatur, Ill.
WWAE-Hammond, Ind.
WRAF-Laporte, Ind.
WMT-Waterloo, Iowa
KFJB-Marshalltown, Iowa
WCAT-Rapid City, S. D.
KGDY-Oldham, S. D.
WIL-St. Louis, Mo.
KFWF-St. Louis, Mo.
KFKZ-Kirksville, Mo.
KGDE-Fergus Falls, Minn.
KGFK-Hallock, Minn.
WCLO-Kenosha, Wis.
WHBY-West DePere, Wis.
KFWC-Ontario, Calif.
S-Pomona, Calif.
KPPC-Pasadena, Calif.
KXO-El Centro, Calif.
KMJ-Fresno, Calif.
KSMR-Santa Maria, Calif.
KGEK-Yuma, Colo.
KGEW-Ft. Morgan, Colo.
KFHA-Gunnison, Colo.
KVOS-Bellingham, Wash.
KGY-Lacey, Wash.
***1210 KC, 247.8 METERS**
WJBI-Red Bank, N. J.
WGBB-Freeport, N. Y.
WINR-Bayshore, N. Y.
WCOH-Greenville, N. Y.
S-Yonkers, N. Y.
WOCL-Jamestown, N. Y.
WLCI-Ithaca, N. Y.
WPAW-Pawtucket, R. I.
WDWF-WLSI-
Cranston, R. I.
WMAN-Columbus, Ohio
WJW-Mansfield, Ohio
WEBE-Cambridge, Ohio
WBAX-Wilkes-Barre, Pa.
WJBU-Lewisburg, Pa.
WTAZ-Richmond, Va.
WMBG-Richmond, Va.
WSIX-Springfield, Tenn.
WRBU-Gastonia, N. C.
WJBY-Gadsden, Ala.
WMBR-Tampa, Fla.
WRBQ-Greenville, Miss.
WGCM-Gulfport, Miss.
KWEA-Shreveport, La.
KDLR-Devils Lake, N. D.
KGCR-Watertown, S. D.
KFOR-Lincoln, Neb.
WHBU-Anderson, Ind.
KFVS-Cape Girardeau,
Mo.
WEBQ-Harrisburg, Ill.
WSBC-Chicago, Ill.
WCRW-Chicago, Ill.
WEDC-Chicago, Ill.
WCBS-Springfield, Ill.
WTAX-Streator, Ill.
WHBF-Rock Island, Ill.
WIBA-Madison, Wis.
WOMT-Manitowoc, Wis.
KPQ-Seattle, Wash.
KPCB-Seattle, Wash.
1220 KC, 245.8 METERS
WCAD-Canton, N. Y.
WCAE-Pittsburgh, Pa.
WREN-Lawrence, Kan.
KFKU-Lawrence, Kan.
1230 KC, 243.8 METERS
WNAC-Boston
WBIS-Boston
WPSC-State College, Pa.
WSBT-South Bend, Ind.
WFBM-Indianapolis, Ind.
KYA-San Francisco, Calif.
KFIO-Spokane, Wash.
KFQD-Anchorage, Alaska
1240 KC, 241.8 METERS
WGHP-Fraser, Mich.
S-Detroit, Mich.
KTAT-Ft. Worth, Tex.
WJAD-Waco, Tex.
WQAM-Miami, Fla.
WRBC-Valparaiso, Ind.
1250 KC, 239.9 METERS
WGCP-Newark, N. J.
WODA-Paterson, N. J.
WAAM-Newark, N. J.
WLB-WGMS-Minneapolis
WRHM-Fridley, Minn.
KFMX-Northfield, Minn.
WCAL-Northfield, Minn.
KFOX-Long Beach, Calif.
KXL-Portland, Ore.
KILO-Boise, Idaho
1260 KC, 238 METERS
WLBW-Oil City, Pa.
WJAX-Jacksonville, Fla.
KVOA-Tucson, Ariz.
KWWG-Brownsville, Tex.
KRGV-Harlingen, Tex.
KOIL-Council Bluffs, Ia.
1270 KC, 236.1 METERS
WJDX-Jackson, Miss.
WEAI-Ithaca, N. Y.
WFBR-Baltimore, Md.
WASH-Grand Rapids,
Mich.
WOOD-Furnwood, Mich.
S-Grand Rapids, Mich.
WDSU-New Orleans, La.
KWLC-Decorah, Iowa
KGCA-Decorah, Iowa
KTW-Seattle, Wash.
KOL-Seattle, Wash.
KFUM-Colo. Springs, Col.
1280 KC, 234.2 METERS
WCAM-Camden, N. J.
WCAP-Asbury Park, N.J.
WOAX-Trenton, N. J.
WDOD-Chattanooga, Tenn.
WRR-Dallas, Tex.
WDAY-Fargo, N. D.
WEBC-Superior, Wis.
S-Duluth, Minn.
1290 KC, 232.4 METERS
WNBZ-Saranac Lake,
N. Y.
WJAS-Pittsburgh, Pa.
KTSA-San Antonio, Tex.
KFUL-Galveston, Tex.
KLCN-Blytheville, Ark.
KDYL-Salt Lake City
1300 KC, 230.6 METERS
WBBR-Rossville, N. Y.
WHAP-Carlstadt, N. J.
S-New York, N. Y.
WEVD-Woodhaven, N. Y.
S-New York, N. Y.
WHAZ-Troy, N. Y.
KFH-Wichita, Kan.
WIBW-Topeka, Kan.
KGEF-Los Angeles
KTBI-Los Angeles
KFJR-Portland, Ore.
KTBR-Portland, Ore.
1310 KC, 228.3 METERS
WKAV-Laconia, N. H.
WEBR-Buffalo, N. Y.
WNBH-New Bedford,
Mass.
WOL-Washington, D. C.
WGH-Newport News, Va.
WRK-Hamilton, Ohio
WAGM-Royal Oak, Mich.
WFDF-Flint, Mich.
WNAT-Philadelphia, Pa.
WFKD-Frankford, Pa.
S-Philadelphia.
WHBP-Johnstown, Pa.
WFBG-Altoona, Pa.
WRAW-Reading, Pa.
WGAL-Lancaster, Pa.
WRBI-Tifton, Ga.
WSAJ-Grove City, Pa.
WBRE-Wilkes-Barre, Pa.
WMBL-Lakeland, Fla.
WKBC-Birmingham, Ala.
KGHG-McGehee, Ark.
WOBT-Union City, Tenn.
WNBJ-Knoxville, Tenn.
KRMD-Shreveport, La.
KTSL-Cedar Grove, La.
S-Shreveport, La.
KFPM-Greenville, Tex.
WDAH-El Paso, Tex.
KGFI-Corpus Christi, Tex.
KFPL-Dublin, Tex.
KFXR-Okla. City, Okla.
WKBS-Galesburg, Ill.
WEHS-Evanston, Ill.
WCLS-Joliet, Ill.
WKBB-Joliet, Ill.
WKBI-Chicago, Ill.
WHFC-Cicero, Ill.
KWCR-Cedar Rapids, Ia.
KFJY-Ft. Dodge, Ia.
KFGQ-Boone, Ia.
WBOW-Terre Haute, Ind.
WJAK-Marion, Ind.
WLBC-Muncie, Ind.
WIBU-Poynette, Wis.
KFBK-Sacramento, Calif.
KGEZ-Kalispell, Mont.
KFUP-Denver, Colo.
KFXJ-Edgewater, Colo.
KMED-Medford, Ore.
WJDZ-Winston Salem, N.
C.
1320 KC, 227.1 METERS
WADC-Akron, Ohio
WSMB-New Orleans, La.
KGIO-Idaho Falls, Idaho
KGIQ-Twin Falls, Idaho
KGHF-Pueblo, Colo.
KID-Idaho Falls, Idaho
1330 KC, 225.4 METERS
WDRC-New Haven, Conn.
WSAI-Harrison, Ohio
S-Cincinnati
WTAQ-Washington, Wis.
S-Eau Claire, Wis.
KSCJ-Sioux City, Iowa
1340 KC, 223.7 METERS
WSPD-Toledo, Ohio
KFPW-Siloam Springs,
Ark.
KMO-Tacoma, Wash.
1350 KC, 221.1 METERS
WBNY-New York, N. Y.
WMSG-New York, N. Y.
WCDA-New York, N. Y.
WKBQ-New York, N. Y.
KWK-St. Louis, Mo.
1360 KC, 220.4 METERS
WLEX-Lexington, Mass.
WMAF-South Dartmouth,
Mass.
WQBC-Utica, Miss.
WJKS-Gary, Ind.
WGES-Chicago, Ill.
KFBB-Great Falls, Mont.
KGIR-Butte, Mont.
KGB-San Diego, Calif.
1370 KC, 218.8 METERS
WMBO-Auburn, N. Y.
WSVS-Buffalo, N. Y.
WCBM-Baltimore, Md.
WBBL-Richmond, Va.
WHBD-Bellefontaine, O.
WHDF-Calumet, Mich.
WJBK-Ypsilanti, Mich.
WJDW-Emory, Va.
WIBM-Jackson, Mich.
WRAK-Erie, Pa.
WELK-Philadelphia.
WJBO-New Orleans, La.
WHBQ-Memphis, Tenn.
WRBT-Wilmington, N. C.
KGFG-Okla. City, Okla.
KCRC-Enid, Okla.
KGCI-San Antonio, Tex.
KGRC-San Antonio, Tex.
KFJZ-Ft. Worth, Tex.
KGKL-San Angelo, Tex.
KFLX-Galveston, Tex.
WFBJ-Collegeville, Minn.
WGL-Ft. Wayne, Ind.
KGDA-Dell Rapids, S. D.
KFJM-Grand Forks, N. D.
KWKC-Kansas City, Mo.
KGBX-St. Joseph, Mo.
WRJN-Racine, Wis.
KGAR-Tucson, Ariz.
KIT-Yakima, Wash.
KOH-Reno, Nev.
KZM-Hayward, Calif.
KRE-Berkeley, Calif.
KGER-Long Beach, Calif.
KLO-Ogden, Utah
KOOS-Marshfield, Ore.
KFBL-Everett, Wash.
KVL-Seattle, Wash.
KFJI-Astoria, Ore.
KGFL-Raton, N. M.
KGGM-Albuquerque, N.M.
1380 KC, 217.3 METERS
WCSO-Springfield, Ohio.
KQV-Pittsburgh, Pa.
KSO-Clarinda, Ia.
WKBH-LaCrosse, Wis.
1390 KC, 215.7 METERS
WHK-Cleveland, O.
KLRA-Little Rock, Ark.
KOY-Phoenix, Ariz.
KUOA-Fayetteville, Ark.
KOW-Denver, Colo.
KWSC-Pullman, Wash.
KFPY-Spokane, Wash.
1400 KC, 214.2 METERS
WCGU-Coney Isl., N. Y.
WSGH-WSDA-Bklyn, N Y
WLTH-Brooklyn, N. Y.
WBBC-Brooklyn, N. Y.
KOCW-Chickasha, Okla.
WCMA-Culver, Ind.
WKBF-Indianapolis, Ind.
1410 KC, 212.6 METERS
WBCM-Hampton, Mich.
S-Bay City, Mich.
KGRS-Amarillo, Tex.
WDAG-Amarillo, Tex.
KFLV-Rockford, Ill.
WHBL-Sheboygan, Wis.
WSGP-Savannah, Ga.
1420 KC, 211.1 METERS
WHDL-Tupper Lake, N.Y.
WHIS-Bluefield, W. Va.
WLBH-Patchogue, N. Y.
WMRJ-Jamaica, N. Y.
WLEY-Lexington, Mass.
WTBO-Cumberland, Md.
WSSH-Boston, Mass.
WPOE-Patchogue, N. Y.
WIBR-Steubenville, O.
WILM-Wilmington, Del.
WEDH-Erie, Pa.
WMBC-Detroit, Mich.
WKBP-Battle Creek, Mich.
WQBZ-Weirton, W. Va.
KGFF-Alva, Okla.
KTAP-San Antonio, Tex.
KTUE-Houston, Tex.
KFYO-Abilene, Tex.
KICK-Red Oak, Iowa
WIAS-Ottumwa, Iowa
WLBF-Kansas City, Kan
WMBH-Joplin, Mo.
KGFW-Ravenna, Neb.
KFIZ-Fond du Lac, Wis.
KFXY-Flagstaff, Ariz.
KGFJ-Los Angeles, Calif.
KFQU-Holy City, Calif.
KGGC-San Francisco.
KFXD-Jerome, Idaho
KGIW-Trinidad, Colo.
KGCX-Vida, Mont.
KFIF-Portland, Ore.
KORE-Eugene, Ore.
KFQW-Seattle, Wash.
KXRO-Aberdeen, Wash.
KGKG-Minot, N. D.
1430 KC, 209.7 METERS
WBRL-Manchester, N. H.
WHP-Harrisburg, Pa.
WBAK-Harrisburg, Pa.
WCAH-Columbus, Ohio
WGBC-Memphis, Tenn.
WNBR-Memphis, Tenn.
1440 KC, 208.2 METERS
WHEC-WABO-
Rochester, N. Y.
WOKO-Mt. Beacon, N. Y.
S-Poughkeepsie, N.Y.
WCBA-Allentown, Pa.
WSAN-Allentown, Pa.
WNRC-Greensboro, N. C.
WTAD-Quincy, Ill.
WMBD-Peoria Hts., Ill.
KLS-Oakland, Calif.
1450 KC, 206.8 METERS
WBMS-Fort Lee, N. J.
WNJ-Newark, N. J.
WIBS-Elizabeth, N. J.
WKBO-Jersey City, N. J.
WSAR-Fall River, Mass.
WFJC-Akron, Ohio
KTBS-Shreveport, La.
WTFI-Toccoa, Ga.
1460 KC, 205.4 METERS
WJSV-Mt. Vernon, Va.
KSTP-Westcott, Minn.
S-St. Paul, Minn.
1470 KC, 204 METERS
WKBW-Amherst, N. Y.
S-Buffalo, N. Y.
KFJF-Okla. City, Okla.
WRUF-Gainesville, Fla.
KGA-Spokane, Wash.
1480 KC, 202.6 METERS
WJAZ-Mt. Prospect, Ill.
S-Chicago, Ill.
WSOA-Deerfield, Ill.
S-Chicago, Ill.
WORD-Batavia, Ill.
S-Chicago, Ill.
WCKY-Villa Madonna, Ky.
S-Covington, Ky.
1490 KC, 201.2 METERS
WBAW-Nashville, Tenn.
WLAC-Nashville, Tenn.
KPWF-Westminster, Calif
1500 KC, 199.9 METERS
WMBA-Newport, R. I.
WLOE-Chelsea, Mass.
WMES-Boston, Mass.
WNBF-Binghamton, N. Y.
WMBQ-Brooklyn, N. Y.
WLBX-L. I. City, N. Y. C.
WCLB-Long Beach, N. Y.
WWRL-Woodside, N. Y.
WKBZ-Ludington, Mich.
WMPC-Lapeer, Mich.
WMBJ-Wilkinsburg, Pa.
S-Pittsburgh, Pa.
WOPI-Bristol, Tenn.
WPEN-Philadelphia, Pa.
KGHI-Little Rock, Ark.
WRBJ-Hattiesburg, Miss.
KGKB-Brownwood, Tex.
KGDR-San Antonio, Tex.
KGHX-Richmond, Tex.
WKBV-Brookville, Ind.
KPJM-Prescott, Ariz.
KWBS-Portland, Ore.
KWTC-Santa Ana, Calif.
KDB-Santa Barbara, Calif.
KUJ-Long View, Wash.

POLO

Transformer Block

2.5 v. at 3 amps., 2.5 v. at 12 amps., 5 v. at 2 amps., 724 v., CT; two chokes, all in one casing . . . $10



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

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

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

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

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

[Center taps on all windings except primary.]

POLO ENGINEERING LABORATORIES

57 Dey Street, N. Y. City

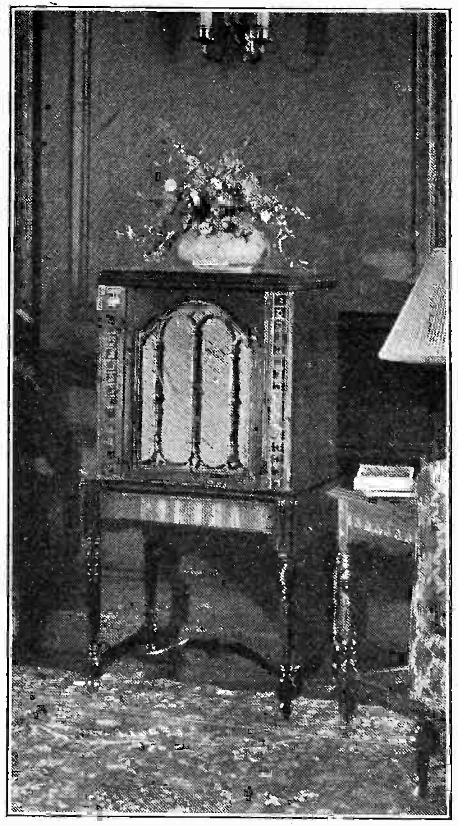
Suite 6 **Walter J. McCord, Manager**

PEERLESS

12" AC Dynamic Speaker in SONORA Highboy Cabinet

At Only $37.50

LIST PRICE, $155.00



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

Amazing Buy!

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

Money-Back Guarantee!

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

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

ACOUSTICAL ENGINEERING ASSOCIATES,
143 West 45th Street, New York, N. Y.

Gentlemen: Enclosed please find $37.50 for which please ship by express at once one 12" diameter genuine Peerless AC dynamic speaker, with built-in Kuprox dry rectifier, 1,500 mfd. hum-killing condenser, AC cable, speaker cord, and AC switch built in, all contained in the Sonora ply-walnut highboy cabinet, with cane removable back; the cabinet consisting of one piece, ply-walnut, 40" high, 19" wide, 16" front to back; all in original factory carton. No C.O.D.

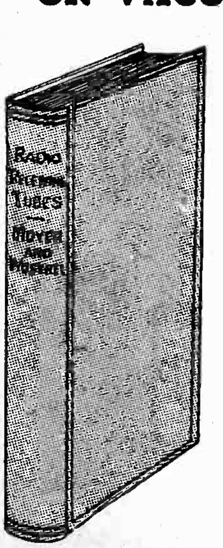
Name ....

Address ....

City .... State ....

5-DAY MONEY-BACK GUARANTEE

NEWEST BOOK ON VACUUM TUBES



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In this book the essential principles underlying the operation of vacuum tubes are explained in as non-technical a manner as is consistent with accuracy. The book covers the construction, action, reactivation, testing and use of vacuum tubes as well as specifications for vacuum tubes and applications for distant control of industrial processes and precision measurements.

Price $2.50

RADIO WORLD

145 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 YORK CITY

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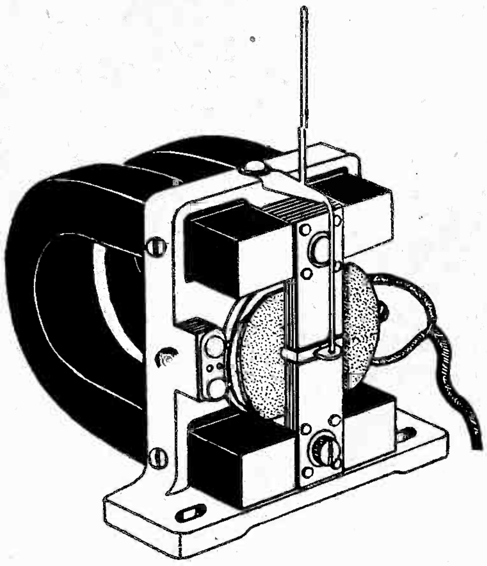
Circulation Dept., Radio World, 145 W. 45th St., N. Y. City.

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
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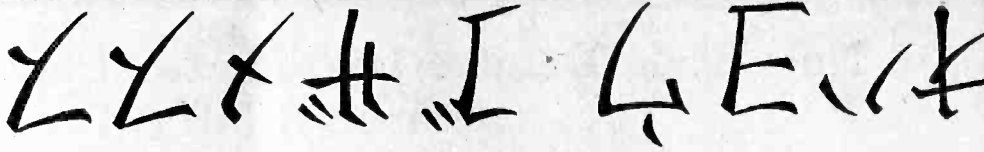
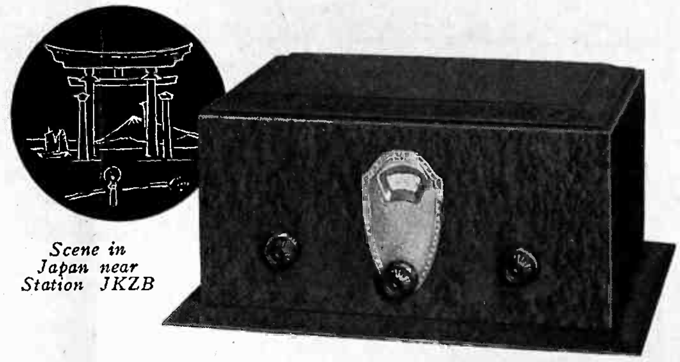
(Just East of Broadway)



Okayo gozaimazu, "Good day" Japanese



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One 6.5 ohm	.30
4 binding posts at .10	.40
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Two dials at .70 ea	1.40
Two dial pointers at .10 ea	.20
7-lead cable	.50
Two links at .35 ea	.70
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POLO

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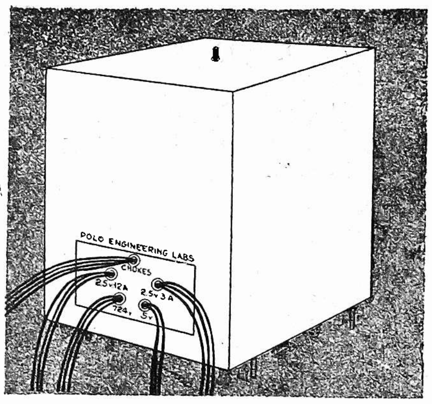

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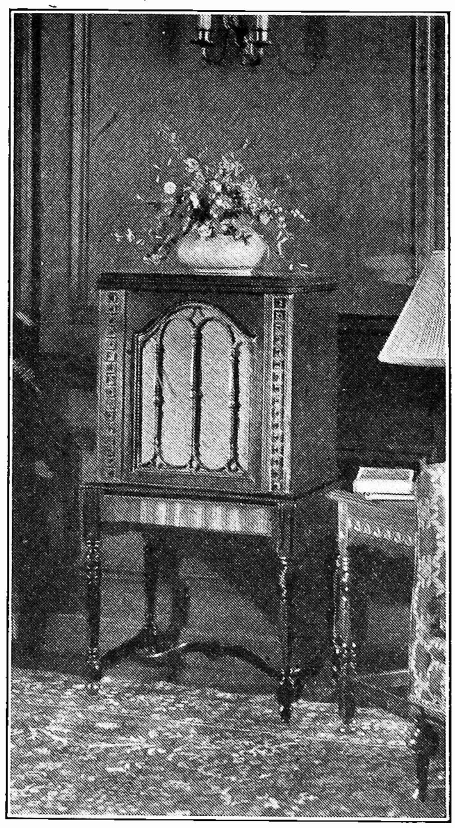
SONORA Highboy Cabinet

At Only $37.50

LIST PRICE, $155.00



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Name ....

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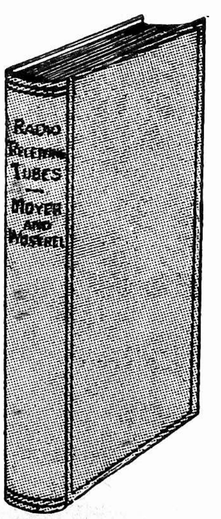
5-DAY MONEY-BACK GUARANTEE

NEWEST BOOK ON VACUUM TUBES



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Price $2.50

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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.)

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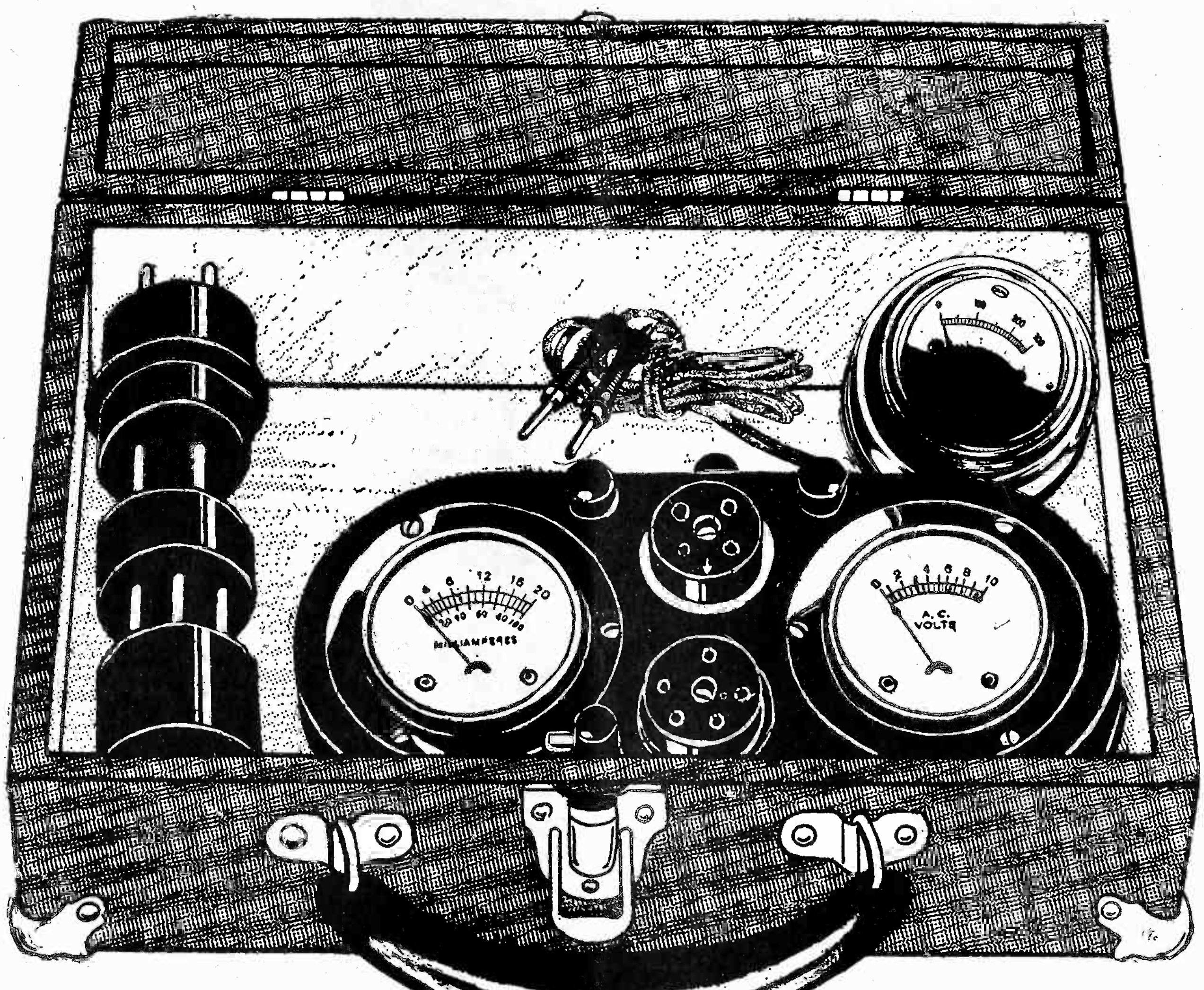
If you have missed any copies of Radio World for the summer of 1929 and want to complete your file, let us know what issues you are short and we will mail them to you at 15c a copy, or any seven issues for $1.00, mailed postpaid.

Circulation Dept., Radio World, 145 W. 45th St., N. Y. City.

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

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



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

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

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

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

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

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

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

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

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

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

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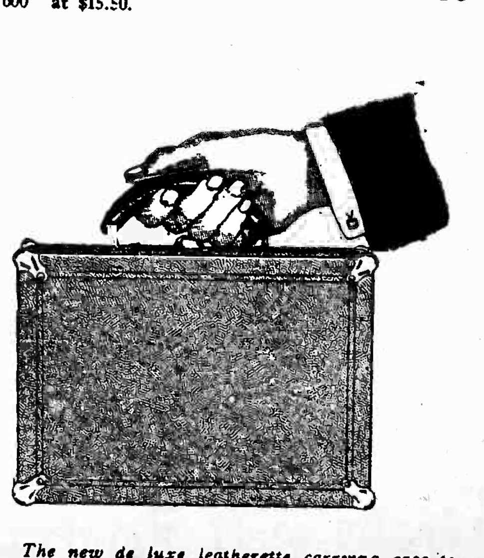
FIVE-DAY MONEY-BACK GUARANTY



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

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

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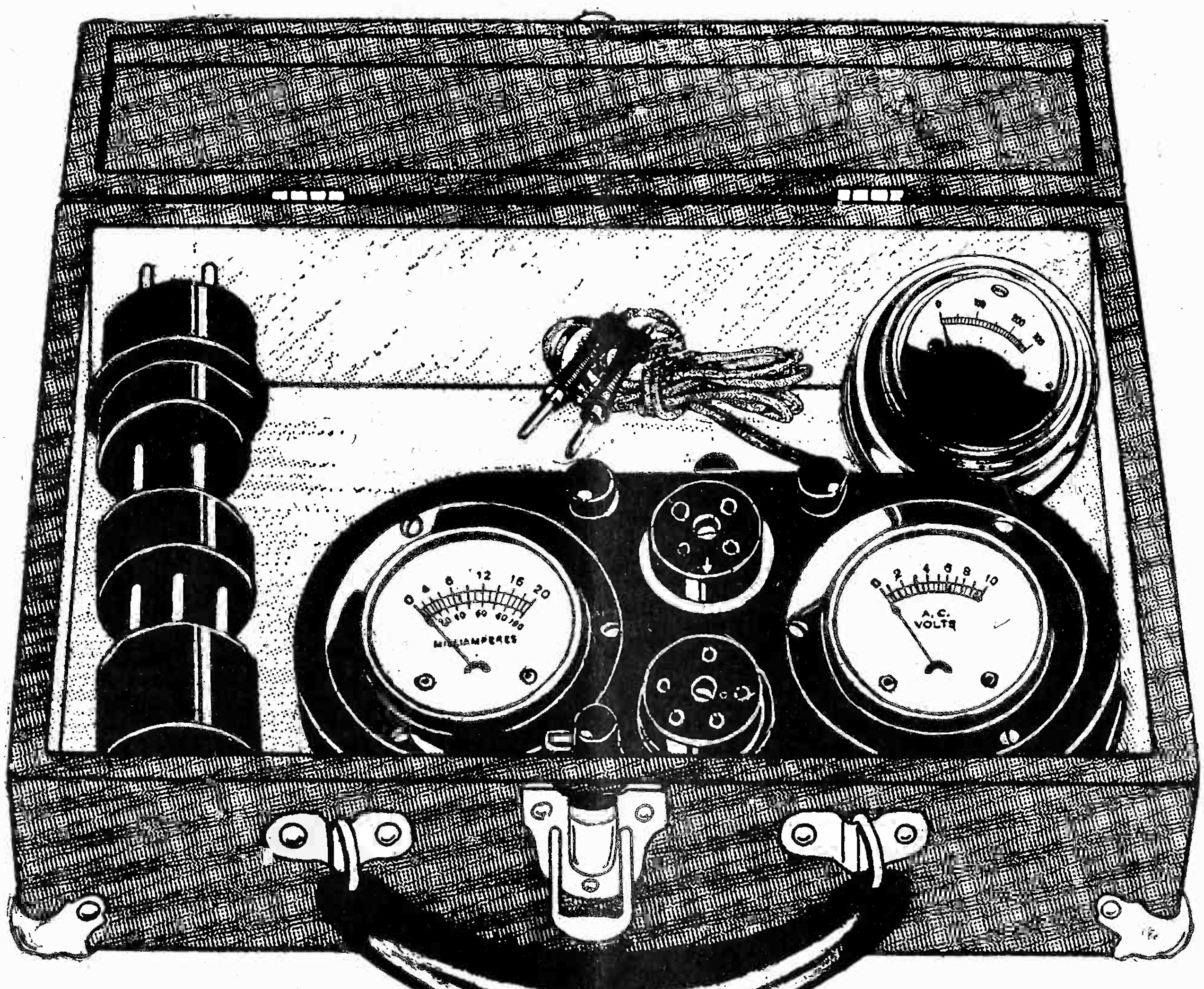

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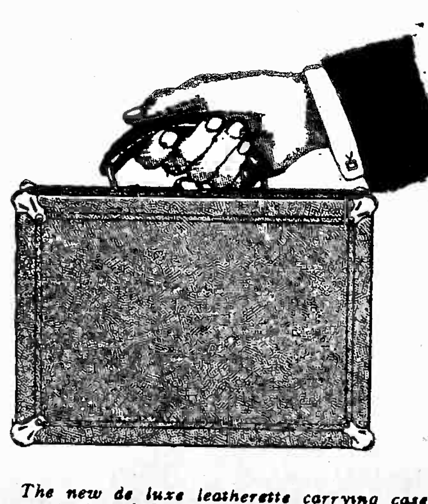
ADDRESS ....

CITY .... STATE ....

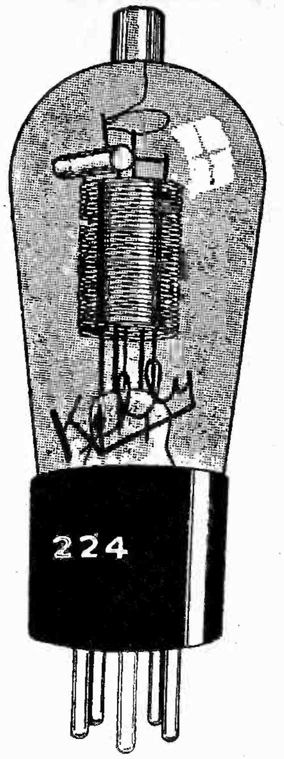
FIVE-DAY MONEY-BACK GUARANTY



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

Leaders—224 and 245!

What These Marvelous Tubes Do



224 *AC-SG Tube,* $3.00

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

PANEL AC VOLTMETERS

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

No. 851—For reading 0-15 volts AC..........$2.25
No. 852—For reading 0-10 volts AC.......... 2.25
No. 853—For reading 0-6 volts AC.......... 2.25

(See No. 848 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, 1-8 volts, 0-100 volts.................... 1.50

GUARANTY RADIO GOODS CO.
145 West 45th Street, New York City.
Just East of Broadway

All Parts

for

NATIONAL

MB-29

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

245 PP Power Amplifier, built up, $55.00

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

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

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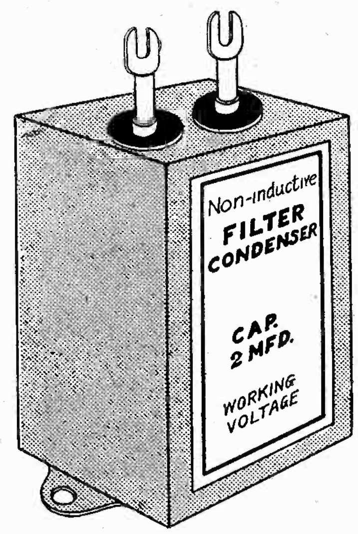
800 Volts DC

550 Volts AC

The Working Voltages of New

Filter Condensers

at Economical Net Prices



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

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

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

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

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

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

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

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

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

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

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5-DAY MONEY-BACK GUARANTY

Socket Wrench FREE!

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

LACAULT'S BOOK

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

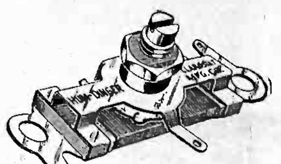
RADIO WORLD 145 W. 45th St., N.Y. City Just East of B'way

Your Choice of These Nine Meters FREE!

- ☐ 0-6 Voltmeter D.C. .... No. 326
- ☐ 0-50 Voltmeter D.C. .... No. 337
- ☐ 6-Volt Charge Tester D.C. .... No. 23
- ☐ 0-10 Amperes D.C. .... No. 338
- ☐ 0-25 Milliamperes D.C. .... No. 325
- ☐ 0-50 Milliamperes D.C. .... No. 350
- ☐ 0-100 Milliamperes D.C. .... No. 390
- ☐ 0-300 Milliamperes D.C. .... No. 399
- ☐ 0-400 Milliamperes D.C. .... No. 394

Center Accurately!

Get Rid of Hum!



In AC circuits accuracy of the electrical center, particularly with power tubes, is easily obtained through a fixed resistor with adjustable center tap. Then hum due to unbalance in the filament circuit is dispelled. Use the 30-ohm Humdinger, adjustable with knife or screw driver. Connect extreme ends across filament winding, biasing resistor to center lug. Then adjust. Also useful as 30-ohm filament resistor in battery sets, using extreme terminals, or 4 to 15 ohms adjustable, from center to one extreme terminal. Special!

Guaranty Radio Goods Co.
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Equip Yourself Now With Necessary Meters!

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

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

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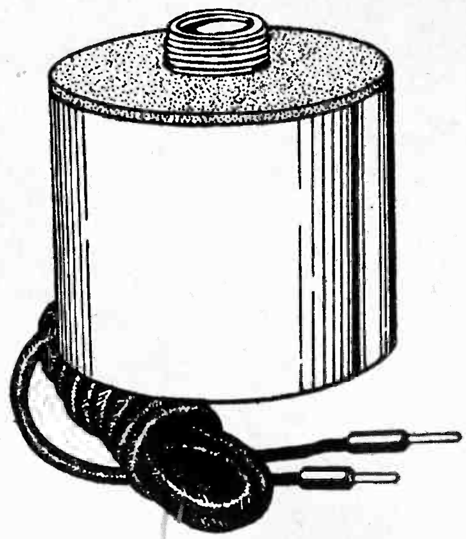
Horn Unit $2.25



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

For Portable Use

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

Air-Column Horn

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

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

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

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

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FIVE-DAY MONEY-BACK GUARANTEE

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

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