August 30th 1930

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RADIO WORLD

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The First and Only National Radio Weekly

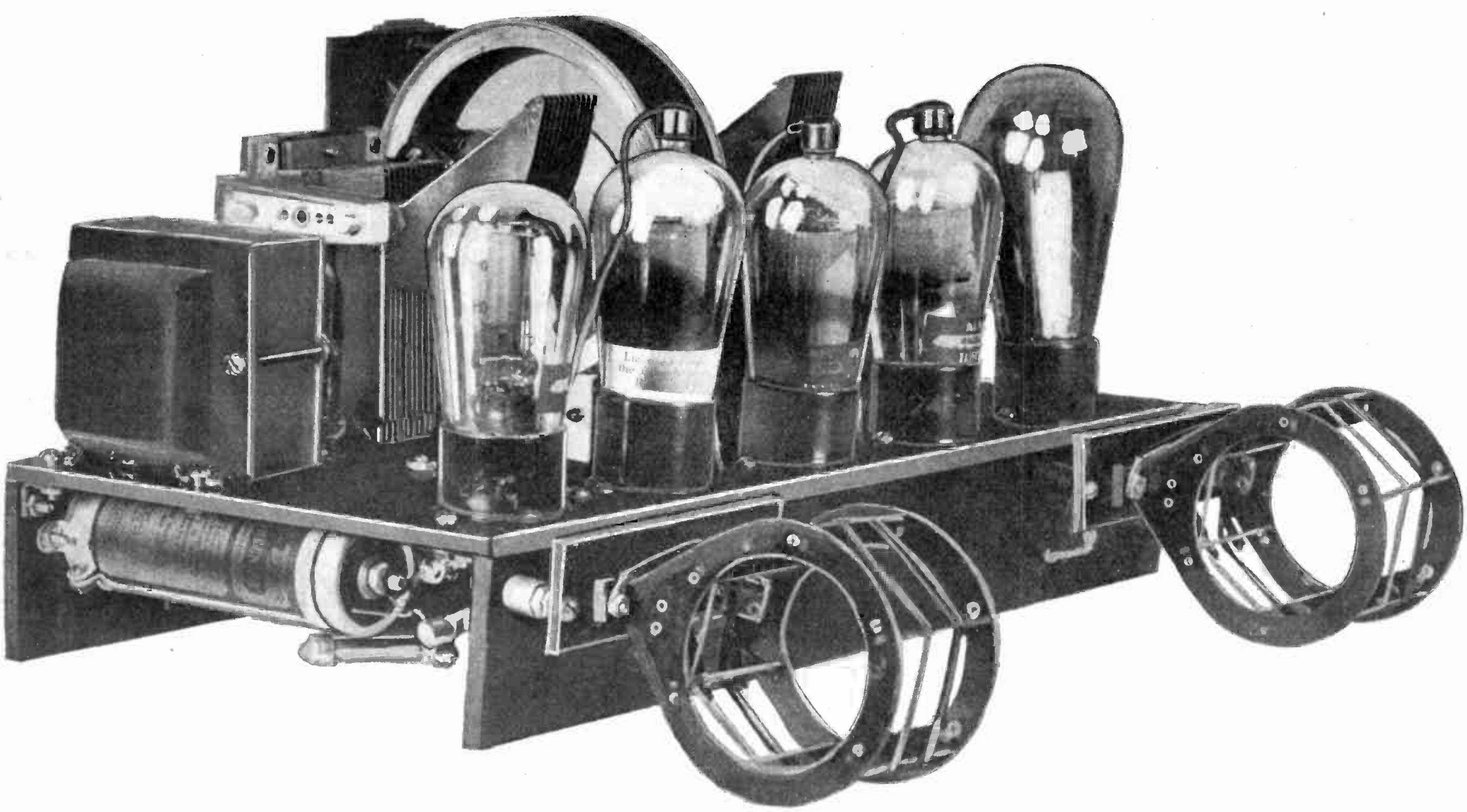
440th Consecutive Issue—NINTH YEAR

Pick-up's Pressure on Record 13¼ Tons to Square Inch

Trouble-Shooting in Radio Frequency Stages

What Makes a Receiver "Toot" Told for Novices

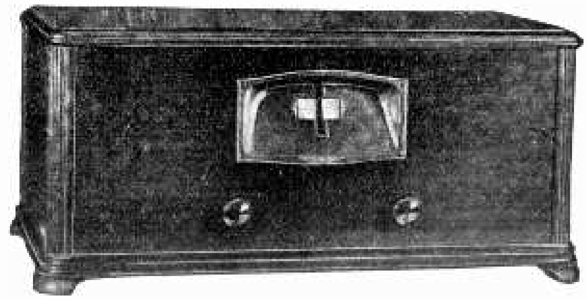
New All-Wave Design for AC Operation



The Air-King All-Wave Receiver, Using five tubes. The B supply, with 280 rectifier, is built in. See pages 3, 4, 5 and 6

RADIO WORLD, Published by Hennessy Radio Publications Corporation. Roland Burke Hennessy, editor; Herman Bernard, managing editor and business manager, all of 145 West 45th Street, New York, N. Y.

Balkite Push-Pull Receiver



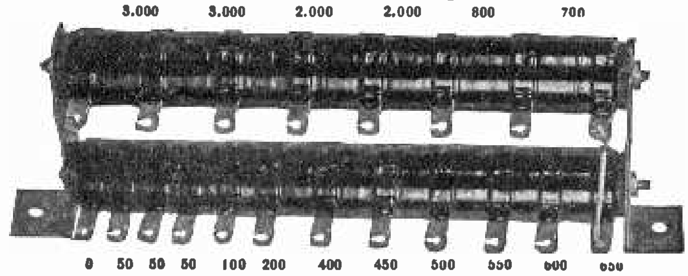
The Balkite A-5 Neutrodyne, one of the most sensitive commercial receivers ever developed; 8 tubes, including 280 rectifier. Wholly AC operated, 105-120 v. 50-60 cycles; in a table model cabinet, genuine walnut, made by Berkey & Gay.

Three stages of tuned RF, neutralized, so there's no squealing; easy tuning; operation on short piece of wire indoors perfectly satisfactory; no repeat tuning points; no hum; phonograph pickup jack built in; excellent tone quality; good selectivity. Two posts are accessible for connecting the field coil of a DC dynamic speaker.

The parts of which this receiver is made are all ace-high and the wiring is done with extreme expertness, by Gilfillan. The power supply is exceptionally fine, the set being worked at 50% less than the rated capacity of the power transformer and chokes, assuring long life. There is no hum, as filtration is remarkably good.

The illuminated drum dial, at center, reads 0-100 at left, and at right has a blank space in which to write call letters. The little knob at left is the volume control, and the one at right is the AC switch. Each RF stage is filtered and bypassed individually, and the RF coils, tuning condenser and power transformer are separately and totally shielded. The lead from antenna binding post to antenna winding of the first coil is of shielded wire that is grounded. Also, the receiver as a whole is totally shielded, with metal chassis and metal under cover, so there is no stray pickup. Complete with walnut magnetic speaker and tubes..... **$56.57**

New Multi-Tap Voltage Divider



The resistance values between the twenty taps of the new Multi-Tap Voltage Divider are given above. The total is 17,100 ohms and affords nineteen different voltages.

The Multi-Tap Voltage Divider is useful in all circuits, including push-pull and single-sided ones, in which the current rating of 100 milliamperes is not seriously exceeded and the maximum voltage is not more than 400 volts. Higher voltages may be used at lesser drain.

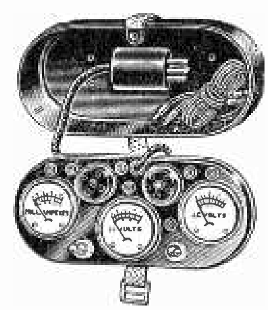
The expertness of design and construction will be appreciated by those whose knowledge teaches them to appreciate parts finely made.

When the Multi-Tap Voltage Divider is placed across the filtered output of a B supply which serves a receiver, the voltages are in proportion to the current flowing through the various resistances. By making connection of grid returns to ground, the lower voltages may be used for negative bias by connecting filament center, or, in 227 and 224 tubes, cathode to a higher voltage.

If push-pull is used, the current in the biasing section is almost doubled, so the midtap of the power tubes' filament winding would go to a lug about half way down on the lower bank.

Order Cat. MTVD, list price $6.50, net price.................... **$3.90**

R-245 Set and Tube Tester



With the R-245 Tube and Set Tester you plug the cable into a vacated socket of a receiver, putting the removed tube in the tester, and using the receiver's power for making these tests: Plate current, on 0-20 or 0-100 ma. scale, changed by throwing a built-in switch; 0-60, 0-300 v. DC, changed by moving one of the tipped cables to another jack; filament or heater voltage (AC or DC), up to 10 volts, or any other AC voltage source, measured independently, up to 140 volts, including AC line voltage. Also screen grid voltage and screen grid current may be read by following connections specified in the new 8-page instruction sheet.

Each meter may be used independently. The two test leads, one red, the other black, with tip jack terminals, enable quick connections to meters for independent use.

With this outfit you can shoot trouble in receivers and test circuits using the following tubes: 201A, 200A, UX199, UX120, 210, 171, 171A, 112, 112A, 245, 224, 222, 226, 227, and pentodes.

When the R-245 is plugged into the vacated socket of a set and the removed tube is placed in the proper socket of the Tester, the receiver's power supplies all the voltages and currents. You see the vital tests made right before your eyes, all three meters registering immediately, all three reading at the same time.

Here are some of the questions answered by the Tester when plugged into the receiver:

What is the filament or heater voltage (no matter if DC or AC)? What is the plate voltage at the plate itself? What is the plate current drawn by the tube? Is the tube in good condition or does it require replacement? What is the grid bias voltage? What is the cathode voltage? What is the screen grid voltage? Besides, when meters are used independently, you can answer these questions: What is the screen grid current? What is the line voltage (no mater if AC or DC)? Is the circuit continuous or is it open? What is the total plate current drawn in the receiver? What are the respective B voltages at the B batteries or voltage divider?

Order Cat. R-245. List price, $20; net price........... **$11.40**

Silver-Plated Coils

Wound with non-insulated wire plated with genuine silver, on grooved forms, these coils afford high efficiency because of the low resistance that silver has to radio frequencies. The grooves in the moulded bakelite forms insure accurate space winding, thus reducing the distributed capacity, and keep the number of turns and separation constant. Hence the secondary reactances are identical and ideal for gang tuning.

The radio frequency transformer may be perpendicularly or horizontally mounted, and has braced holes for that purpose. It has a center-tapped primary, so that it may be used as antenna coil with half or all the primary in circuit, or as interstage coupler, with all the primary on a screen grid plate circuit, or half the primary for any other type tubes, including pentodes. The three-circuit tuner has a center-tapped primary, also. This tuner is of the single hole panel mount, but may be mounted on a chassis, if preferred, by using the braced holes. Pair consists of RF transformer and three-circuit tuner, both for .0005 mfd. only. Order Cat., G-RF-3CT, list price $5.00; net price.................. **$2.48**

Fixed Condensers

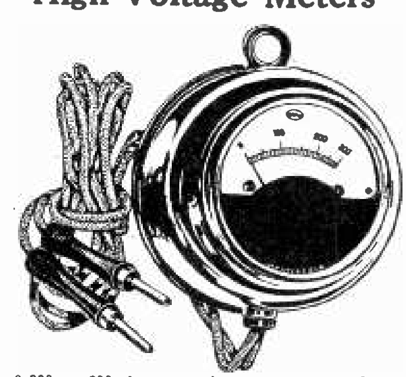
Dubilier Micon fixed condensers, type 642, are available at following capacities and prices:

.0001 mfd.	10c	.006	20c
.00025 mfd.	10c	.00025 with clips.	20c
.0003 mfd.	10c		
.00035 mfd.	15c		
.001	17c		
.0015	17c		
.002	18c		

All are guaranteed electrically perfect and money back if not satisfied within five days.

Order Cat. MICON .0001 etc. at prices stated.

High-Voltage Meters



0-300 v., 200 ohms per volt. Cat. F-300 @ $2.59
0-500 v., 233 o.p.v. Cat. F-500 @...... 3.73
0-600 v., AC and DC (same meter reads both); 100 ohms p.v. Order Cat. M-600 @ 4.95

Shielded Lead-in Wire

No 18 solid wire, surrounded by a solid rubber insulation covering, and above that a covering of braided copper mesh wire, which braid is to be grounded, to prevent stray pick-up. This wire is exceptionally good for antenna lead-in, to avoid pick-up of man-made static, such as from electrical machines. Also used to advantage in the wiring of receivers, as from antenna post of set to antenna coil, or for plate leads, or any leads, if long. This method of wiring a set improves selectivity and reduces hum. This wire is now appearing on the general market for the first time although long used in the best grade of commercial receivers. Order Cat. SH-LW. List price 9c per ft.; net price per foot **5c**

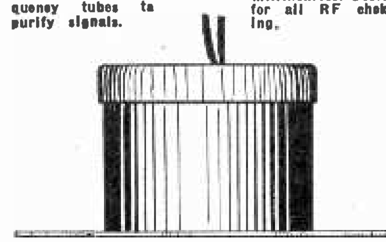
Double Drum Dial

Hammarlund double drum dial, each section individually tunable. Order Cat. H-DDD. List price $6.00; net price **$3.00**

Shielded RF Choke

Excellent in detector plate circuit or in B-plus RF leads of radio frequency tubes to purify signals.

An efficient radio frequency choke in a shielded case. Inductance, 50 millihenries. Useful for all RF choking.



In some instances one outlead is connected to case, so use this lead for B-plus or for ground, otherwise ground the case additionally. Order Cat. SH-RFC. List price, $1.00; net price **50c**

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

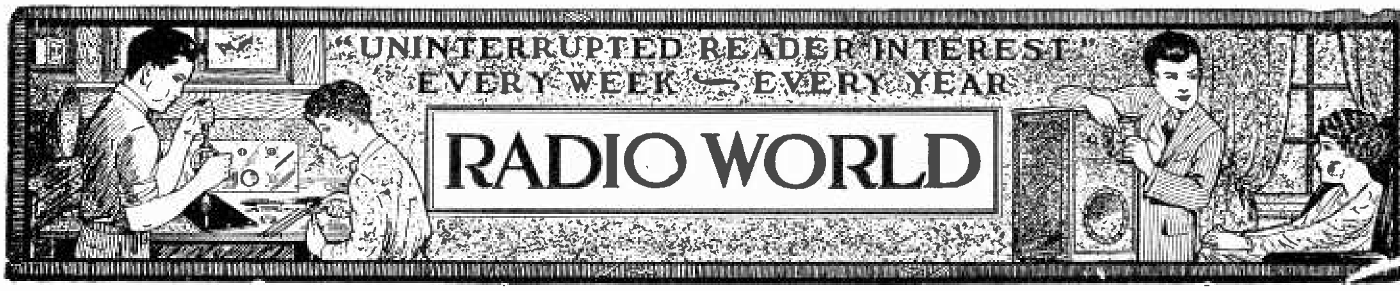
Enclosed please find $................................ (Canadian must be express or post office money order, for which please ship:

- ☐ Balkite comp. $56.57
- ☐ MTVD @ ... 3.90
- ☐ G-RF-3CT @ 2.48
- ☐ R-245 @..... 11.40
- ☐ Ft. of SH-LW @.......5c p. f.
- ☐ H-DDD @... $3.00
- ☐ SH-RFC @... 50c
- ☐ M-600 @.... $4.95
- ☐ F-300 @..... $2.59
- ☐ F-500 @..... 3.73
- ☐ MICON.... @ ....
- ☐ MICON.... @ ....
- ☐ If C.O.D. shipment is desired put cross here.

Your Name ....

Address ....

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



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Technical Accuracy Second to None

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An All-Wave AC Set

By Herman Bernard

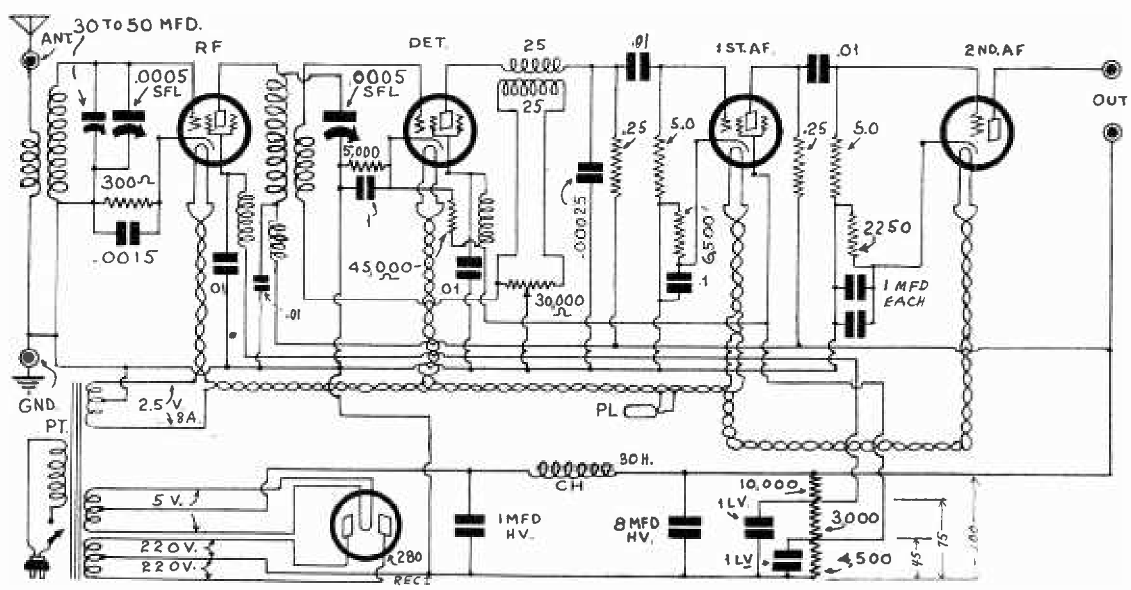


FIG. 1
CIRCUIT DIAGRAM OF THE AIR-KING SHORT WAVE AC RECEIVER THAT ALSO BRINGS IN BROADCAST WAVES. A TOTAL OF SIX PLUG-IN COILS IS USED, CONSISTING OF THREE PAIRS

IN a compact all-wave AC receiver it is desirable to use screen grid tubes, for high gain is needed. A subpanel 7 x 14 inches, with uprights 2⅛ inches high supporting it, was used in a model receiver of this type, as illustrated on the front cover, so here is an example of compactness. Still, the gain requirements are exacting.

In the radio frequency amplifier the use of the screen grid tube is familiar, and the stated voltages of 180 on the plate and 75 on the screen are orthodox. But in the circuit shown, about 200 volts were used on the RF plate, with 75 on the screen, because the higher plate voltage was found safe, and was most accessible, as will be shown.

Some experimenting was necessary to find out how the 224 could be best used as a negative bias detector. As the receiver was to tune in not only short waves but broadcast waves as

(Continued on next page)

LIST OF PARTS

Two Hammarlund straight frequency line (SFL) variable condensers, .0005 mfd. with bracket for each.
Set of six Air-King short-wave precision type coils (2 extra coils are for broadcast); two plug-in receptacles.
One trimming condenser, 30 to 50 mmfd.
One Electrad 300 ohm wire-wound flexible resistor.
One 5,000-ohm detector biasing resistor (1 watt or more).
One 45,000-ohm bleeder resistor, from plus 45 volts to cathode (1 watt or more).
One 6,500-ohm resistor (1 watt or more).
One 2,250 ohm resistor (1 watt or more).
One 30,000-ohm potentiometer with AC switch attached.
One voltage divider, 17,500 ohms, tapped at 4,500, and 3,000 ohms (10 watts or more).
Two 0.25 meg. Lynch metalized resistors with pigtails.
Two 5.0 meg. Lynch metallized resistors, with pigtails.
One .0015 mfd. fixed condenser, mica dielectric.
Six 1 mfd. 200 volt paper condensers (two in parallel to constitute 2 mfd. across 2,250 ohms in last stage).
One 1 mfd. high-voltage paper condenser (500 v AC or more).
One 8 mfd. electrolytic condenser (500 v AC or more).
Five .01 mfd. condensers, mica dielectric.
One .00025 mfd. fixed condenser, mica dielectric.
One double RF choke, 25 millihenries each winding.
Three single RF chokes, 50 microhenries.
One shielded power transformer: primary 110 v, 50-60 c; secondaries: 2.5 v, 8 amps., C. T.; 5 v, 2 amps., C. T.; 440 v AC, C. T. (220 v each side of center).
One shielded choke, 30 henries, 100 ma rating.
Four binding posts, antenna, ground, two for speaker.
One chassis, 7x14x2 1/8 inches.
Four five-prong (UY) sockets and one four-prong (UX) socket.
Three screen grid clips.
One National modernistic drum dial with color wheel and 2.5 volt AC pilot lamp.
One cabinet (for table model); or, one 8½" x 14" panel, for console.

224 Detector Bias Solved

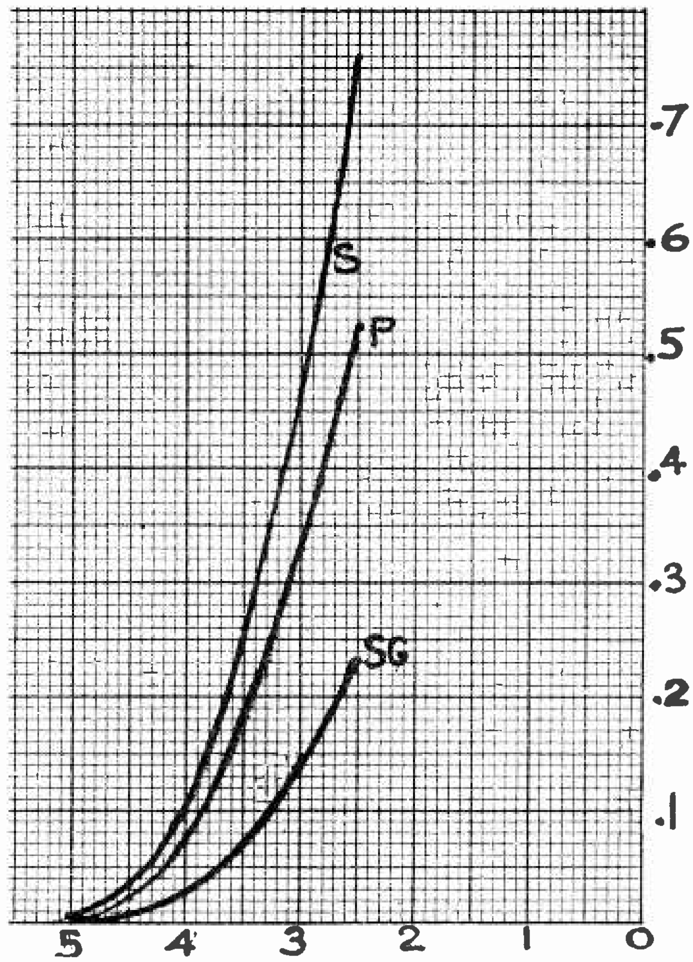


FIG. 2
CURVES OF THE 224 TUBE. THE APPLIED PLATE VOLTAGE WAS 200, THE APPLIED SCREEN GRID VOLTAGE WAS 45, THE PLATE LOAD WAS A RESISTOR OF 250,000 OHMS. CURVE SG IS FOR SCREEN GRID CURRENT, CURVE P IS FOR PLATE CURRENT, AND CURVE S IS FOR THE SUM OF THE PLATE AND SCREEN CURRENTS

well, it was desirable for broadcast purposes to use negative bias detection, for better quality.

Consultation of tube data sheets revealed that manufacturers recommended the 224 as a negative bias detector, and stated that at 200 applied volts, with a 250,000 ohm plate resistor load (0.25 meg.) and a screen voltage of 45, and negative grid bias of 5 volts, the plate current was 0.1 milliampere (.0001 ampere). If 0.1 ma flowed, the biasing resistor would have to be 50,000 ohms. Interposition of such a high resistance in the circuit would reduce the plate current one-half of one per cent., which is in no sense prohibitive.

The same data sheets would reveal nothing as to what the screen current would be, but the reason is that the screen current is so extremely small, since the screen also is affected by the increased negative grid bias, the DC resistance being heightened thereby. The total resistance to the plate current would be 2,000,000 ohms (2 meg.), which accounts for the 0.1 ma at 200 volts with plate load of 250,000 ohms.

So small is the screen current that it does not give any help where help is needed to simplify the bias attainment under desirable conditions. The sum of the screen and plate currents would flow through the biasing resistor.

It was evident that independent research was necessary to solve the problem of how to get the right bias. In the course of the experimenting it was found that 4.5 volts was a better detecting point under the previously described conditions of screen and plate voltages and plate load.

Curves were run on the 224 tube. The results are shown in Fig. 2. The negative bias variation is shown on the horizontal line or abscissas (0 bias to minus 6), although the curves are plotted for the range 2.5 to 5.2 volts negative. The applied screen voltage was 45 and the applied plate voltage was 200, the load resistor being 250,000 ohms. From right to left the curves are, screen grid, plate and sum of screen grid and plate currents. The amount of current is shown in the perpendicular line of ordinates.

As the grid bias was varied the screen and plate currents changed, and, of course, the sum of these two currents changed. The three curves show what these changes were.

At a negative bias of 5 volts the currents were virtually cut off. On the other hand, the sum curve, on which we would depend for bias calculation, shows best detecting sensitivity at 4.5 volts negative grid, when the sum currents are 0.035 ma (.000035 ampere). This is approximately one-third of the current that was predicted and would call for a biasing resistor of 135,000 ohms if this resistor did not reduce the current, but as it does, about 150,000 ohms would be required. Such a value of resistance for grid biasing a tube is out of the question.

However, the desirability of using 4.5 volts as the negative bias is undisturbed, and the only question remaining is, how can this bias be best obtained? It is certainly much more satisfactory, because more dependable, to bias the cathode positively from the B voltage supply, and send this extrà or bleeder current through the biasing resistor. Due to the great increase in current (from 0.035 ma to nearly 1 ma, which is about 30-fold), the value of the negative grid biasing resistor will be reduced proportionately. Hence, instead of 150,000 ohms we would have 5,000 ohms, which is the same 30-to-1 ratio, the plate and screen currents being too small to affect the ratio more than trivially.

How to Connect Resistor

To obtain the desired voltage, therefore, connect a 45,000-ohm resistor of 1 watt or greater rating between 45 volts above ground potential and cathode, and 5,000 ohms between cathode and ground. The total is 50,000 ahms. The plate-screen currents will be 0.035 ma, and the total 0.935 ma, yielding 4.675 volts negative bias, which is as near to 4.5 volts as you can expect to get in every-day practice.

In connection with the screen voltage, this is stated throughout as being 45 volts, but it is understood that 4.67 volts (the grid bias voltage) are subtracted, yielding an effective 41.325 volts on the screen. The citation of the applied rather than the effective voltage is standard, since no series resistor is interposed in the screen-to-B supply voltage, a practice utterly taboo because of variations in screen current.

While the experiments led us into very minor fractions, they did lead to a satisfactory method of obtaining the grid bias with commercial values of resistors and easily obtainable applied voltages.

The experiments also showed how small indeed are the plate and screen currents and we chose a grid bias voltage that gave us a plate current farther removed from the vanishing point. The advantage of this is that the electrons from the cathode are not obstructed or stopped in their course to the plate.

The drop in the 250,000 ohm plate load can be determined readily, since the plate current is known to be .025 ma. The drop is 6.25 volts (250,000 ohms x .000025 ma).

The First Audio Tube

The same curves, Fig. 2, may be used for determining the operation for amplification at audio frequencies, since the applied plate voltage, applied screen voltage and the plate load resistor are the same as in the detector circuit. Select 3 volts as the negative bias. Take readings for grid voltages one-half volt on each side of the operating point, using the plate current curve F. These are .525 and .19 ma, a difference of .335 ma plate current change for each volt of grid change. Hence the circuit amplification in the first audio stage is .335 x 250,000, or 83.75, a very substantial effective gain. Also, the mutual conductance of the tube is the ratio of plate current change to grid voltage change, which is 335 micromhos.

The bias required on the first audio tube, the selected operating point, is 3 volts, and this condition imposes a sum current drain, curve S, of .47 ma, so the biasing resistor's values would be 6,380 ohms, but this added resistance would decrease the current a little, so a higher value would be selected, a commercial value of 6,500 ohms.

The 227 Output Tube

Finally the output tube, a 227, comes in for attention. Seldom is this tube used for output, yet it is a semi-power tube. At 180 plate volts it takes 13.5 volts negative bias, which is exactly the same as the grid bias required by the 112A at that plate voltage. The 112A has a maximum undistorted output of 275 at those voltages, whereas the 227 has 164, but the 112A has an amplification factor of 8, while the 227 has an amplification factor of 9.

The choice had to be made rather between a 245 and a 227, as the 112A is not as well suited to AC filament heating as is the 245. Comparing the maximum undistorted power output of the 245 and the 227 leaves the 245 far ahead, but the 245 has an amplification factor of only 3.5. The 227 amplifies 2.5 times as much as the 245, and accounts in part for the large values of volume obtainable from the present receiver, where disap-

Winding All-Wave Coils

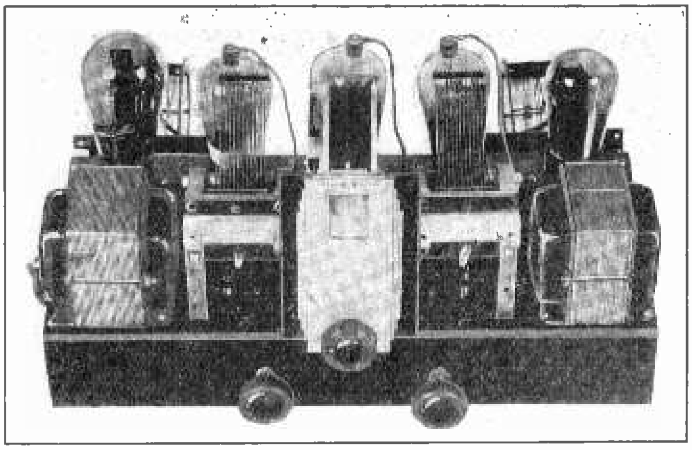


FIG. 3
AN ANGULAR FRONT VIEW OF THE RECEIVER

pointingly low volume might result on far-distant signals if every precaution, including proper choice of tubes, voltages and loads, were not taken to assure full capitalization of high gain. The power handling capacity of the 245, moreover, is not needed.

With 200 volts applied to the plate-grid return, and 6.3 ma flowing through a biasing resistor of 2,250 ohms, the bias is 14.175 volts, leaving exactly 185.125 applied plate volts. The speaker input winding will reduce this applied voltage.

The formation of the circuit as outlined, to constitute the Air-King All-Wave Receiver, permits the application of the same plate voltage, 200, to all four receiver tubes, while the first RF screen takes 75 volts and two succeeding screens take 45 volts each. These different screen voltages are obtainable from the voltage divider.

How Sensitivity Is Controlled

In the detector circuit a novelty is introduced by two RF choke coils closely coupled inductively, constituting a single unit with four leads. The inductance of each winding is 25 millihenries. One winding is used in the plate circuit to help keep the RF out of the audio amplifier, aided in this work by a .00025 mfd. fixed condenser. The other winding is in series with the grid return and has a 30,000-ohm resistor across it, so that as much of the voltage in this choke may be utilized as desired, from zero to maximum. Hence the potentiometer may be used as a sensitivity control. But it is important properly to connect the potentiometer-controlled coil. Reverse its connections. The right way affords much greater sensitivity.

B Supply Analyzed

The B supply is a good one. The power transformer has 220 volts across each half of the secondary, or 400 volts AC center-tapped. When the resistance of the tube and of the B choke coil are considered, there will remain a rectified voltage of about 200 volts. Next to the rectifier is a 1 mfd. condenser of the high voltage type, as distinguished from other 1 mfd. condensers used in the circuit. The AC rating for continuous duty for this condenser and for the 8 mfd. condenser, which is a dry electrolytic, may be around 500 volts. A single B choke is ample, especially with the large reservoir capacity. The B supply is adequate for a drain of 90 ma, whereas only about 30 ma flow. The result is hum-free reception.

The power transformer has four windings. One is the primary, for 110 volts, 50-60 cycles. The three others are 2.5 volts 8 amperes for the UY tubes, and 5 volts for the rectifier tube. These three windings are center-tapped, and in two instances the center tap goes to grounded B minus, whereas in the third instance, that of the 5-volt winding for the 280 filament the center-tap is the positive B lead .

The receiver is built on a chassis and is suitable either for installation in a console or in a table model cabinet. There is no objection to use in a console, since short waves and broadcast waves are received. The rear of the console is open, to permit plugging in when short waves are to be received. Otherwise it is assumed the broadcast coils will be left in the plug-in receptacles at rear of the set.

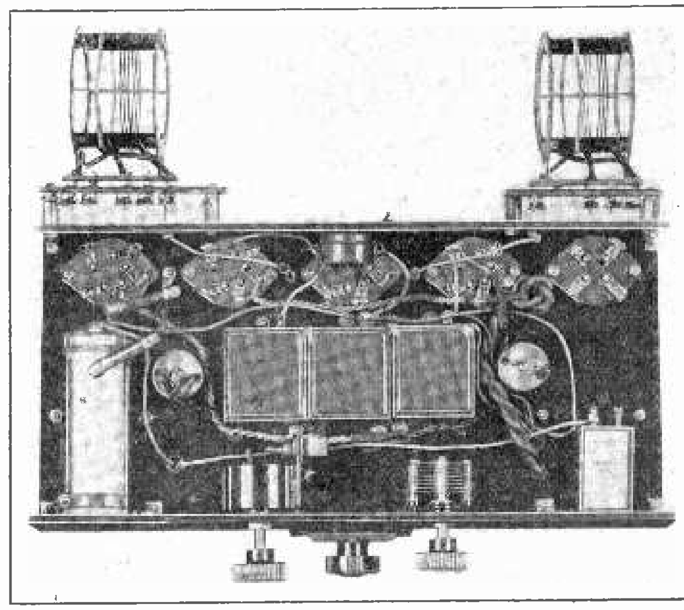


FIG. 4
LOOKING AT THE RECEIVER FROM THE BOTTOM. THE SIX 1 MFD. CONDENSERS CONSIST OF TWO LAYERS OF 1 MFD. EACH, HENCE WHY THREE ARE SEEN

The coils used in the laboratory model were wound on air dielectric and were a factory product, not reproducible at home, because of the special machinery used in making the forms, which forms are not separately available. However, any one who desires to wind his own coils may do so by using 3 inch diameter bakelite or hard rubber tubbing, about 3 inches long. Six plug-in coils are needed. There are three pair of coils, each pair alike.

Coil No. 1 consists of 3 turns primary, 3 turns secondary (wind two).

Coil No. 2 consists of 7 turns primary, 17 turns secondary (wind two).

Coil No. 3 consists of 14 turns primary, 57 turns secondary (wind two). No. 3 are broadcast coils.

The wire is No. 24 silk insulated, the separation between primary and secondary is ¼ inch for all save the largest coil, where the separation is ⅛ inch. The direction of winding is not important.

The coil exposition does not tally exactly with that for the commercial coils, but it is satisfactory for achievement of excellent results, with wave band of coverage of 15 to 120 meters, and, for broadcasts, from 197 to 550 meters, the same bands that the commercial coils cover.

Advice on Substitution

Options in the use of parts may be exercised in this circuit, as in any other, with the usual proviso you must not make any mistaken choice.

In the radio frequency amplifier and detector the condensers do not have to be straight frequency line, nor do they have to be .0005 mfd., nor need the stated diameter and number of turns characterize the coils. The resistance values, both for

(Continued on next page)

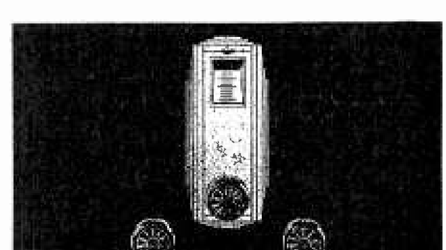
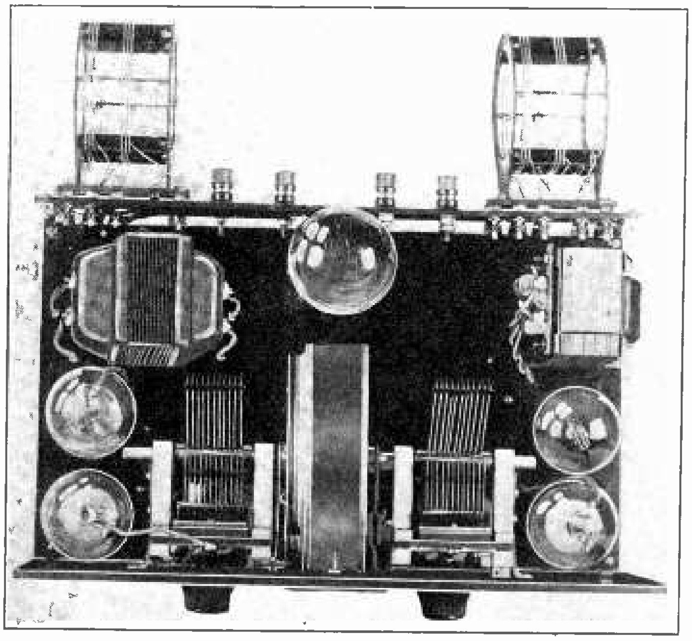
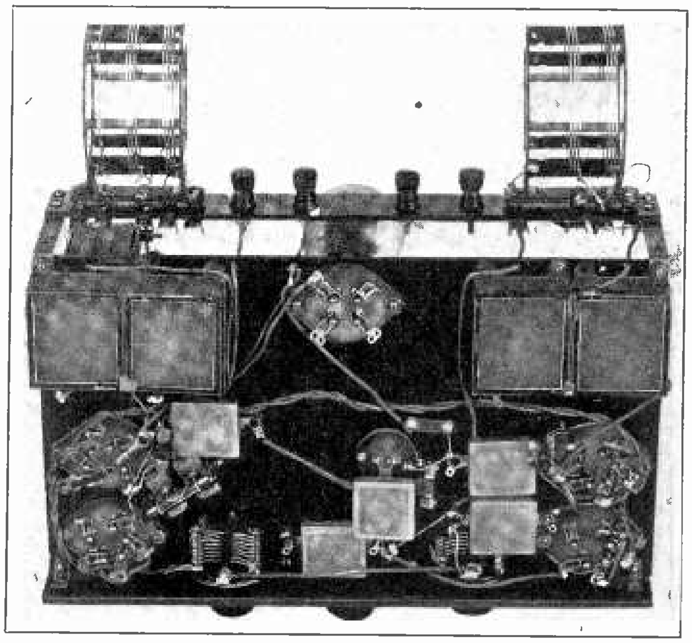


FIG. 5
The front panel appearance. The knob at left is for the trimming condenser across the first tuned circuit. This permits sensitivity despite single control. The knob at right is for the potentiometer, to which the AC switch is attached

Tests for All-Wave Set





FIGS. 6 AND 7
AN EXPERIMENTAL ARRANGEMENT, AS SHOWN IN THESE ILLUSTRATIONS, WAS DISCARDED IN FAVOR OF THE LAYOUT SHOWN ON THE FRONT COVER AND IN FIGS. 3 AND 4. IMPROVED APPEARANCE RESULTED WHEN THE CHANGES WERE INTRODUCED

(*Continued from preceding page*)

biasing and for loads, need not be as stated, although where a substitution of values is made, some other consideration enters.

The choice of .0005 mfd. tuning condensers was based on the desirability of reducing the number of coils. The usual practice in short-wave work is to use small capacity condensers, say, .00014 mfd., necessitating three coils for each tuned stage; or a total of six coils for the present receiver, to cover the wave lengths. By using .0005 mfd. only two coils for each tuned stage are necessary, to cover the same bands as would have been covered with .00014 mfd. and three coils per stage. The smaller capacity, with the extra two coils, is used in circuits so that there will be wider dial separation or better dial visibility or tuning ease, particularly as on short waves frequencies far apart may be close together on the dial. For a given freuency separation, the shorter the wave to which you tune, the less the dial separation to represent that change in frequency.

Larger Diameter Preferred

So .0005 mfd. for tuning would not be so acceptable, due to physical crowding, were other than straight frequency line capacity variation introduced. While any type of capacity variation will work, will be just as selective and just as sensitive, the danger of physical overcrowding, which has nothing to do with selectivity, would be present. It is better to avoid this. So if you have .00014 mfd. condensers and two-winding coils for such capacities, you may use six of them.

This is not a circuit that works on only some particular type of coil, the winding data for which are the guarded secret of some adroit manufacturer. You may even use plug-in coils of small diameter, as those wound on tube bases, approximately 1¼-inch diameter, or on larger diameters. But smaller coils have smaller fields, and the performance of a coil depends on the extent of its field. It would have been easy enough to use tube-base coils, and plug them into tube sockets pressed into service as coil receptacles, putting sockets and coils inside the cabinet, instead of having coils sticking out at the rear, with some room to spare on top the subpanel. Indeed, that very method of ultra-compactness was tried, but the results were as expected. The sensitivity was lower and the selectivity was less. The better type of short-wave equipment always has coils of relatively large diameter, say, around 3 inches. And the particular coils used were wound on air dielectric, except for the ribs that support the windings. The losses are much lower than with coils wound on bakelite tubing, and lower than coils wound on special compounds, where the dielectric also is solid.

Resistance Values

As for the resistance values, the plate loads are important principally from the viewpoint of amplification. As already explained. the plate current is small. Even half the prescribed 250,000-ohm load would not double the plate current. If it did. that would not upset the bias values, but affect them so slightly that no particular attention need be paid to that. However, you can not get any kick out of less than 100,000 ohms of plate load, and it is strongly recommended that the full 250,000 ohms be used. It is not practical to use audio transformers with screen-grid tubes.

The leak values in the audio amplifier may be less than prescribed, but hardly more. In fact, even the 5 meg. loads may cause incipient audio oscillation, the remedy for which would be to use lower leak values, although no less than 1 meg. may be used without serious reduction in the amplification of the low notes.

The audio circuit, as constituted, affords a gain of 540, as compared with the average gain of about 400 in commercial broadcast receivers. While on broadcast signals it may be possible to overload the last tube on loudest local signals, since it is a 227, correction may be made at the volume control, by adjustment from the front panel. It is better to have the high amplification of the 227 as an output tube, as it will be needed for short-wave work.

The voltage divider values are not imperatively prescribed. The only object is to afford the desired voltages, 45, 75 and 200 volts. Keep the bleeder current low. A voltage divider of at least 10,000 ohms total should be used. If you have a divider of 10,000, 15,000, 20,000 or 25,000 ohms, with adjustable taps, and can not calculate the resistance porportion, which is a rather complicated task, you can set the three taps so that the intended 75-volt tap is in the center and the intended 45-volt tap one-quarter way up from grounded B minus.

Use a Good Voltmeter

While the correct voltages may not prevail, you may move the taps so that the voltages will register exactly as desired For this purpose use a vacuum tube voltmeter or a voltmeter of at least with a resistance of 1,000 ohms per volt. If the voltmeter range does not extend to 200 volts, measure the voltages between ground and intended 45, between 45 and 75 and between 75 and 200, and add up the individual voltage readings, say. 45, 30 and 125 volts.

If the total voltage is a little less than 200, let the same proportion prevail, changing the inferior voltages accordingly. There are 22½, 37½ and 62½ per cent, respectively.

The power transformer pictured was made specially, and took so much time, due to small space allowed in the case, that it was found impractical as a production proposition, so any power transformer you will use will have a regular power transformer case, instead of a case intended primarily for a choke coil. By using right-angle placement in respect to the front panel, the larger power transformer will fit on the subpanel.

[*More details about the Air-King AC Short Wave Receiver will be published in next week's issue, dated September 6th.—Editor.*]

Pressure Baffles Many

By Horace Long

PRESSURE is a subject not well understood by non-technical individuals. Take, for example, air pressure. It is nearly 14 pounds to the square inch on an average. Yet we are not aware of it unless there is a change in the pressure, when we become aware of the change although we may not know that it is a pressure change. About the only change in air pressure that we experience more or less consciously is sound. Yes, sound is only a change in the air pressure about us occurring at a very rapid rate.

But how great is the change in pressure when a sound of medium intensity is heard? Is it of the order of one pound, that is, one part in fourteen? Or is it smaller or larger than that? If we express the air pressure in meteorological units instead of in pounds per square inch the number is very nearly 1,000,000 dynes per square centimeter, or better, 1,000,000 bars. A sound wave having a pressure of one bar may be considered medium in intensity. Thus when we hear a moderate sound the pressure of the air about us changes one part in a million.

Barometric Pressure

The pressure of the air about us undergoes daily changes and this change is read two or three times a day by weather observers of the United States Government, as well as by observers of other nations. This pressure is expressed either in millibars or in inches of mercury. (If a bar is a dyne per square centimeter, the millibar is a misnomer, for it should really be a kilobar since it is a pressure of 1,000 dynes per square centimeter. However, a bar is sometimes defined as 1,000,000 dynes per centimeter.)

In the United States Weather Bureau the pressure is recorded in terms of inches of mercury. Normal pressure is that which is equal to the pressure of a column of mercury 30 inches high. Recorded pressures vary from about 29 inches to 31 inches of mercury. When the pressure goes down below 29 inches a tornado may be looked for, especially if it goes to 28 inches, which it does on rare occasions. When the pressure goes up to 31 inches clear and cold weather is the prospect. Wind is the inevitable result when the air, or barometric, pressures at two different points differ considerably, and the greater the difference per mile the more intense is the wind.

Wind also accompanies a sound wave but the pressure changes so rapidly and the direction of the wind reverses so quickly that we are not aware of the air movement.

If the air pressure is only 14 pounds per square inch, how is it that an airship weighing several tons can stay up in the air? One reason is that the air pressure does not have very much to do with it. Most flying is done in altitudes where the air pressure is very much less than 14 pounds per square inch, yet the ships fly. But still the pressure has something to do with flying, for an airship cannot go very high up when it is loaded, due largely to the decrease in the air pressure, or rather due to the decrease in the density of the air. It will be recalled that Admiral Byrd had to throw provisions over the side before Balchen could lift the ship over the mountain range between Little America and the South Pole.

The ship flies because there is an upward force, and this force is due to a combination of the speed of the ship forward and the weight of the air. This force is only indirectly due to the normal pressure of the air on the ship. The pressure is increased by virtue of the speed of the ship, and the ship is built so that the increased pressure lifts the ship. A ship will also lift if a wind is blowing in such manner that it passes the ship the same way as the air passes the ship when it is moving. The force lifting the ship is the product of the pressure upward per effective square inch of surface and the total lifting surface of the ship.

When a man descends with a parachute the air pressures on the upper and lower surfaces are at first equal but as soon as the chute begins to move the pressure is greater on the lower side. The lifting force of the parachute is equal to the area of the balloon by the differential pressure due to motion, and this force is very nearly equal to the force of gravity pulling the man and the chute down. If it were not it would not be safe, for it would not check the speed of descent. For a given size lifting surface a large man will descend more rapidly than a small man.

Pressure on Phonograph Needle

What is the pressure on the tip of a phonograph needle? That is, what is the weight per square inch? Let's see. The pick-up unit might weigh three ounces. Therefore the pressure is obviously three ounces. That statement does not mean a thing, not a thing. But we might make it mean something if we modify it a little. The pressure is three ounces per needle point. But what is the area of a needle point? If we find that, we know the pressure of the needle per square inch. We might as well get ready to hear a big number, for the pressure is really enormous.

If we measure the diameter of a new needle with a microscope micrometer we will get something like .003 inch. Thus the area of the point is 7.14 millionths of a square inch. Hence if the weight on the needle is 3 ounces we get a pressure of .42 million ounces per square inch. Let us reduce that to tons per square inch. There are 32,000 ounces to the ton. Hence we get a pressure of 13.25 tons to the square inch. Is there any wonder that the needle cuts the record or that the tip of the needle wears out rapidly?

A weight on the needle of 3 ounces is an average. Some pick-up units are much heavier, others are lighter. The pressure of the needle on the record will vary accordingly. In some cases a very heavy unit is used in order to obtain steadiness on the low notes, that is, inertia to prevent the unit as a whole from moving with the needle. In these cases the pressure is relieved by employing a counterpoise or a counterspring. Of course, it is only the net weight of the needle on the record that counts.

As the needle wears, the surface of the point increases and therefore the pressure decreases. After a 12-inch record has been played with a needle the effective area of the point may be twice as great as it was at the beginning. Accordingly, the pressure is only half as great. After several playings the area is so large that the needle will not follow the undulations in the groove, sliding over the finer ones and possibly skipping the groove on the larger.

In some records there is an abrasive mixed with the wax composition for the express purpose of wearing the needle so that it fits better. But the wear to fit occurs in less than a turn of the record. After the first turn the effective area of the point is so large that additional wear is slow and the cutting of the record is also correspondingly slow.

Electric Pressure

Electromotive force is often called electrical pressure. While this view is often convenient it is not consistent, for pressure implies area as well as force, and it is impossible to attach any significance to area in connection with electromotive force in a circuit. Pressure, as has been stated, is force per unit area. But where is the area in a circuit? Is it the cross-sectional area of the conductor at some point in the circuit? No, because the electromotive force in the circuit is the same whatever the section of the conductor, and the section varies from point to point. Nevertheless, it is convenient to regard electromotive force as pressure, largely because it is easier to write or say "pressure" than "electromotive force." Pressure also seems to be better understood in mechanical and hydraulic problems than force, although in fact non-technical persons use pressure for force.

AURAL INDICATING DEVICES

Fig. 1 on page 11 shows forms of a aural indicating device, two of which (A and B) are common. C, a theoretical circuit, may be good, if the potentiometer is adjusted carefully.

The series condenser plate that is connected to the transformer and battery is charged positively to a potential that is supposed to be equal to the peak value of the grid swing voltage. The transformer core is polarized by the DC that flows through the coil, and hence presents impedance to the impressed AC that changes in value with every half cycle.

If the potentiometer is adjusted correctly, the head phone volume will be loudest. With the polarizing circuit "open" the volume and quality of what you hear is low and "foggy."

Fig. 2 is a form of visual indicator whereby you can measure not only exact resonance, and best average coupling, but the current at resonance, as well.

M is a thermo-galvanometer, or I^2 R meter, and C is a straight-line frequency variable condenser. A and B are flexible leads which run to the inductance coil L whose turns and diameter are arranged so that it resonates over the broadcast band, and slips inside the regular receiver stage coils.

These meters (M) are carefully calibrated at the factory and when sold are accompanied by a plotted curve by means of which you read the value of the current in milliamperes that flows through the thermo-couple.

Once the coil L is wound and finally corrected it is always a reliable standard of frequency with the given condenser C, and you can plot a frequency dial readings scale that enables you to consult the dial reading and refer to the curve when the deflection of the needle is a maximum.

All circuit connections are indicated.

This test device replaces the aural indicator, if you have more money to spend, and furnishes much more information at a glance.

Why Are Power Transfor

By Brunsten

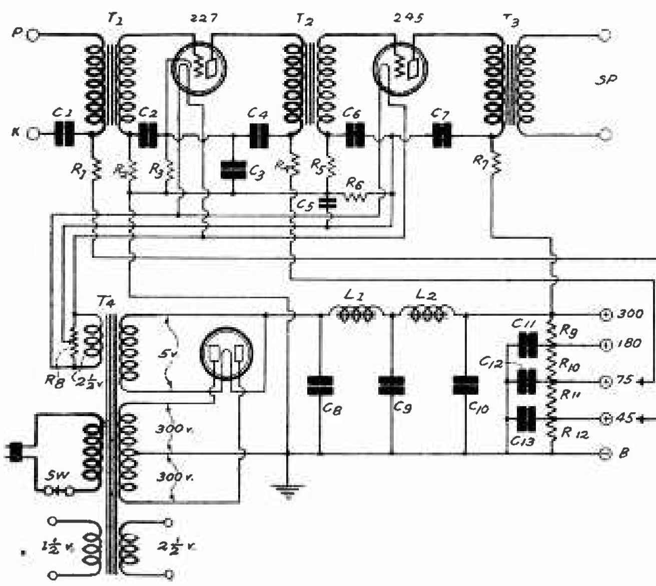


Fig. 1
If the power transformer in this circuit has been designed for a 25 cycle power supply, it can be used also on supplies of higher frequencies, such as 40, 50 and 60 cycles.

WHAT HAS frequency to do with the operation of a power transformer? Such devices are described in terms of primary and secondary voltages, power, and frequency. An audio transformer is described only in terms of primary impedance and ratio of turns. If an audio transformer is useful over a frequency range from 30 to 10,000 cycles why is not a power transformer useful over the same range? Or why should it be necessary to specify that a power transformer should be used with a definite frequency?

If a transformer is designed to operate on a low frequency it will function equally well, or even better, on a higher frequency.

When audio frequency transformers were first made they were designed to work on about 1,000 cycles. At this frequency they worked very well, but they were useless for frequencies much below that value. Due to defect in design they were also practically useless above 1,000 cycles.

Later it was found desirable to design audio transformers so that they were efficient on frequencies as low as 30 cycles, and these were about equally efficient on frequencies up to 2,000 cycles or higher.

Improvement in design removed the faults at the upper frequencis so that gradually the transformers became satisfactory from 30 to 5,000, or even 10,000 cycles.

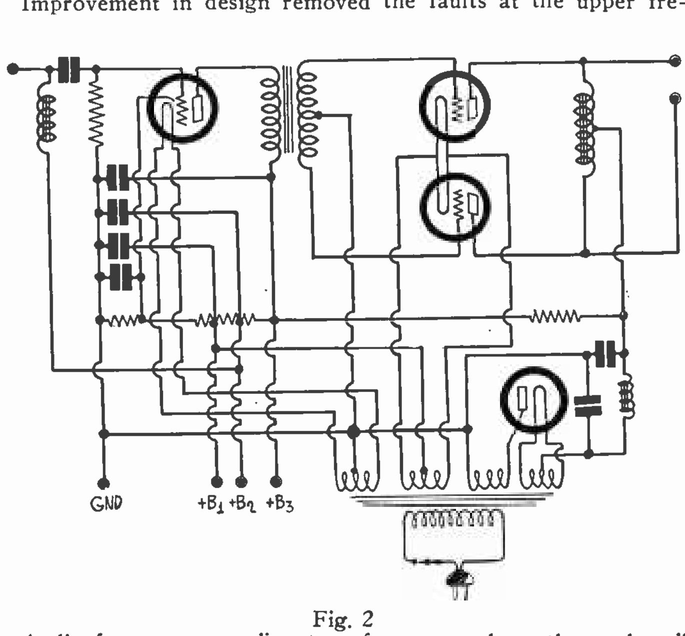


Fig. 2
Audio frequency coupling transformers such as the push-pull transformers in this circuit are designed to work effectively on frequencies as low as 25 cycles. When so designed they work also at higher frequencies.

Design of Power Transformers

The improvement on the low frequency end was achieved by using more turns on the primary windings, better core material and larger cross section of the cores. The impedance of the primary windings was made larger. The improvement on the high frequency end was achieved by reducing the distributed capacity of the windings and by minimizing the leakage inductance between the two windings, that is, by effecting closer coupling.

In the design of power transformers the question of cost enters. Technically, it would be quite possible to make a power transformer that would be efficient over a very wide range of frequencies. Economically, it is better to design a transformer for a specific frequency or for a very narrow range of frequencies. Thus we have transformers designed for 25, 40, 50, and 60 cycles, or for ranges of 25-40, 40-50, and 50-60 cycles.

The lower the frequency for which a transformer is designed, the more that transformer costs, and the bulkier it is. Thus a 25-cycle transformer costs much more than a 60-cycle transformer, and it is also much bulkier. Usually, if a transformer is designed for a frequency of, say, 55 cycles it can be used equally well on frequencies of 50 and 60 cycles. Or if it has been designed for either 50 or 60 cycles it can be used on the other just as well. This also holds for lower frequencies. When a transformer has been designed for a low frequency it can be used for higher frequencies, just as the audio transformer designed for 30 cycles could be used for frequencies up to about 10,000 cycles.

Principles of Transformer

The impedance of the primary of a transformer is determined by the frequency and by the inductance of the primary. The inductance in turn is determined by the number of turns, the area of the cross section of the core, the length of the core, and on the effective permeability of the core material. The impedance and the voltage of the line to which the primary is to be connected determine the current which is to be drawn from

mers Frequency-Rated?

Brunn

the line when the secondary winding is open. If the frequency is low, the inductance of the primary of the transformer must be increased, and this increase may be effected by increasing the turns, the core section, or the permeability of the core material, or by increasing all of these factors.

If the transformer is designed for 25 cycles its dimensions will be large as compared with those of a transformer designed for 60 cycles. Naturally it will cost much more.

If the transformer has been designed for 25 cycles it can be used on any higher commercial frequency without any danger of burn-out. But if it has been designed for 60 cycles it cannot be used safely on a line of any lower frequency. The secondary voltages may be a littlehigher if a 25-cycle transformer is used on 60 cycles, but not so much higher that it will make any practical difference.

Some radio receiver manufacturers are now designing the power transformers os that they will work on any commercial fequency, and this means that they have been designed so that they will be efficient on 25 cycles. It has been found to be more economical to do this than to have one model for each commercial frequency that may be encountered, even if every power transformer put into the receivers costs more than the average transformer would have cost had each been designed specially for the frequency with which the receiver was to be used. There is no doubt that other manufacturers will follow suit.

Getting Full Measure

Certain fans have ordered 50-60 cycle transformers and have received 25-cycle transformers. In nearly all cases the 25-cycle transformers have been returned, and in nearly every case the recipients have been indignant. Instead of returning the transformers they should have sent a letter to the shipper thanking him for his generosity. For the recipient of the 25-cycle transformer was really the beneficiary. If the fan had ordered a 25-cycle transformer he would have had to pay considerably more than the price for a 50-60 cycle transformer.

Why should not the recipient of the 25-cycle transformer in place of a 50-60 cycle transformer be indignant? Because he got a transformer that will work better and more efficiently on 50-60 cycles than a transformer designed for the higher frequency, and because he got it at the price of the less expensive transformer.

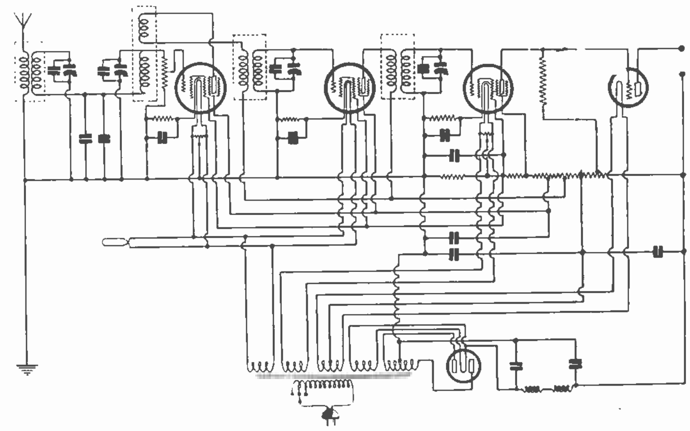


Fig. 3

When the power transformer has been built for a given voltage and a low frequency, it will also work on the same voltage at higher frequencies, and there is no need of changing the voltage distributor in the output of the rectifier.

One may compare the performances of power transformers and audio transformers in respect to frequency, at least in a general way. The audio transformer that has been designed so that the low notes will be amplified well will present a high impedance to the currents of low frequency. It will present a higher impedance to currents of higher frequencies. But the output voltage will not be greatly different for different frequencies because the secondary voltage will depend on the primary voltage and the ratio of turns. The primary voltage will not change greatly as soon as the primary impedance is equal to or greater than the impedance of the source. But it will increase a little as the primary impedance increases with respect to the impedance of the source.

Case of Power Transformer

In the power transformer the impedance of the source is very low as a rule so that the primary impedance does not have to be very high before it is higher than the source impedance. There is a difference between the two cases, however. The audio transformer ordinarily works into an open secondary and hence the impedance of the primary is the impedance of the winding considered as a choke coil. The power transformer invariably works into a closed secondary, that is, into one in which current flows. When this is the case the primary impedance depends on the impedance of the secondary circuits. For example, if the secondary is short-circuited, the primary is practically short-circuited, too. The power taken from the line depends on the power used in the secondary. Indeed, the power used in the secondary is equal to the power taken from from the line, since there is no other source of power. For this equality to hold we must include in the power used the power lost in resistances other than the load resistance.

If we short circuit the secondary of any audio transformer no serious damage, if any, occurs because the impedance of the source limits the current to safe values. But if we short-circuit the secondary of a power transformer connected to a commercial line, great damage may occur unless the fuses blow quickly. Quite often the short is only partial so that the fuses don't function and the transformer overheats and becomes irreparably damaged.

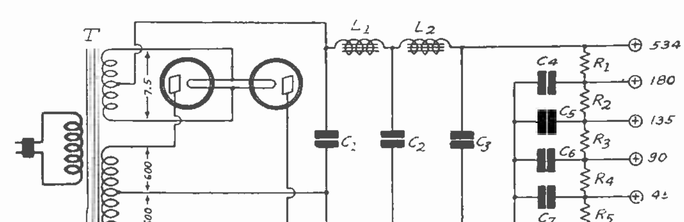


Fig. 4

If the power transformer and the filter have been designed to work on a low frequency, such as 25 cycles, the B supply will work on higher frequencies and the filtering will be better on the higher frequencies than on the 25-cycle frequency.

Trouble-Shooting in Ra

By John C.

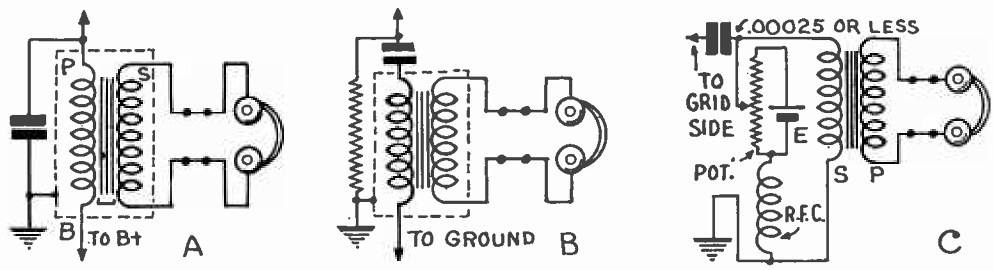


FIG. 1
THREE CIRCUIT FORMS OF A SIMPLE AURAL INDICATING DEVICE A. FOR USE IN PLATE CIRCUIT. B. FOR USE IN GRID CIRCUIT. C. A THEORETICAL MAGNETIC RECTIFYING SCHEME.

WHEN a radio frequency transformer is finally adjusted electrically and mechanically, the inductance of its primary winding and the inductance of its secondary winding in the laboratory model may not agree respectively with the values assigned to each by the circuit designer, when the circuit is first set up, because of the usually unknown factor called distributed capacity.

This capacity effect may be calculated by the designer, or if not, its value and consequent effect depend upon the distribution of competent parts of the intended circuit.

This same "awkward to judge" capacity effect is of course present when the amateur enthusiast creates his own interpretation of a circuit described in a radio periodical, and particularly if he copies the set's circuit only and not the layout of parts.

In the originally designed model of a given set all factors inimical to successful reproduction are supposed to be removed during the various stages of development, so that presumably all the purchaser has to do is to mount the parts in their assigned places and connect them together, and in some instances the principal parts are already mounted, resulting in the rest of the assembly work taking a comparatively brief time.

Interpretation May Spell Trouble

But the duplication of a given circuit from published data is not always successful if all or nearly all details are left to the interpretation of the constructor, and here is where the suggestion of the use of some simple interstage tests comes in.

The apparatus used will consist of the following parts:

1 to 3 audio transformers.
Headphones (2,000-ohm type).
.002 mfd. condenser.
.5 meg. grid leak and .00025 mfd. condenser with clips.
Lamps, socket and dry cell.
High and low range 1,000 ohms per volt voltmeter.

Additional apparatus may consist of a thermo couple type galvanometer, 0-to-100 scale divisions, and a suitably wound coil, combined with a .0005 mfd. straight line frequency condenser. Fig. 2 shows the schematic connections which are simple to copy. The instrument formed by their combination is called a "resonance frequency meter" and its construction and calibration are easy, provided certain precautions are observed.

The assembly of this easily-made resonance frequency indicator will be discussed presently.

Radio receivers that are built up from parts are assembled in two general ways, (a) builder assembles set, wires it completely, then inserts tubes, turns on power and tunes in; (b) builder assembles set parts, tests each part before connections are ready to be made, wires up filament circuits first, and connects filament transformer, and inserts all tubes and checks filament voltage at each tube, then removes tubes and proceeds with wiring, after which the individual circuits are tested for continuity, with a dry cell and a flash light lamp, substituting the headphones for the flash-light lamp when the circuit to be tested includes a grid suppressor or an audio transformer or both, or any device of continuous circuit though of high resistance. All tubes are inserted and the power turned on.

Either May Succeed or Fail

The high-resistance voltmeter is used to check the effective plate voltages, measuring same at the tube in question in each case, and satisfied that these voltages are correct, he connects up the aerial ground and speaker and upon tuning for the stations gets the results he expected.

The other procedure varies vastly, although both had the same ultimate goal in view. You cannot state that one was right and the other wrong, because either method of attack could have been successful or unsuccessful.

Suppose, though, that the more cautious builder had en-

Right or

QUESTIONS

(1)—It is impossible to carry on communication by means of waves modulated in frequency, because there is no detector which will respond to such modulation.

(2)—A wave modulated in frequency but not in amplitude does not contain the usual side frequencies in addition to the carrier frequency.

(3)—Frequency modulation can be effected by making the condenser microphone a part of the condenser in the oscillator.

(4)—The power tubes in a high power transmitting station generate so much heat that if the water circulating around the plates of these tubes should stop a few moments the water would quickly boil and the tubes would burn out.

(5)—Radio communication over distances of 10 miles have been carried on successfully with 2 meter waves.

(6)—The grid current in a tube when the grid is negative is a measure of the amount of gas in the tube, and the gas is often measured in terms of the grid current.

(7)—The sources of radio interference can be identified by taking an oscillograph of the interfering noise and then comparing it with oscillograms of known interferences.

(8)—The radio frequency resistance of a tuning condenser is always negligible in comparison with the resistance of the coil in the tuner.

(9)—The highest detecting efficiency of a 200A tube occurs at the bias at which the grid current is zero.

ANSWERS

(1)—Wrong. Communciation has been conducted in this manner and there are detectors which will respond to this type of modulation.

(2)—Wrong. When the change in frequency with respect to the carrier frequency is small, and also when the audio frequency

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Biffo Has Grouch

The greatest underlying cause of oscillating feedback is stray magnetic coupling and this coupling path is usually traced right through the air between adjacent coils, regardless of whether they are mounted on the top of the sub-panel or whether they are placed underneath. The screen grid tube's low electrode capacity doesn't help where the trouble is magnetic coupling.

The screen grid tube is supposed to be very sensitive, but is this really true? As far as I can determine by observation, extending over a period of nearly a year, I can find no reasonable basis for this assertion, and I am sure that there are many who agree with me. The theoretical gain is enticing, but in practice the tube must be worked at moderate gain.

Circuits employing this new tube do not seem to have the ability to reach out and bring in any greater distance, tube for tube, than did sets with the old tubes. Proof of this is furnished by the fact that nearly all the DX receivers of modern design employ anywhere from four to six screen grid tubes in a radio frequency tuner (exclusive of the audio ampli-

dio Frequency Amplifiers

Williams

countered bad luck and after he had carefully checked everything the results still were poor. Where and how should he seek the probable cause of poor performance, or how should he identify the result of what he hears or reads via the headphones or frequency meter?

Since most of us can do only one thing at a time if we are to do it well, and furthermore since the aural test apparatus was described first, perhaps it would be well to outline some procedure using it first.

Use of Aural Test

If the first radio stage consists of some form of a tunable band filter (it is assumed that the leads issuing from the cores are suitably identified), and if a continuity test shows that the circuit is closed, place your aural indicator in the plate circuit of the tunable stage immediately following the filter.

Fig. 1 shows two views of simple devices, (A) for insertion in the plate circuit, and (B) for use in the grid circuit. A third view of a modification known to most readers is that of A, with a grid leak and condenser in shunt, placed in series

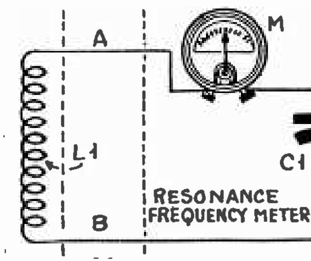

FIG. 2
AN EASILY DUPLICATED RESONANCE FREQUENCY METER.

between the grid terminal of the stage tube and the junction of the fixed core lead and the variable condenser stator plate group terminal. This provides the usual grid leak detector circuit.

Sketch B of Fig. 1 shows an audio transformer similar to sketch A but the first transformer is of ratio 1-to-3, whereas that of B is a 1-to-5 or it might be even better to reverse this one and make it 5-to-1 instead.

You may include in the input circuit of the transformer three devices resulting in the transformer assuming rectification properties in somewhat the same fashion of a magnetic rectifier.

You will find that all three varieties of Fig. 1 work, but also, you will find that one of the three will work best.

The most accurately tuned radio receiver that one could possibly build would be one that employed fixed condensers instead of variable ones and also the electrical coupling between the various stage coils, or radio frequency transformers, would be adjusted to the optimum value for the given frequency, making it theoretically possible to obtain flawless reception on one frequency only, a limitation that none of us would care voluntarily to subscribe to, yet it is not unattainable.

But the average listener, having some degree of the nomadic in his nature, he wants to be able to obtain some variety, if even in radio frequencies, hence the tunable circuit.

Aural Test in RF circuits

The use of the above described aural indicator may be quite easily extended to the cases that include all kinds of cascaded radio frequency circuits.

Those radio frequency circuits that contain Screen Grid tubes are now by far in the majority, and though I have not shown a schematic diagram of the connections it is hardly necessary I thought, because most readers know what the outlead circuits of a screen grid tube are and the circuit forms of Fig. 1 are practically self-explanatory.

But some readers may nevertheless be in doubt and hence I will take up briefly the general application of the diagrams.

The general method of using (A) is to place it directly in series with the B+ supply lead that runs to the RF tube whose circuit you are interested in. You can also detect the presence of modulated signal in the screen-grid circuit by placing (A) in series with its B+ supply lead.

The utility of these simple tests lies in their low construction cost, and the definite information their proper use provides.

Take the case, for instance, of a bypassed circuit that's supposed to contain no audio frequencies—how do you know that it's functioning as it should?

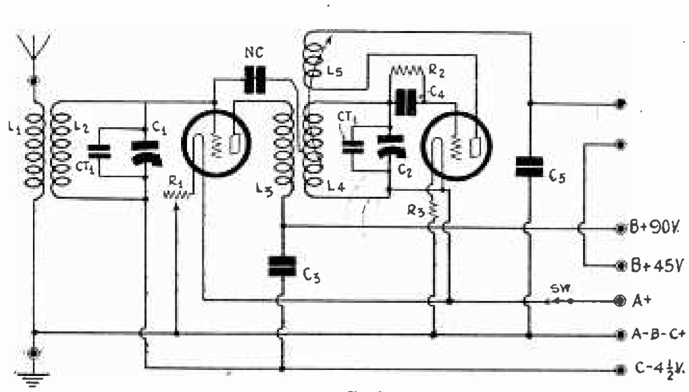

FIG. 3
A MODIFICATION OF THE PREVIOUSLY DESCRIBED TEST CIRCUIT THAT CONTAINS A TUNED RF TUBE AND A TUBE DETECTOR ALSO TUNABLE

Wrong?

impressed on the carrier is relatively small, there is practically no difference between the two methods. When the modulation frequency and the carrier frequency change are not small compared with the carrier there are many more side frequencies than when the amplitude variation method is used.

(3)—Right. That is just how it is done. When sound falls on the diaphragm of the condenser microphone the capacity of the small condenser changes, and if this condenser is a part of the capacity in the oscillating circuit, the frequency of the carrier changes in proportion to the amplitude of the diaphragm.

(4)—Right. It is necessary to circulate a large amount of water around the plate and to cool this water in a radiator before it is sent to the tubes again. The tubes are cooled in the same manner as the engine of an automobile.

(5)—Right. This has been done in England and in other places. Experiments have been successful and there is no doubt that in the near future the ultra-short waves will be used for practical purposes.

(6)—Right. There is a gas pressure, or rather vacuum gauge, based on this principle. One of the tests a radio tube goes through before it is passed also estimates the vacuum by means of the grid current.

(7)—Right. The system is not unlike identification by fingerprinting. Every interfering noise has a type of oscillograph all its own. If a picture of the noise is taken and compared with pictures on file, it is possible to identify the source. Once the source has been identified as to kind it is easy to find its location.

(8)—Wrong. This has been the general assumption but it has been lately that the resistance of a condenser may be as high as one ohm which cannot be neglected in most instances of tuned circuits employed in broadcast receivers.

(9)—Right. The grid current changes from positive to negative, that is, goes through zero, at a grid bias of about 2.5 volts. The maximum detecting efficiency goes through a maximum at the same bias. Both are on the assumption that the applied plate voltage is 45 volts.

On '224 Tubes

fier), whereas the old battery-operated sets used a total of usually not more than six tubes. So while we all have to use the radio tubes that manufacturers provide, it is certain that the modern screen grid tube does not warrant the praise that has been bestowed upon it by various ones.

The screen grid tube also appears to suffer from constructional weakness not easy to overcome. It is harder to make and costs more. The battery-operated screen grid tube, as well as the AC operated counterpart, seem to have inherent defects that demand some further attention from the designers, and have different characteristics.

I have noticed that there is a pronounced tendency for internal short circuits to develop in the 224 tube that result in disastrous consequences to the rectifier tube, especially if it is a 280. The ultimate result of a plate-to-control grid short is the sudden overload of the 280 tube, hence serious overheating of the two plates. The filament expands so much and so quickly that you have no time in which to grab for the power switch and cut the set off.—"Biffo."

Coupling Makes th

By Manning

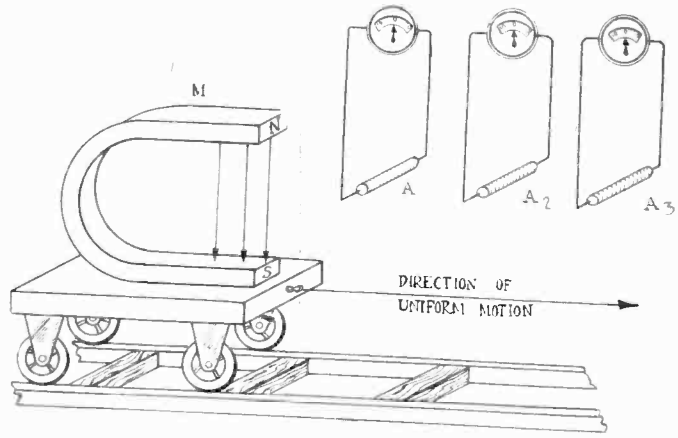

FIG. 1
SHOWING THAT THE FLUX HAS TO MOVE ACROSS THE CONDUCTOR

WHAT makes the radio set toot? This is a query heard often. What happens to the radio station's wave when it encounters your antenna, and what has this connection to do with your hearing music from your loudspeaker.

The general answer is magnetic coupling, because electromagnetic phenomena enable one electrical effect, produced somewhere, to be reproduced somewhere else.

One predominant characteristic of radio enthusiasts and recent recruits alike is that most of them have a lively imagination, a mental trait that when coupled with observation makes an unbeatable combination.

Let us then accordingly, look at Fig. 1 and see what we can make of it.

Imagine that the magnet on the flat top car is a broadcasting station, and that A_1 A_2 and A_3 are the receiving antennas of three radio sets represented by the three meters.

Magnet Poles Oppositely Charged

The direction of motion corresponds to the advancing wave.

The magnet M is charged, and has two poles. These poles being opposite tend to attract each other, with the result that there exists between them a force that is a measure of their inherent separation. This force is called magnetic flux.

In order that a current of electricity, no matter how minute, may appear in or about a wire due to the effect of a magnetic field, it is essential that this field shall move or be moved across the wire at right angles to its longest dimension, always, and in no other way.

Thus, as the car moves along the track the flux of poles N and S of magnet M (which flux is acting downward) are seen to cut across the receiving conductors A_1 A_2 and A_3 and a current induced in them flows through the meters associated with the respective induced circuits.

So it is essentially with your receiving set. The broadcasting station transmits a magnetic wave, which upon bridging the distance between the station and your receiving antenna, merely sweeps across the antenna and in doing so sets up a current in your antenna that flows in the lead-in wire and in the antenna-ground coil of your set just as long as the wave continues

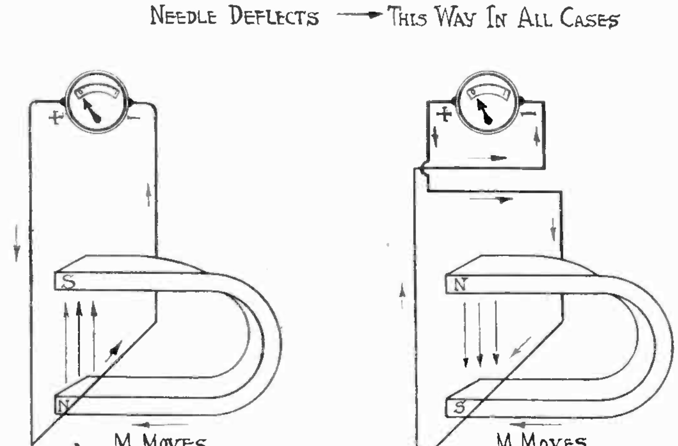

FIG. 2
SHOWS THAT SIMILAR DEFLECTION EFFECTS MAY BE THE RESULT OF DIFFERENTLY ACTING FLUXES

Flux Direction and Its Effect

Fig. 2 shows something of the relationship between a flux direction and the resultant electrical effect. It will be noted here that the direction of the needle's deflections is the same, regardless of the fact that the inducing fluxes were opposite in direction initially. This is somewhat analagous to the radio reception situation, you receive stations—whose waves come from different quarters of the globe—but these all produce their largest effect when they cut across your antenna at right angles.

If the reader will imagine himself standing and facing a horizontal wire extending away from him along the line of sight, and imagine at the same time that a current of electricity is flowing along the wire, away from him, the wire will be found to have around it a circular flux with a directive effect agreeing with the motion of the hands of a clock, when one looks at the face of the clock.

You cannot crawl inside your radio set to verify any of the foregoing, but there are other ways in which the effects may be observed and confirmed.

Fig. 3 is of interest now because with it you can progress a little farther with the study of magnetic coupling without the necessity of going into complicated issues.

Apparatus Easy to Construct

The novice can easily construct all the apparatus of Figs. 1, 2 and 3 as there is no fussy detail in connection with any of them.

A in Fig. 3 is an ordinary piece of soft iron bar, sawed off smooth. And windings P, E and P, are made of No. 24 or No. 22 double cotton wire. The wavy mark denotes that AC is applied, but a battery and contact key may be used.

Assume that the iron bar A of Fig. 3 is a sample of standard stock, 1 inch in diameter and 4 inches long. There are shown three windings P, E and P_1, in a particular circuit arrangement, but it is not difficult for the novice to exert some imagination and picture them not connected to anything at all. The galvanometer shown is one of the many portable student types which have 30 scale divisions and are of the center zero type. They require two micro-amperes for a deflection of one scale division, and have an internal resistance of around 160 ohms.

The power source is a dry cell and a contact-key, or a telegraph key will do for a circuit maker or breaker.

To construct an analogous broadcasting station the component parts are to be dry cell, contact key and coil P (which may be made of No. 24 double cotton covered magnet wire and consist of eight turns as shown). You are to complete the following circuit, beginning at one of the terminals of the contact key and using the No. 24 wire to make the hook-up. Don't forget to remove insulation from the wire at points where the wire is engaged by a terminal.

Analysis of Circuit

The circuit is as follows: From contact key terminal to positive (center post) terminal of dry cell, from negative of dry cell to one side of coil P, from remaining side of coil P to remaining terminal on contact key.

To the terminals of the galvanometer connect the two leads of coil P, and now you are ready for the demonstration.

Coil P and its associated circuit constitute the broadcasting station in simple form, while coil P, and the galvanometer represent the receiver.

With one eye on the galvanometer needle depress the key, closing the circuit of coil P, and notice that the galvanometer needle deflects.

You have now transmitted a magnetic pulse and have received it again, its presence having been plainly shown by the galvanometer-indicator that is operated by a distinctly different circuit.

From what has gone before you know that when the key was depressed a current of electricity started to flow in the circuit of coil P, resulting in a circular magnetic field appearing around the conductor with which coil P is wound. But this conductor instead of being a straight wire is coiled, hence all the circular magnetic paths are concentrated into a very small space, resulting in a group magnetic effect that is transmitted through the bar.

The "transmission through the bar" process is called magnetic induction and is most simply explained by stating that soft iron bars consist in reality of hundreds of tiny magnets arranged in

e Receiver "Toot"

Manwaring

a very topsy turvey fashion, and not pointing anywhere in particular. Therefore the bar is not magnetized. Also these hundreds of tiny magnets by nature would much rather remain as they are, consequently when their disposition at the coil P end of the bar is affected by the previously described group magnetic effect of the turns of coil P, the tiny magnets at this end of the bar all line up and this "line-up" effect is passed along to the coil P, end of the bar.

Second Group Magnetic Effect

Here the tiny magnets, each with its small external field, exercise a second group magnetic effect. As current flow is building up to a steady value set up a magnetic field at coil P end of the soft iron bar. The exact reverse occurs at coil P, end. The magnetic field developed at the coil P end of the soft iron bar results in a current being started in coil P, which deflects the galvanometer.

So if you remove the dry cell from coil P circuit and substitute antenna and ground, and connect coil P, to a grid-leak detector tube, turning the coil so that it selects the desired inducing frequency, a station will be heard. (The iron bar is removed under these conditions).

Substantially the same effect may be demonstrated with Fig. 3. If coil E be supplied with say 60 cycle AC obtained from the lighting circuit, and run through coil E, in series with a 25-watt lamp, the current flow will be about .2 of an ampere, (neglecting the small reactance and resistance of the coil E) and if you select a milliammeter (AC type) and connect it up to coil P or P, in series with a dry rectifier you will obtain a steady deflection within the scale confines of the meter.

The rectifier is analogous to the detector tube and the milliammeter represents the head phones.

What Magnetic Coupling Is

The foregoing pass-it-along magnetic characteristic, called induction, and the entirely reversible arrangement whereby an electric current sets up a magnetic field, or a magnetic field sets up an electric current, (it matters not which way you want to work it) is called magnetic coupling, or more briefly just "coupling," the basis of all manifestations utilized in your broadcast receiver, and without which none of the present-day progress in electrical applied science would have been possible.

All novices should read considerably, but also it is doubly important for them to experiment.

And experiment need not necessarily be expensive, but it should always be instructive. The sort of experiments that develop the understanding of the printed matter before you are the ones that should be performed first.

The simplest apparatus should be bought or built first, then the more advanced experiments are more readily understood, and appreciated.

If you cannot afford to buy a student galvanometer, for instance, you can build a repulsion type meter with the aid of 6 inches of ¼ inch brass rod, two pointed 8-32 brass screws, a bit of copper or iron sheet and a wooden strip 1 inch square with which you can make the supporting frame work.

Hammered Flat at End

The needle is a 4 inch length of No. 20 round aluminum wire hammered flat at one end and filed to an arrowhead shape to form a pointer, the filed point is to be painted black and the rear end of the aluminum rod is forced through a drilled hole in the brass axial rod that is mounted vertically between the two pointed 8-32 brass screws that fit into drilled depressions at either end of the brass rod.

The copper or iron vane with which you produce deflections is soldered or otherwise mounted directly on the brass pivot-rod, and the final detail is to attach an ordinary alarm clock hair spring near either extremity of the pivot-rod and adjustably secure it so that your pointer may have a "central zero" position on a scale which you are to make and calibrate. The scale will of course be arbitrary and you can only make comparative deflection tests, but you can use even a crude device like this to advantage if you will exercise imagination.

In order to be able to tune one circuit to resonate to the range of frequencies present in a coupled circuit it is desirable that the frequencies present in the inducing circuit shall be coupled with the greatest possible degree of uniformity, and it is to this ideal for which circuit designers strive.

Frequency Range Is Wide

The ideal coupling condition, however, is not obtained, because the range of frequencies we have to make our circuit resonate

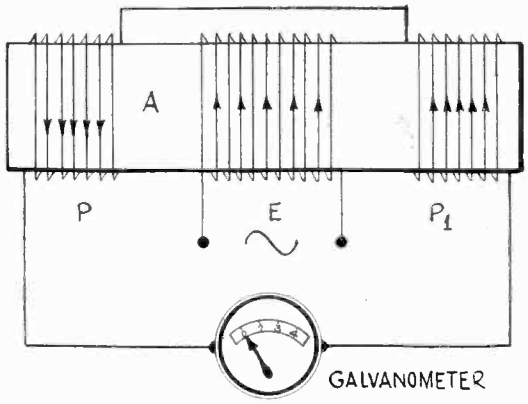

FIG. 3
A TEST EXPERIMENT THAT IS EASY FOR THE NOVICE TO BUILD

to extends over a nearly continuous range of 1,000 kc, and as a consequence no simple and at the same time fixed form of coupling will provide the necessary resolving ability desired of the tunable system.

Therefore our circuits have to be so designed that we obtain the best average effect under the given conditions, and with the limitations of certain fixed and adjustable apparatus.

There are two important devices in present-day radio receivers: the variable condenser and the tuning coil which is shunted across it.

The function of the condenser is to enable the shunt circuit, formed by it and the inductance coil, to respond or resonate to the radio frequencies (carriers) that are induced by the so-called primary coil or winding that is usually connected in series between the plate of the preceding stage tube and its source of AC potential.

The variable condenser adjusts the response of the shunt combination by altering the amount of shunt capacitance, and commercial variable condensers are supposed to provide sufficient capacity change, i.e., (total capacity when movable plates are fully meshed minus the final capacity when the movable plates are out of mesh) to enable the designer to provide a shielded coil which when combined with a correct condenser will result in the 1000 kc frequency range of the broadcast band.

This means that if a correctly designed condenser shunts an incorrectly designed coil the frequency range will not be covered. Likewise, if a correctly designed coil is combined with a condenser that has a capacity change less than a chosen minimum standard value, the results will be incorrect.

Non-Electrical Factors

The above limitations insofar as the variable condenser is concerned are influenced by some factors not wholly electrical.

It is a difficult economic problem to provide a variable condenser with a safe margin of capacity change; in a compact size, and at the same time keep the price reasonably low.

But another factor of greater interest to the set constructor, especially the one who likes to make his own coils, is the influence of resonance-frequency magnetic field amplitude. How much pep is transferred from the plate coil to the tunable grid coil, and is this transfer of energy dependant upon the resonant frequency?

Assume that a pre-selector circuit's tuning condenser, and the following first stage condenser, dial similarly, and that the input signal current is kept constant by adjustment as the various local stations are tuned in, an aural indicator being in the circuit.

As you listen you may detect somewhat less pep on the 570 kc signal than on 1,000 kc, and greater output at 1,500 kc as compared to 1,000 kc.

If you can change the coupling between the primary inducing coil and the secondary winding that is operating the grid of the tube whose plate circuit includes the aural indicator, when the signal frequency is 570 kc you will find that observed results change. And if you increase the coupling you will get a louder response. Adjust the coupling so that the response is a maximum. You will find that the response on the higher frequency end of the frequency scale is much less than it was previously and also all the intervening frequency responses have been affected adversely in varying degrees. The same thing of course obtains if the experiment is repeated at the 1,500 kc end of the frequency scale. Hence if you are setting up a tunable circuit, you can expect to have to make tuning adjustments until you obtain the best average response.

The 171A and the 230

By J. E. Anderson

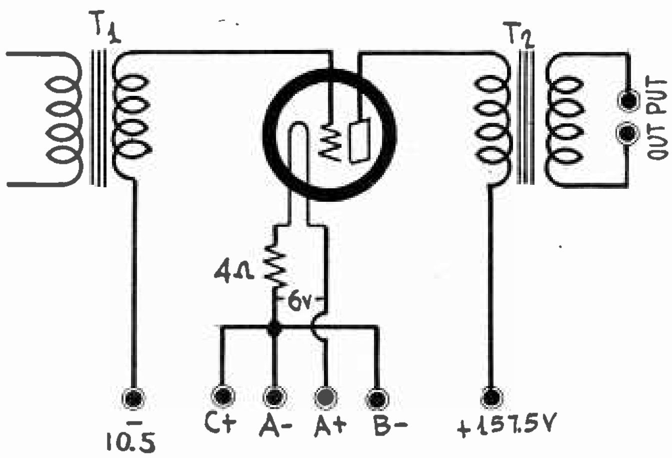

FIG. 37
THE SAME CIRCUIT AS IN FIG 36, EXCEPT THAT AN OUTPUT TRANSFORMER IS USED.

*[Herewith is the fourth instalment of "Modern Radio Tubes." The first instalment, in the August 9th issue, contained a discussion of the WD11, WD12, UV199 and UX199. The second instalment, in the August 16th issue, treated of the 120, 201A and 240. Last week, issue of August 23rd, the 200A and 112A were discussed. Next week, September 6th issue, additional information will be given about the 230, 231 and the 232.—*EDITOR.]

The maximum undistorted power output should not be confused with the maximum output power, for the first occurs when the load resistance is twice the internal resistance of the tube and the second occurs when the two resistances are equal. The maximum power contains a great deal of harmonic distortion, whereas the maximum undistorted power contains only 5 per cent. second harmonic.

112A Output Circuits

In Figs. 36 to 41, inclusive, are the diagrams of 6 output circuits incorporating the 112A tube. Fig. 36 is a single sided circuit for battery operation and with output filter. Fig. 37 shows the same circuit with an output transformer in place of the output filter. Figs. 38 and 39 are the same circuits, respectively, but arranged for alternating current heating of the filaments. In the battery circuits the grid bias is supplied by a 10.5 volt battery and the drop in the 4-ohm ballast resistor. In the AC heated circuits the bias is supplied by a 1,500-ohm resistor in the plate return lead.

The applied plate voltage is the same for all these four circuits, namely, 157.5 volts. The applied plate voltage in the AC heated circuits is higher than that in the battery circuits because it includes the grid bias.

In Fig. 40 is the diagram of a push-pull circuit in which the 112A tubes are operated with the same voltages as in the preceding circuits, and in Fig. 41 is the same push-pull circuit arranged for AC heating of the filaments. In this circuit the grid bias resistor is 750 ohms since plate current is twice as in either Fig. 38 or Fig. 39.

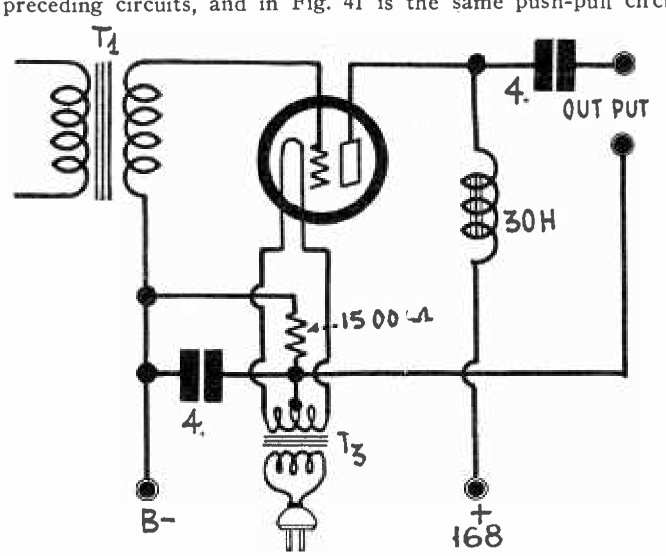

FIG. 38
THE SAME CIRCUIT AS IN FIG. 36 BUT ARRANGED FOR AC HEATING OF THE FILAMENT.

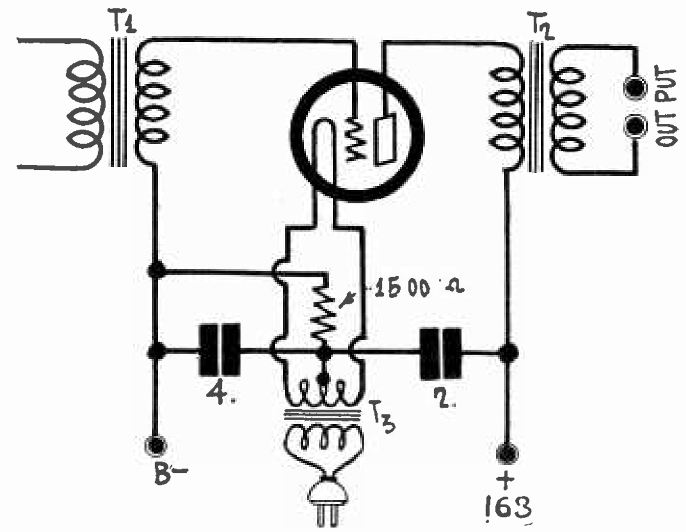

FIG. 39
THE SAME CIRCUIT AS IN FIG. 37 BUT ARRANGED FOR AC HEATING OF THE FILAMENT.

171A

THE 171A is power amplifier and cannot be used advantageously for any other purpose. Its low amplification constant of 3.0 makes it unsuitable for detection and voltage amplification. It may be operated on either a six volt storage battery or a five volt transformer. Its filament is an oxide coated ribbon rated at 5 volts and 0.25 ampere. With 180 volts on the plate and 40.5 volts on the grid it is capable of delivering a maximum undistorted output power of 710 milliwatts. In order to deliver this power the amplitude of the signal voltage should be equal to the bias, that is, 40.5 volts.

The base is standard and fits either the old type bayonet socket or the new UX socket.

CHARACTERISTICS OF THE 171A

Filament voltage.............	5.0
Filament supply voltage.......	6.0 DC or 5.0 AC
Filament current, amperes....	0.25
Amplification factor..........	3.0
Plate voltage, maximum.......	180
Grid bias, volts..............	40.5

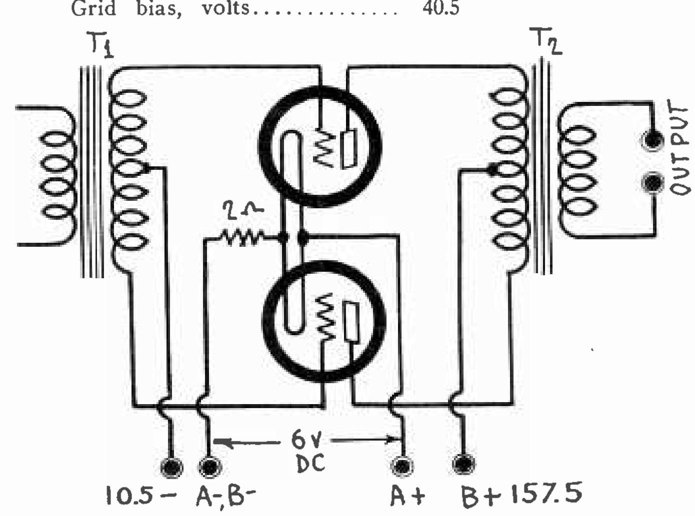

FIG. 40
A PUSH-PULL, BATTERY OPERATED POWER AMPLIFIER WITH 112A TUBES.

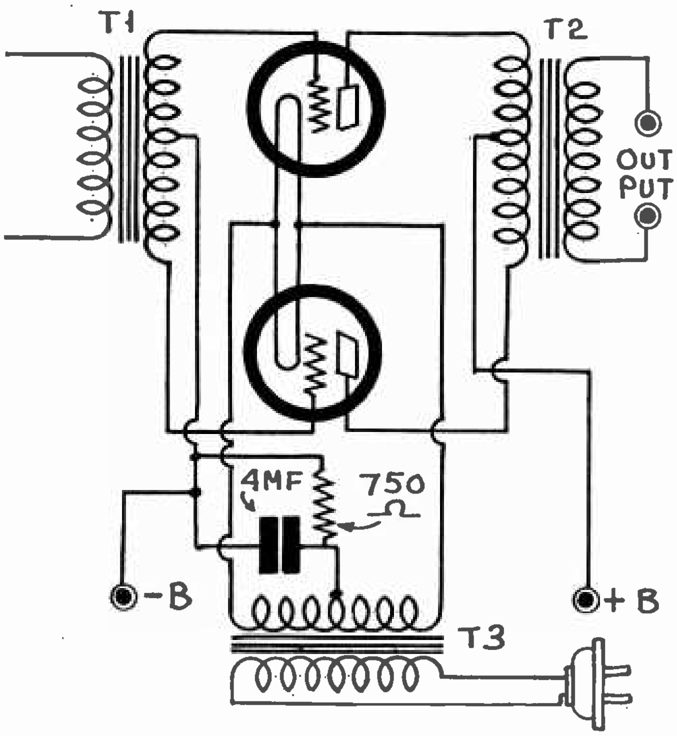

FIG. 41
THE SAME CIRCUIT AS IN FIG. 40 EXCEPT THAT THE FILAMENT CURRENT IS SUPPLIED BY A TRANSFORMER.

GRID BIAS VOLTAGES

Plate Voltage	Grid Voltage for DC	Grid Voltage for AC	Mean Plate Current (ma.)
90	16.5	19.0	10
135	27.0	29.5	16
157.5	33.0	35.5	18
180	40.5	43.0	20

Two columns of grid bias are given in the above table, one for cases when the tube is heated with direct current and the other when it is heated with alternating current. The values given in the second column are the total grid voltages and include the one volt drop in the filament ballast resistor. However, one volt more or less does not make much difference. The bias values given in the third column are 2.5 volts greater than the corresponding values in the second column. The reason for this difference is that in AC heated circuits the grid return is made to the mid-point of the filament and allowance must be made of one-half of the voltage drop in the filament. Even in a battery operated circuit the extra 2.5 volts should be used if the grid return is made to the center-tap of a resistance connected across the filament. The need for the higher bias in this case is obvious for the center of the filament is 2.5 volts positive with respect to the negative end of the filament.

In the case of an AC heated circuit the need for the extra 2.5 volts is not so obvious, yet the need for the higher bias is even greater. If we take the mid-point of the filament as zero potential, one end or the other of the filament is always negative with respect to the center-point and consequently the grid, if there were no applied bias, would always be positive with respect to some portion of the filament. Thus grid current would flow.

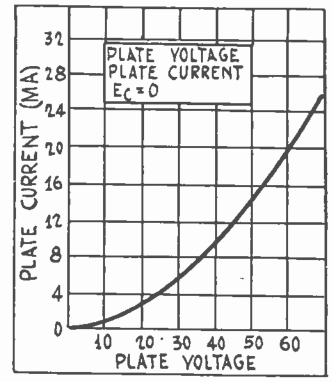

FIG. 42
THE PLATE VOLTAGE, PLATE CURRENT RELATIONSHIP AT ZERO BIAS FOR THE 171A TUBE.

For this reason it is necessary to increase the bias by at least 2.5 volts, the drop in either half of the filament, before we can begin to count the applied grid bias. That is, if we want a bias of 40.5 volts we have to apply 43 volts between the grid and the center-point.

We said "at least 2.5 volts" above advisedly because the maximum voltage drop in each half of the filament is greater than the effective value in the ratio of 1:0.707. Hence it would be desirable to increase the applied bias by 3.54 volts when the filament is heated with AC and the grid return is made to the center-point of the filament or to the center-point of the 5-volt heater winding. However, it is not necessary to allow for more than 2.5 volts for the effect of grid current that would flow during a small part of each half-cycle of the heater voltage would be very small and would occur only when the maximum signal was impressed.

Output Filtering Necessary

The plate current in this tube for all operating voltages is relatively high and for that reason it is necessary to arrange the output circuit so that this current is kept out of the loudspeaker winding. It may not be necessary when the plate voltage is as low as 90 volts, but since the tube will be operated at much higher voltages in most instances, it is best to provide either an output filter or a transformer.

Another reason for filtering the output current is that the resistance of the average loudspeaker winding is high so that the voltage drop in it would also be high. The choke in the filter or the primary of the output transformer usually has a much lower resistance to direct current and therefore the voltage drop would be lower. This would conserve the available voltage for useful purposes on the plate of the tube.

It is important that the recommended grid voltages be used for all applied plate voltages for if the grid bias be reduced the plate current will be excessive and the life of the tube will be short. Since the filament is oxide coated it cannot be reactivated and any considerable overload will damage the tube irreparably.

Curves

In Fig. 42 we have the plate voltage, plate current relationship for the 171A tube for plate voltages up to 70 volts and for zero grid bias. This shows the heavy plate current that can be expected for such low plate voltages when the bias is zero.

Fig. 43 contains a family of plate voltage, plate current curves for the tube over the usual operating range of grid voltages. It also contains two load lines, both for 4,000 ohms. The lower line is for 180 volts in the plate circuit and the upper for 255 volts.

The minimum current for this tube is taken at 2 milliamperes. If the plate current is permitted to become less the output will contain more than 5 per cent. second harmonic and the quality will not be good.

Let us calculate the output power on the basis of the upper load line. When the grid voltage is zero the plate current is 40 milliamperes and the plate voltage is 94 volts. At the minimum cur-

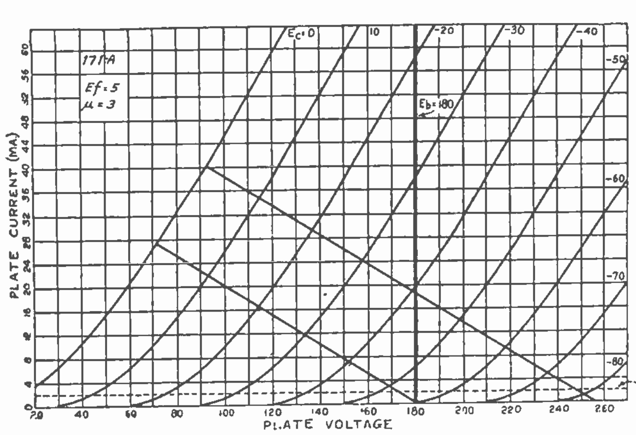

FIG. 43
A FAMILY OF PLATE VOLTAGE, PLATE CURRENT CURVES OVER THE OPERATING RANGE OF GRID BIAS FOR THE 171A TUBE.

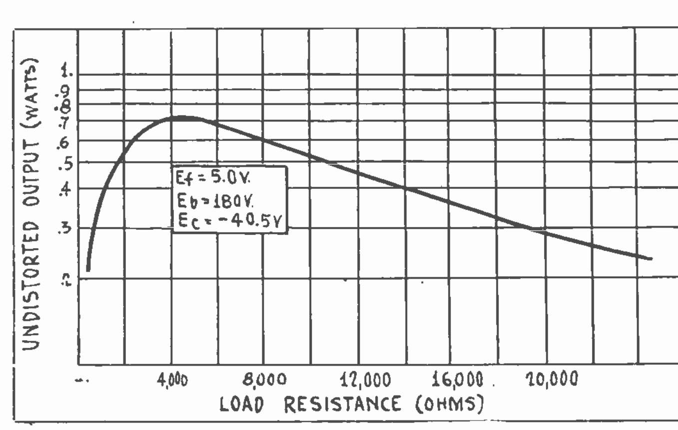

FIG. 44
THE RELATION BETWEEN THE UNDISTORTED POWER OUTPUT AND THE LOAD RESISTANCE FROM THE 171A TUBE UNDER THE CONDITIONS STATED.

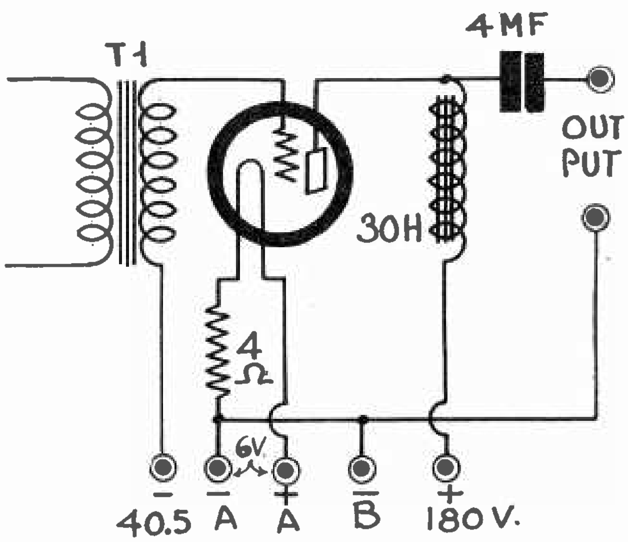

FIG. 45
AN OUTPUT AMPLIFIER USING THE 171A TUBE AND OUTPUT FILTER, DESIGNED FOR BATTERY OPERATION.

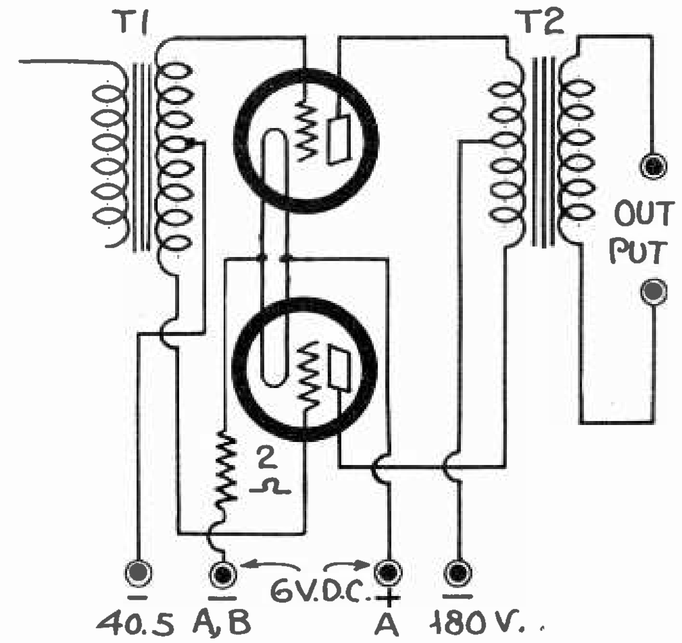

FIG. 47
A STAGE OF PUSH-PULL USING 171A TUBES AND DESIGNED FOR BATTERY OPERATION.

rent line the plate voltage is 248 volts. Thus the double amplitude of the voltage change is 154 volts and the double amplitude of the plate current change is 38 milliamperes. The product of these factors is eight times the output power. Hence the power is 731 milliwatts. The rated value is 710 milliwatts. The difference is due to the difficulty of reading the curves accurately.

The heavy vertical line represents 180 volts on the plate. Note that the load line crosses this line at 19 milliamperes at a point where the bias is slightly less than 40 volts, which means that the steady plate current is 19 milliamperes when the bias is 40 volts, under these particular conditions.

Variation of Output Power

Fig. 44 shows the relation between the undistorted power output and the load resistance on the tube under the conditions stated on the graph. The maximum undistorted output occurs at slightly more than 4,000 ohms, according to the graph, and at that point is 710 milliwatts.

A power amplifier circuit incorporating this tube is given in Fig. 45, and is of the output filter type. The ballast resistor should be four ohms, the applied plate voltage 180 volts, and the grid bias 40.5 volts. The 30 henry choke coil should be wound with heavy wire so that the voltage drop in it will be as low as possible. The condenser in series with the speaker should be at least 4 mfd. and the speaker return should be made to B minus.

Fig. 46 shows the same circuit when arranged for heating the filament with alternating current. In this case the grid bias resistor should be 2,000 ohms and it should be shunted with a condenser of at least 4 mfd. The total voltage applied to the AC circuit between B plus and B minus should be 220 volts, which will be divided automatically into 40 volts on the grid and 180 on the plate. The applied voltage may be increased somewhat to compensate for the drop in the choke coil. Note that the speaker return is made to the mid-point of the filament where the 2,000 ohm bias resistor and the 4 mfd. condenser also connect. This is the best return because it keeps the signal current out of the B supply.

If it is desired to use an output transformer in either of these circuits in place of the ouput filter, the corresponding circuits given for the 112A tube may be used, provided that the design values specified in Figs. 45 and 46 are used, when they differ in the circuits for the two types of tubes.

When push-pull amplification is desired the circuits in Figs. 47 and 48 may be used. Fig. 47 is for battery operation and Fig. 48 for alternating current heating. The grid and plate voltages are the same in the push-pull circuits as in the corresponding single sided circuits, but the filament ballast resistor in Fig. 47 is only 2 ohms and the grid bias resistor in Fig. 48 is only 1,000 ohms. That is, each is one-half the value of the corresponding resistor in the single tube amplifiers. The shunt condenser across the 1,000-ohm resistance in Fig. 48 is really not necessary when the circuit is truly balanced but since it is difficult to balance the two push-pull transformers and the tubes it is just as well to include the condenser to minimize the effect of any unbalance.

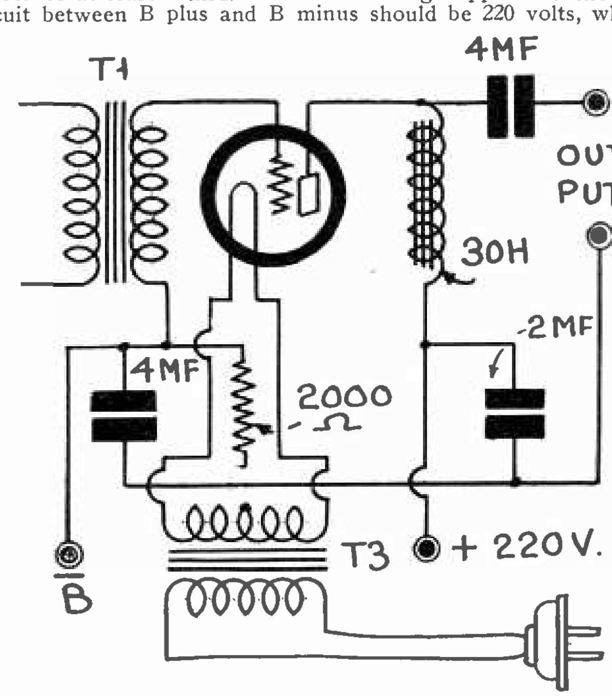

FIG. 46
THE SAME CIRCUIT AS IN FIG. 45 BUT ARRANGED FOR HEATING THE FILAMENTS WITH ALTERNATING CURRENT.

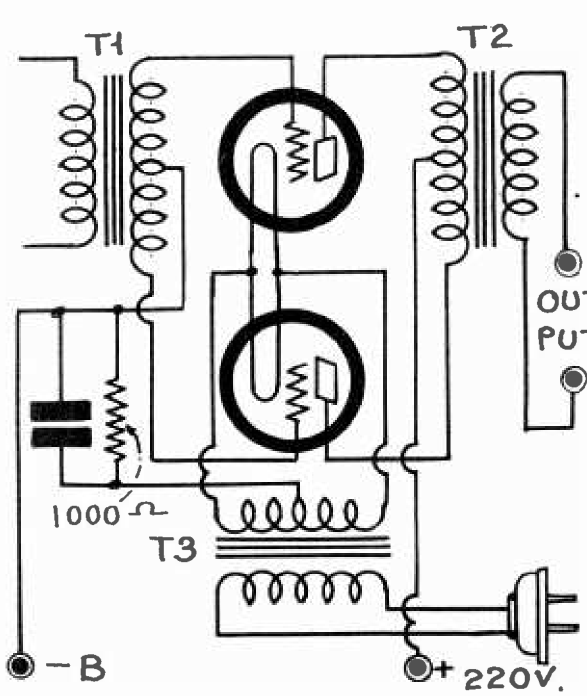

FIG. 48
THE SAME CIRCUIT AS IN FIG. 47 BUT ARRANGED FOR AC HEATING OF THE FILAMENTS.

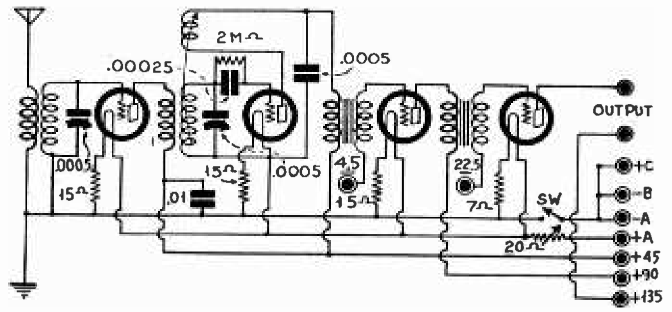

FIG. 49

THE CIRCUIT OF A FOUR-TUBE REGENERATIVE RECEIVER INCORPORATING THREE 230 TUBES AND ONE 231 POWER TUBE. TWO NO. 6 DRY CELLS WILL OPERATE THE FILAMENTS OF ALL THE TUBES.

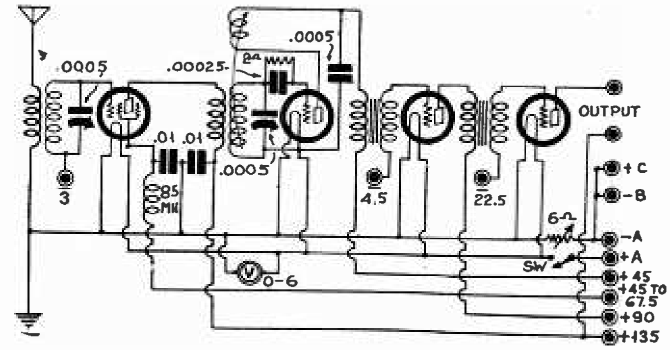

FIG. 50

A CIRCUIT SIMILAR TO THAT IN FIG. 49 BUT INCORPORATING ONE 232 SCREEN GRID TUBE FOR RADIO AMPLIFICATION. A FILAMENT VOLTMETER SHOULD BE USED AS AN AID IN ADJUSTING THE FILAMENT VOLTAGE.

230

THE 230 is one of a series of three new tubes designed especially for battery operation where economy of filament pofer is important. The other tubes of this series are the 231, a power tube, and the 232, a screen grid tube. The filament terminal voltage of each of these tubes is 2 volts.

The 230 tube is of the general purpose type, that is, it has a medium value of amplification factor so that it can be used as radio frequency amplifier, detector, audio frequency amplifier, and oscillator. As audio frequency amplifier it can be used in transformer, resistance, and impedance coupled circuits, and it can also be used as output tube provided that only headset volume is desired.

The tube has a small standard base and fits into standard UX sockets. In external appearance it is like the 120 power tube.

CHARACTERISTICS OF 230

Filament voltage	2.0
Filament current, amperes	0.06
Filament power, watts	0.12
Plate voltage, maximum	90
Grid bias, volts	—4.5
Plate current, milliamperes	2.0
Plate resistance, ohms	12,500
Amplification factor	8.8
Mutual conductance, micromhos	700
Grid-Plate capacity, mmfd.	6.0

The plate voltage of 90 volts given in the table is the maximum that should be used on the tube, and it is also the recommended value. If, however, the tube is used in a resistance coupled circuit, higher applied plate voltages may be used since the plate current and the effective plate voltage will be low. If the coupling resistor is of the order of 100,000 ohms, the applied voltage could well be 135 volts.

If the tube is used in a resistance coupled amplifier with 100,000 ohms in the plate circuit, a .01 mfd. stopping condenser between the plate and the grid of the following tube, and a 2 megohm grid leak preceding the second tube, a voltage amplification of about 5.5 can be obtained. If the plate load resistance is increased, and if at the same time the applied plate voltage is increased proportionately, a voltage amplification of about 7 can be obtained without trouble.

A higher gain per stage can, of course, be obtained if transformer coupling is used. For example, if the ratio of the transformer windings is 4-to-1 a gain of about 24 can be obtained. Hence this tube should be used in a transformer coupled circuit except for special purposes. Any audio transformer designed for tubes of the general purpose types previously discussed can be used with this tube.

Radio frequency transformers designed for other general purpose tubes can also be used for this tube since the output impedances are roughly equal.

Use As Detector

The 230 tube can be used as detector either with grid bias or with grid leak and condenser. If bias is used the plate voltage may be 45 volts and the bias 3 volts. For greater output the applied voltage may be 90 volts, when the grid bias should be 9 volts. If the other type of detection is used, the grid leak resistance should be 2 or 3 megohms and the stopping condenser should be .00025 mfd. The grid return should be made to the positive end of the filament in this case.

Regeneration may be used in the detector, especially when the grid leak and condenser method of detection is used. The turns required on the tickler are the same as those required for a 201A and therefore a three-circuit tuner designed for the 201A will be all right for this tube also.

In Fig. 49 is a diagram of a four tube regenerative receiver employing three 230 tubes and one 231 power tube. The ballast resistors in this receiver are given on the assumption that the filament voltage source is 3 volts, that is, made up of two dry cells connected in series. Each ballast is a little smaller than that required to drop one volt but the excess is provided for by a 20-ohm rheostat in the positive lead to filament battery. The voltage should be adjusted with the aid of a voltmeter so that the drop across the terminals of any filament is 2 volts, or else with the aid of an ammeter connected in series with the filament battery so that the total current for the four tubes is 0.31 ampere. The ballast resistors are made small purposely so that the proper filament current may be obtained after the battery voltage has dropped below 3 volts.

All necessary design values except those for the coils are given on the circuit diagram, and the coils may be any standard radio frequency transformers designed for the specified tuning condensers. The first is an antenna coupler and the second a three circuit tuner.

Fig. 50 outlines another four-tube receiver in which the new tubes are used, but only the detector and the first audio frequency amplifier are of the 230 type. The radio frequency amplifier is one of the new screen grid tubes to be discussed later and the output tube is one of the new 231 power tubes. Fig. 51 is another receiver in which the detector and the first audio frequency amplifier are of the 230 type.

A Push-Pull Circuit

In Figs. 50 and 51 no ballast resistors are used because the grid bias is provided for by batteries and the excess filament voltage is dropped in a 6-ohm rheostat common to all the filaments. In each of these circuits it is essential that a voltmeter be used as indicated so that the filament voltage may be adjusted to 2 volts with the rheostat. When using any of these circuits, the rheostat should always be set at maximum when the switch is first closed and then the resistance should be decreased until the indicated filament voltage is 2 volts. This procedure is especially important when the filament battery has been used for some time, for a used battery has a higher voltage after a period of rest than its voltage after it has functioned a few minutes. The filaments must be protected against the over-voltage when the current is first turned on. To ensure this protection it is preferable to use the rheostat as a switch rather than to use a separate switch as indicated.

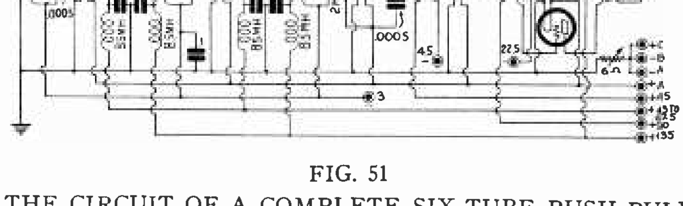

FIG. 51

THE CIRCUIT OF A COMPLETE SIX-TUBE PUSH-PULL RECEIVER INCORPORATING TWO 232 SCREEN GRID TUBES, TWO 230 TUBES AND TWO 231 POWER TUBES.

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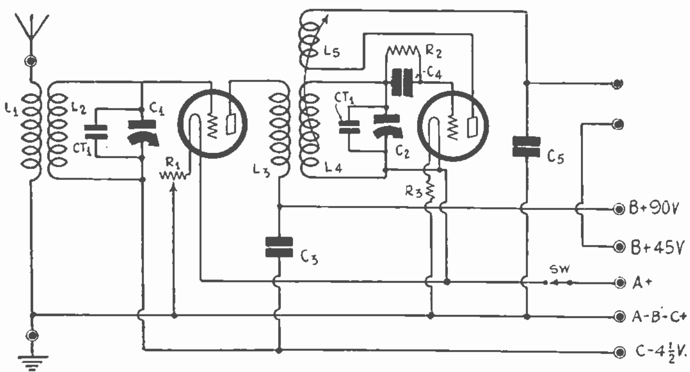


FIG. 842
WHEN ECONOMY OF TUBES IS PARAMOUNT THIS RADIO FREQUENCY AMPLIFIER AND REGENERATIVE DETECTOR MAY BE USED AHEAD OF AN AUDIO AMPLIFIER

Simple Regenerative Tuner

I WISH TO BUILD a radio frequency amplifier and regenerative detector comprising two tubes to go with an amplifier I have. I have the parts which were taken out of a circuit of this type but I don't have a diagram. If you will publish one I shall appreciate it very much.—C. E. P.

Fig. 842 gives such a circuit. It is supposed to be operated with tubes of the 201A type, and the detector should be followed by an audio frequency transformer.

* * *

Substitution of Tubes

IS IT PRACTICAL to substitute the new screen grid tube 232 in a receiver designed for using 222 tubes? If so, what changes in the circuit are necessary?—W. H. W.

The new tube cannot be substituted directly because it takes less filament current and filament voltage. To adapt the circuit, therefore, it will be necessary to change the value of the ballast resistor so that the net voltage on the filament is two volts. The 232 takes a filament current of .06 ampere and a terminal voltage of 2 volts. Therefore, if the supply voltage is 6 volts it is necessary to put in a rheostat or ballast resistor having a resistance value of 4/.06, or 66.6 ohms. It is best to make at least a part of this resistance a rheostat so that the voltage may be adjusted until the terminal voltage is exactly two volts, or until the current is .06 ampere. The 4 volt drop in the resistance is greater by one volt than the required grid bias. Hence part of the ballast resistor should be put in the positive leg. The required grid bias is 3 volts.

* * *

Tubes for Portable Sets

WHAT TUBES are most suitable for portable sets? I want a set of about six tubes capable of operating a loudspeaker. It is to be used both in a car and in camp. I have several circuit diagrams and I can adapt any one to any type tubes you recommend.—S. E. R.

There are two types of tubes generally available suitable for portable sets. One type is the 199 with 120 power tube and the other type is the 230, 231, and 232. Good portable sets can be built around either type. Perhaps the new two-volt tubes are better. These are the 230 general purpose tube, 231 power tube, and the 232 screen grid tube.

* * *

Change of Inductance With Current

IS THERE ANY change in the inductance of a radio frequency choke coil with DC flowing through the winding? I have heard that there is no change but I cannot see why there should be no change when there is a change of the inductance of an audio frequency choke or transformer.—J. L.

There is no change in inductance of a radio frequency choke coil with direct current provided that choke coil has no iron or other magnetic material in its field. The inductance changes because the permeability of the core changes with direct current. If there is no material in the core the permeability of which can change there is no change in the inductance. Audio frequency chokes and transformers always have iron, steel or alloy cores and the permeability of the core material depends largely on the amount of direct current that flows through the winding around the core. Hence the inductance of such coils changes with the direct current. As the coils are designed and used, the inductance always decreases as the current increases.

Frequency Modulation in Oscillator

S THERE ANY frequency modulation in an ordinary vacuum tube oscillator or is the frequency constant? If there is frequency modulation to what is it due?—B. A. S.

Assuming that the capacity and inductance of the oscillating circuit do not change, and that the filament, grid and plate voltages remain constant, there is no frequency modulation. However, when the generated oscillation is modulated by voice or otherwise there is a change in the effective plate voltage, and this change results in frequency modulation. In the analysis of the circuit the generated frequency is shown to depend not only on the capacity and the inductance in the circuit but also on the ratio of the internal plate resistance of the tube to the external resistance. The external resistance remains constant but the internal resistance of the tube changes with changes in the voltages on the elements. The plate voltage particularly changes with modulation and therefore frequency modulation sets in. The smaller the ratio between the internal plate resistance of the tube to the external resistance the smaller is the change in frequency generated. When the generated frequency is controlled by means of a quartz crystal frequency modulation does not occur.

* * *

Separate B Supplies

I HAVE A FIRST-CLASS audio amplifier with built-in power supply. I am now planning to build a radio frequency tuner to go with it. There is provision on my audio amplifier to tap the voltage divider for the radio frequency amplifier. Will the audio amplifier work just as well when the radio frequency tuner is connected to the voltage supply as it does when no extra current is taken from the B supply? If not, please explain why it will not. Would it be advisable to build a separate B supply for the radio frequency amplifier?—T. P. T.

Many high class audio amplifiers with built-in B supplies work excellently as long as no extra current is taken from the B supply, but as soon as additional current is taken the operation becomes unsatisfactory. The reason for this is that the extra current causes a drop in the output voltage so that all the tubes in the audio amplifier get insufficient voltage for proper operation. It would scarcely be practical to build a B supply with regulation so good that the voltage would remain at the desired level when a drain from the device is nearly doubled. It is by far better to use one B supply for the radio frequency amplifier and another for the audio amplifier, each designed for the special purpose. Both parts of the receiver will then work at their best.

* * *

Flow of AC in a Vacuum Tube

HOW CAN alternating current flow in a vacuum tube plate circuit when the electrons can flow only from the cathode to the plate? For example, how does the current through a by-pass condenser in the plate circuit flow through the tube?—L. A. T.

No AC can flow in the plate circuit, only direct current. But the direct current may be pulsating, that is, it may contain an AC component. The DC through the tube acts as a carrier for the AC component. When the condenser current is such as to require the current through the tube to flow in the wrong direction the direct current simply decreases in value. When the condenser current is such as to require the current through the tube to flow in the normal direction the plate current simply increases above the mean value.

* * *

A Vacuum Tube Voltmeter

IF A VACUUM TUBE voltmeter is calibrated with direct voltage will it also read effective values of alternating voltages? A thermo-couple meter is usually calibrated with direct current and then used for measuring alternating current, but I doubt that the same hold for a vacuum tube voltmeter.—A. T. H.

A vacum tube voltmeter calibrated on DC would not measure AC because when steady voltages are used on the grid the plate current has the same value all the time as long as the grid voltage remains constant. If an alternating voltage is used on the grid the plate current will vary according to the grid voltage and will not remain constant. The meter in the plate circuit, however, will average the plate current and give a steady reading. The average current will be lower than the peak since the alternating voltage varies between zero and the maximum value. If the vacuum tube is operated so that the relation between the grid voltage and the plate current is linear, which may be done by putting a very high resistance in the plate circuit, then the mean current is 0.636 of the peak value. Hence if we calibrate the meter in terms of DC and then use it on pure AC, we get the mean value of the alternating voltage. The mean voltage is less than the effective voltage, and to get the effective voltage we have to multiply the mean value by 1.111. This is true only if the calibration curve is a straight line. It is always best to calibrate the meter with DC, if it is to be used for measuring steady voltages, and with AC, effective values, if it is to be used to measure effective values of alternating voltages.

* * *

Service Range of a Broadcast Station

HOW STRONG SHOULD the field strength from a station be if the service of that station is to be satisfactory, and upon what factors does the strength depend beside the power of the transmitting station?—J. C.

The signal strength required for satisfactory service depends on many factors such as the quietness of the receiver, the amount of noise in the vicinity of the receiver, the amount of fading of the signal, and on the sensitivity of the receiver. Under average conditions a field strength of 1 millivolt per meter should give satisfactory service. Many receivers have a sensitivity that will produce standard output on as weak signals as 1 microvolt per meter, but it is seldom that satisfactory signals can be received on such weak signals even if they are loud enough. It will be noted that the ratio of the signal giving satisfactory service under average conditions to the signal which in the most sensitive sets will put out standard volume is 1000 to 1.

* * *

Converter Intermediate Coil

I WANT TO BUILD a short-wave converter with an intermediate frequency of 1,500 kc. My receiver is quite sensitive at this end of the broadcast band but I want to increase the sensitivity by adding one intermediate stage in the converter. I have a 100 mmfd. trimmer condenser which I want to use across the secondary of the 1,500 kc. transformer, and I want to wind the coil on a tube base. How much inductance do I need and how many turns of what size wire?—C. D.

Assuming that the total capacity across the secondary is 100 mmfd., the inductance should be 112.5 microhenries. This will be given by 51 turns of No. 32 enameled wire wound as close as the insulation permits. The primary may contain half as many turns of the same wire wound at the ground end of the secondary winding. The windings should be separated by several layers of paper. Since there will be some distributed capacity in the coil and in the tube not all the capacity of the trimmer condenser will be needed. Thus there will be some latitude for changing the frequency in case it is desired to make it a little higher or lower than 1,500 kc.

* * *

Band Pass Filters and Static

DO BAND-PASS FILTERS have any appreciable superiority in regards to the suppression of static disturbances over ordinary tuners? I have built receivers both with ordinary tuners and band-pass tuners and have noted that static seems to be just as severe in the band-pass filter circuit as in the other. Yet when it comes to selectivity as among stations the band-pass filter circuit seems to be decidedly superior.—A. D. S.

The theory of filter circuits shows that the highly selective properties of such circuits apply mainly to the steady state and not to transient conditions. Since static, so-called, is a transient condition a highly selective filter does not discriminate against it any more than an ordinary tuner. Yet the filter circuit discriminates against carrier frequencies more than an ordinary tuner. The modulation carried by a wave is largely a transient condition because any one sound does not remain constant in amplitude or frequency for any length of time. Consequently the highly selective filter is not so selective to a modulated wave as to an unmodulated wave. There may be an advantage in this fact. In the first place the band-pass filter discriminates sharply against the carriers outside its own transmission band, and in the second place it does not discriminate against modulation even if the transmission band is narrower than the modulation band.

* * *

Rectification of Radio-Frequency Currents

WOULD IT BE possible to rectify radio-frequency currents in the same manner and with similar circuits as 60-cycle current is now rectified in B supply circuits? It seems to me that if this were possible very small condensers and choke coils could be used for smoothing out the ripples. —Q. R. V.

This has been done for the purpose of getting a ripple-free direct current supplied at very high voltage. It is doubtful, however, that it would be suitable for a B supply in a radio frequency receiver because if only alternating current is available, a B supply of the regular kind would have to be used for supplying the plate of the oscillator tube which would generate the high frequency, and the output of this rectifier and filter would contain ripple, which would appear in the high frequency current as a modulation. It would also appear in the rectified output of the high-frequency rectifier and filter. The system is suitable for applications where a very high, ripple-free voltage and low current are required. The plate of the oscillator could then be served by a comparatively low-voltage battery. In that case the only ripple that would occur in the rectified output would the high-frequency variations, which could be taken out with small chokes and condensers.

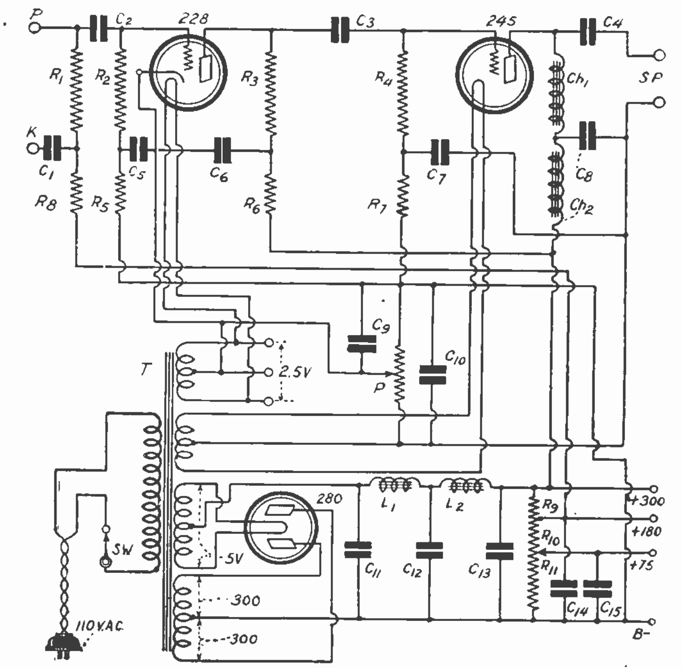


FIG. 843
THE STABILITY OF A RESISTANCE COUPLED AMPLIFIER SERVED BY A RECTIFIER AND FILTER THROUGH FILTERING OF THE PLATE LEADS IS NECESSARY AS IS ILLUSTRATED HERE

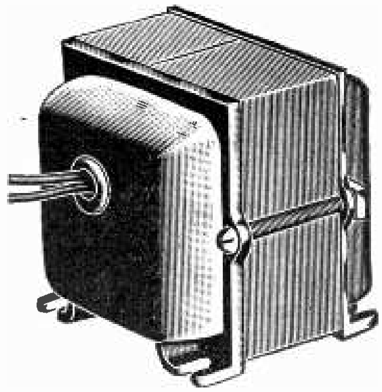
* * *

Stopping Motorboating

PLEASE ILLUSTRATE by means of a complete diagram of a resistance coupled amplifier and B supply, how the plate circuits should be filtered so as to eliminate feed-back and motorboating.—G. B. A.

A circuit that meets this request is shown in Fig. 843. There is filtering in both the grid and the plate circuits. Whenever there is a choice of connections of condensers and plate returns they have been made so as to assure greatest stability without reverse feed-back. Note especially how the plate circuit of the last tube has been treated.

New Polo Power Transformers and Chokes

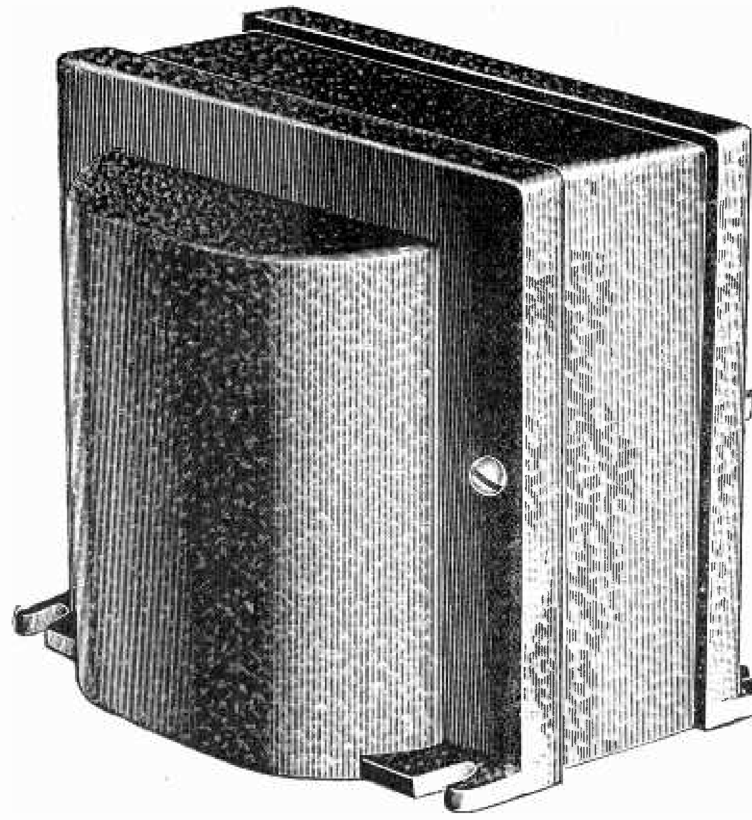


Shielded single choke, 200 ohms D.C. resistance, non-saturable at 100 milliamperes, with two black outleads, each 6 inches long. For filtration of B supplies. Inductance, 30 henrys.
Cat. SH-S-CH, price..............................$5.00

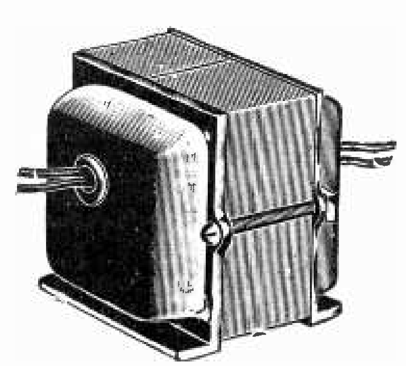
The shielded single choke will pass 100 ma. One will suffice if the current is 100 ma. or less, for filtration of B supplies, provided the capacity at the filter output is 8 mfd. or more. Use two such shielded chokes if less than 8 mfd. is used at the filter output. Also, the shielded single choke may be used as in the power tube circuit for an output filter. In this connection use at least 2 mfd. for the capacity section of the filtered speaker output. Order Cat. SH-S-CH @ $5.00

The shielded double choke may be used for filtration where the B current is 60 ma. or less, with relatively small filter capacities, no less than 4 mfd at the output, however. This choke consists of one winding, center-tapped. Its use is especially recommended for 171, 171A, 245 or 210 push-pull output. Connect the black leads (extremes of windings) to plates of the push-pull tubes, red center tap to B plus, and the speaker may be connected directly to plates without any direct current, but only signal current, flowing through the speaker. This system is applicable only to push-pull. Order Cat. SH-D-CH @ $6.00

In the same type of case a 20-volt secondary filament transformer, for 110 volts, 50-133 cycle, may be obtained for use in conjunction with dry rectifiers, such as Kuprox, Westinghouse, Benwood-Linze and Elkon, in dynamic speakers or A battery eliminators. Not made for 25 or 40 cycles. Order Cat. SH-F-20 @....................$2.50



245 Power Transformer for use with 280 rectifier, to deliver 300 volts D.C. at 100 milliamperes, slightly higher voltage at lower drain, and supply filament voltages.
Cat. 245-PT price $8.50

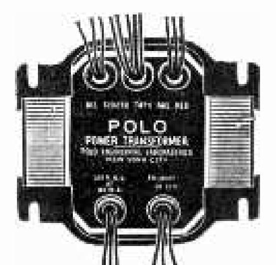


Twenty-volt filament transformer, 110 v. 50-133 cycle input, for use in conjunction with dry rectifiers. It will pass 2.25 amperes.

In a different type case, square, of cadmium plated steel with four mounting screws built in, size 4⅛ inches wide by 8¾ inches high by 4 inches front to back, a 50-60 cycle filament transformer is obtainable with the same windings as the 245 power transformer, except that the high voltage secondary is omitted. Order Cat. 245-FIL, @ $4.50
For 40 cycles order Cat. 245-FIL-40 @.......... 7.00
For 25 cycles order Cat. 245-FIL-25 @............8.50
[Any of the above three in the same case as the 245 power transformer, © $1.00 extra. Add PTC after the Cat. number.]

A single choke, unshielded, 65 ma rating, 30 henrys inductance, for B filtration or single output filter of speaker, is our Cat. US-S-CH @..................$1.25

The Polo 245 power transformer is expertly designed and constructed, wire, silicon grade A steel core and air gap large enough to stand the full rated load. The primary is for 110v A.C., 50-60 cycles, tapped for 82.5 volts in case a voltage regulator, such as a Clarostat or Amperite, is used. The black primary lead is common. If no voltage regulator is used, connect black lead to one side of the A.C. line, green lead to the other side of the line, and ignore red lead, except to tape the end. For use with a voltage regulator (82 5-volt primary) use red lead and ignore the green except to tape the end. The secondaries are: high voltage for 280 plates, with red center tap to ground; 2.5 volts, 3 amperes, red center tap to C plus, for 245 output, single or pushpull; 5 volts, 2 amperes, red center tap, as positive B lead, for filament of 280 tube; 2.5 volts, 16 amperes, red center tap to ground, for 224, 227 and pentode tubes, up to nine heater type tubes. Hence there are five windings.



Bottom view of the 245 power transformer. All leads are plainly marked on the nameplate, including the top row.

A special filament transformer, 110 v., 50-60 cycles, with two secondaries, one of 2.5 v. 3 amp. for 245s, single or push-pull, other 2.5 v. 12 amperes for 224, 227, etc., both secondaries center-tapped. Shielded case. 6 ft. AC cable, with plug. Order Cat. F-2.5-D @.......$3.75

The conservative rating of the Polo 245 power transformer insures superb results even at maximum rated draw, working up to twelve tubes, including rectifier, without saturation, or overheating due to any other cause. This ability to stand the gaff requires adequate size wire, core and air gap, all of which are carefully provided. At less than maximum draw the voltages will be slightly greater, including the filament voltages, hence the 16 ampere winding will give 2.25 volts at maximum draw, which is an entirely satisfactory operating voltage, increasing to 2.5 volts maximum as fewer than a total of nine RF, detector and preliminary audio tubes are used.

The avoidance of excessive heat aids in the efficient operation of the transformer and in the maintenance of good regulation, for excessive heat increases the resistance of the windings.

The transformer is equipped with four slotted mounting feet and a nameplate with all leads identified. It is one of the very finest instruments on the radio market.

Highest Capacity of Filament Secondary

SPECIAL pains were taken in the design and manufacture of the Polo 245 power transformer to meet the needs of experimenters. For instance, excellent regulation was provided, to effect minimum change of voltage with given change in current used. Also, the 2.5 volt winding for RF, detector and preliminary audio tubes, was specially designed for high current, to stand 16 amperes, the highest capacity of any 245 power transformer on the market. Hence you have the option of using nine heater type tubes. The shielded case is crinkle brown finished steel, and the assembly is perfectly tight, preventing mechanical vibration.

The power transformer weighs 11½ lbs., is 7 inches high, 4⅞ inches wide, and 4¼" front to back, overall.

Elevating washers may be used at the mounting feet to clear the outleads, or holes may be drilled in a chassis to pass these leads, and the transformer mounted flush.

Advice in Use of Chokes and Condensers in Filter

With the 245 power transformer either one or two single chokes should be used, or a shielded double choke, depending on the current drain and the capacity of filter condenser used. Where the capacity at the output is 8 mfd. or more for a drain of 65 to 100 ma., a single choke will suffice (Cat. SH-S-CH), but where smaller output capacity than 8 mfd. is used on such drain, two such chokes should be used in series. Next to the rectifier, in either instance, use a 1 or 2 mfd., 550 A.C. working voltage rating condenser (D.C. rating, 1,000 volts). You may use your choice of capacity at the midsection.

If the drain is to be 65 milliamperes or less, the double choke, Cat. SH-D-CH, may be used for filtration, instead of two single shielded chokes.

The Polo 245 power transformer may be obtained for 25 cycles or 40 cycles on special order, as these are not stocked regularly, and remittance must accompany order. The same guaranty attaches to them as to all other Polo apparatus—money back if not satisfied after trial of five days. In these the primary and secondary voltages and taps are the same, only the case is deeper (front to back) because of larger core and wire for lower frequency.
For 40 cycles order Cat. 245-PT-40..@ $9.50
For 25 cycles order Cat. 245-PT-25..@ $12.50
[Note:. The filter for 40 cycles should consist of two shielded single chokes, Cat. SH-S-CH, with 2 mfd. next to the rectifier and 4 mfd. minimum at the joint of the two chokes and at the end of the filter. For 25 cycles the same holds true, except that the output capacity at end of chokes should be 8 mfd. minimum.]

We Make Special Transformers to Order

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Enclosed please find $———— for which ship at once:

☐ Cat. 245-PT @...$8.50	☐ Cat. 245-FIL @..$4.50
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☐ Cat. SH-S-CH @ 5.00	☐ Cat. SH-F-20 @. 2.50
☐ Cat. SH-D-CH- @ 6.00	☐ Cat. UN-S-CH @. 1.25
☐ F-2.5-D @ 3.75	

Note: Canadian remittance must be by post office or express money order.

☐ If C.O.D. shipment is desired, put cross here. No C.O.D. on 25 and 40 cycle apparatus. For these full remittance must accompany order. The 25 and 40 cycle apparatus bears the 50-60-cycle label, but you will get actually what you order.

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AUCTION

By Order of the U. S. District Court for the Southern District of New York

In the Matter of { SONORA PRODUCTS CORP. of AMERICA / SONORA PHONOGRAPH CO. Inc. } Bankrupts

We Will

Commencing on Wednesday, September 3rd, 1930, at 10:00 A. M. (Eastern Standard Time) and proceeding continuously thereafter until completed; at

1900 S. MICHIGAN AVE., SAGINAW, MICHIGAN

Sell at Public Auction the Assets of
SONORA PHONOGRAPH CO. INC.
SONORA PRODUCTS CORP. OF AMERICA

INVENTORY VALUE OVER $550,000.00

consisting of:

TOOL-ROOM EQUIPMENT

30 Iron-working machines such as Lathes, Screw Machines, Millers, Gear Cutters, Planers, Shapers, Surface Grinders, in such makes as Hendey, American, South Bend, Warner-Swasey, Pratt & Whitney, Cincinnati, Kempsmith, Barber-Colman and other well-known makes.

20 Drill Presses such as Leland-Gifford, U. S., Sipp, Reed, Manhattan, Mechanics, Barnes, Hendry & Wright, from 1 to 4 spindle.

Miscellaneous such as Hack-Saws, Emery Grinders, Furnaces, Tumbling Barrels, Arbor-Presses, Tapping Machines, etc.

GRINDING EQUIPMENT

Automatic Knife Grinders, Saw Grinders, Bench Grinders, etc., in such makes as Brown & Sharpe, U. S., Baldwin, Tuttle & Bolton, Woode, etc.

300 Motors ranging from 1/4 to 30 Horse Power in such makes as Western Electric, General Electric, Wagner, Westinghouse, Robbins & Meyers, etc.

Note:—All these motors are 60 cycle, 220 volt, 3 phase.

POWER-HOUSE EQUIPMENT

Vertical Pumps, Air Compressors, Engines, Generator Sets, Frequency Changers, etc.

WOOD-WORKING MACHINERY

275 Modern Wood-working machines, mostly all motorized, such as Sanders, Tenoners, Routers, Shapers, Moulders, Band Saws, Mitre Saws, Scroll Saws, Swing Saws, Rip Saws, Jointers, Carving Machines, Scraping Machines, Boring Machines, Wood-working Lathes, Veneer Presses, Planers, Doweling Machines, Nailing Machines, Veneer Machines and Glue Presses in the best known makes such as American, Berlin, Mattison, Fay & Egan, Moore-Garvin, Curtis, Wayne, H. B. Smith, Ames, Jenkins, Buss, Yates, Baxter D. Whitney, Beech, Porter, Valley City, Bental & Margedant, Oliver, Linderman, Dauber-Bell, Clements, Perkins, Francis, Tannewitz, Morgan, Falls, Sheridan, New Britain, etc.

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Birch and Poplar from 1/20 to 1/2, Ebony, Laurel Wood, Blistered Maple, Curly Maple, Bosse, Lacewood, Prima Vera, Japanese Ash, Zebra, Mahogany Stripped, Mahogany Lining, Mahogany Mottled, Birdseye Maple, Oak Burl, Redwood Burl, Rosewood, East India, Satinwood, Thuya Burl.

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