TWO TUBE AC SCREEN GRID TUNER

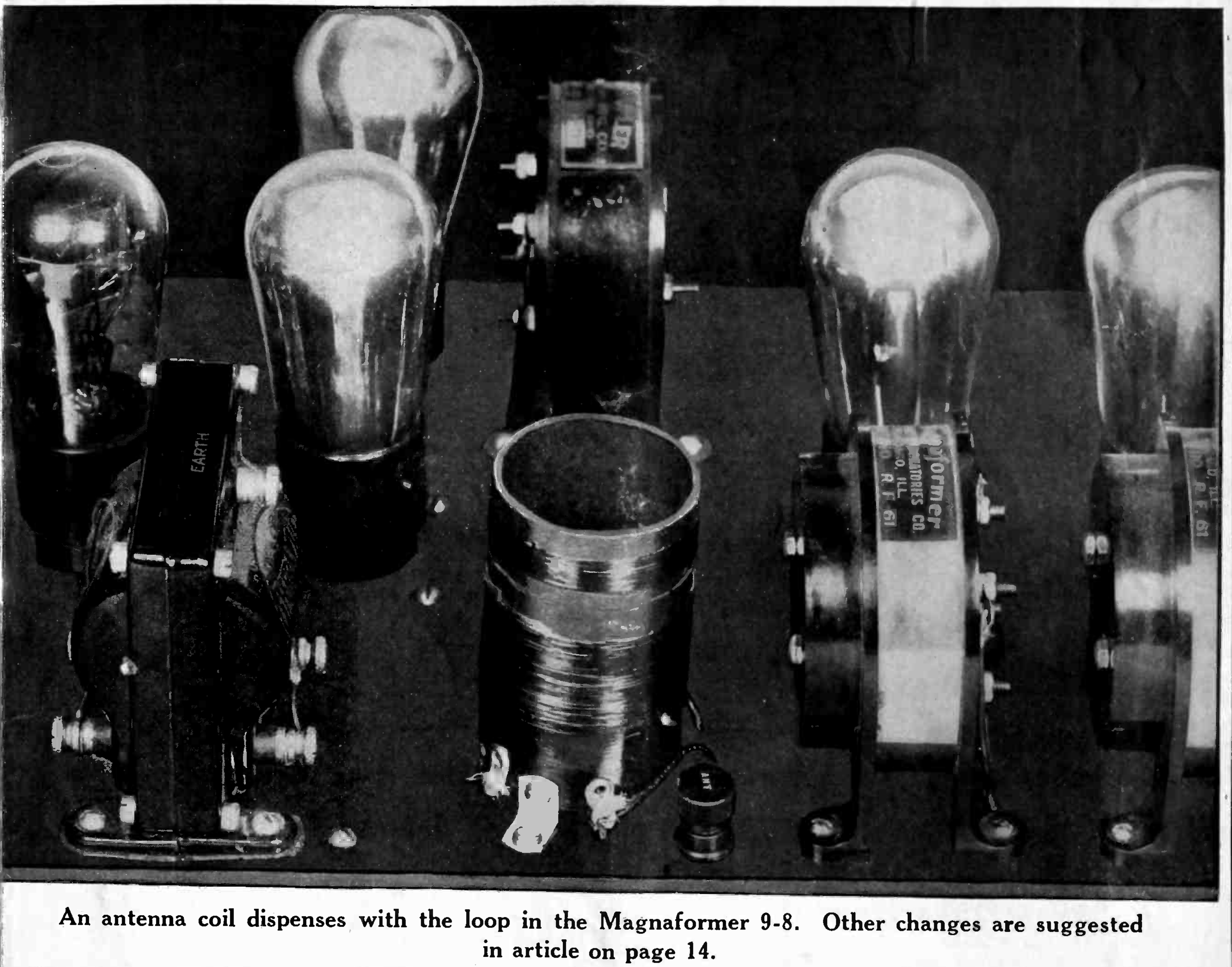
JAN. 4th, 1930

15 CENTS

RADIO WORLD

REG. U.S. PAT. OFF.

406th Consecutive Issue—EIGHTH YEAR



An antenna coil dispenses with the loop in the Magnaformer 9-8. Other changes are suggested in article on page 14.

WHAT ABOUT PUSH-PULL RESISTANCE AF?

HB55, AC Circuit for a 180 Volt B Eliminator

MICROVOLT PER METER—WHAT'S THAT?

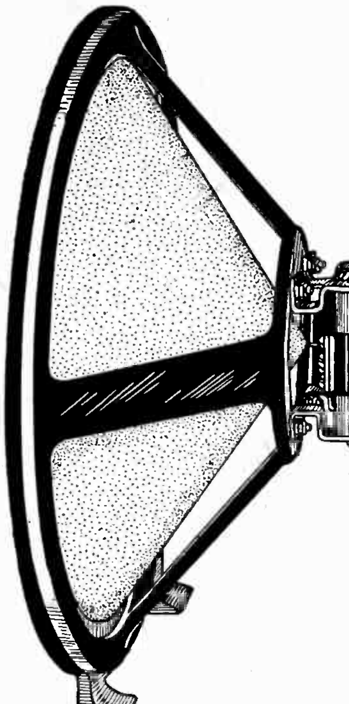
RADIO WORLD, published by Hennessy Radio Publications Corporation. Roland Burke Hennessy, editor; Herman Bernard, managing editor and business manager, all of 145 West 45th Street, New York, N. Y.

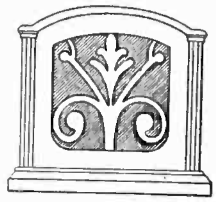
Highest Grade Speakers at Lowest Prices!

T-E-M-P-L-E F-A-R-R-A-N-D

Temple AC Dynamic Model 10, in a beautiful cabinet. The speaker chassis is one of the finest made. There are an output transformer and dry rectifier built in. The cabinet has decorated walnut front and back, with carved grille ornament. An AC switch is accessible underneath cabinet. Rear is removable for adjustment of resistor knob to match the impedance of your receiver's output tube. Connect plugged AC cable to 110 volts AC, 50 to 60 cycles, and connect tipped cords to speaker post of receiver. This remarkable speaker Cat. TEM-10 at only..

$15.34





Farrand Inductor Chassis, consisting of the unit, cone, spider, bracket, assembled, but not in a cabinet.

Model 6-G, 10" extreme diameter of cone front rim	**$9.00**
Model 10-G, 12" extreme diameter of cone front rim	**$10.00**
Model 10-G-PP for connection to push-pull, requiring no output device, because unit is constructed as a center tapped output impedance. Center tap is yellow and goes to B+. Tipped cords go direct to plates. Outside diameter 12".........	**$11.00**
Brookfield cabinet, No. 10 or No. 6 for those speakers.	**$6.50**

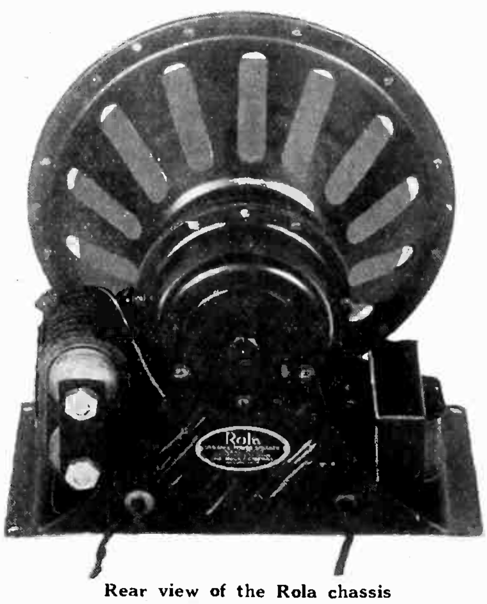
R-O-L-A

Rola Model D-10 dynamic chassis, less cabinet, for 110 volts 50-60 cycles AC. Dry rectifier and output transformer built in. The fine workmanship of this chassis is shown in the illustrations of the front and rear views. Extreme diameter of rim 9 inches but baffles with cutouts down to 7 inches may be used.

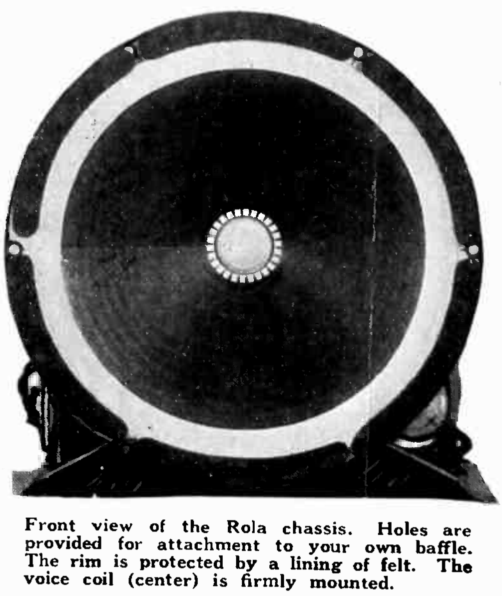
This is the biggest dynamic chassis bargain we have ever offered and enables you at low price to obtain one of the best chasses made. Tone is most excellent.

Order Cat. No. RO-10 at ......

$11.34



Rear view of the Rola chassis



Front view of the Rola chassis. Holes are provided for attachment to your own baffle. The rim is protected by a lining of felt. The voice coil (center) is firmly mounted.

Acoustical Engineering Associates
143 West 45th Street, New York City. (Just East of Broadway)

Gentlemen: Enclosed please find ☐ money order ☐ check for $ .... for which please send me at once

- ☐ One Model 6-G Farrand Inductor $9.00
- ☐ One Model 10-G Farrand Inductor 10.00
- ☐ One Model 10-G-PP Farrand Inductor 11.00
- ☐ One Model 10 Brookfield cabinet 6.50
- ☐ One Model 6 Brookfield cabinet 6.50
- ☐ One TEM-10 Temple Dynamic in cabinet 15.34
- ☐ One RO-10 Rola dynamic chassis.................. 11.34

☐ For C. O. D. shipment put cross here

Name ....

Address ....

City .... State ....

[Prepaid orders shipped same day as received. Canadian remittance must be by postal or express money order.]

The Temple, Rola and Farrand speakers are highly recommended by us for true tone and high volume. They are extremely sensitive as well. The chasses (Farrand and Rola) will work without a baffle, but it is preferable to provide one. The Temple requires no extra baffle, as the cabinet is itself a baffle box.

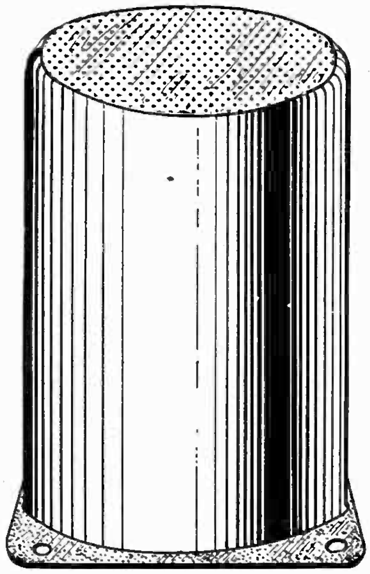
All three speakers are sold in factory-sealed cartons. Immediate delivery.

Model 10-G-PP Farrand may be used in push-pull without any output device. Connect yellow lead to B+, tipped leads to power tube plates. May be used on single output by ignoring yellow lead.

RADIO WORLD, published weekly by Hennessy Radio Publications Corp., from 145 West 45th St., New York, N. Y. 15c per copy, $6 per year. This is Vol. XVI. No. 16. Whole No. 406, dated January 4th, 1930.

The Latest in Tuning Equipment

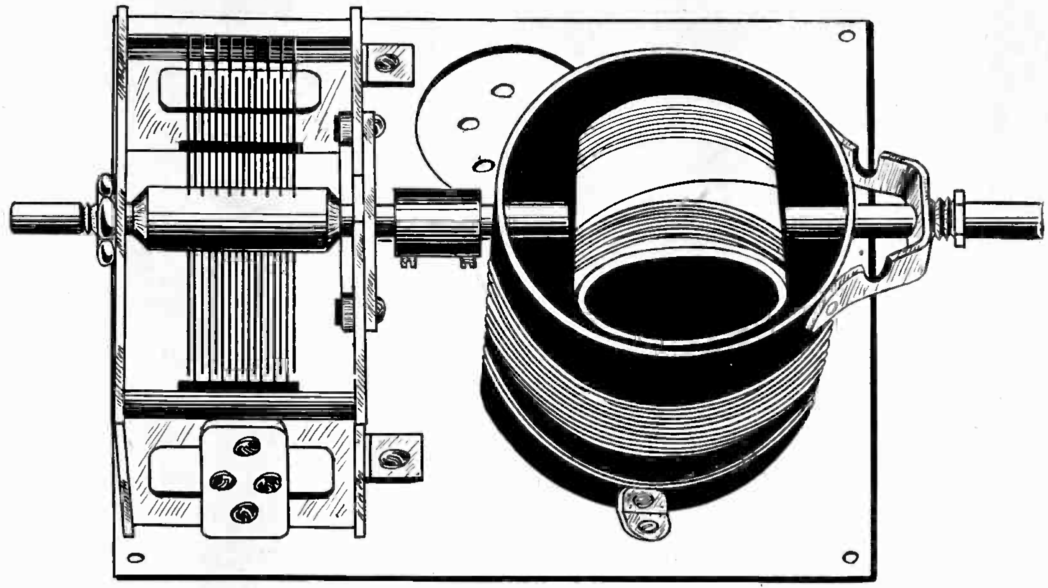
SHIELDED COIL



RF transformer in aluminum shield 2¾" square at bottom, 3¾" high. If metal sub-panel is used no extra base is needed.
Coils have brackets on. You must assemble in shield yourself and solder winding terminals to built-in lugs. For all circuits and stages, including screen grid tubes.

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

BERNARD TWO-TUBE TUNER ASSEMBLY



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

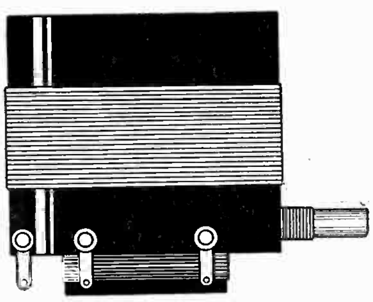
The condenser has shaft protruding at rear, so if two dials are used coil is put at front panel in either instance and condenser at front panel for the other.

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

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

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

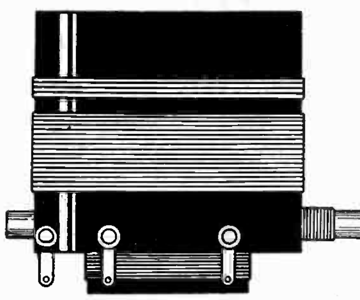
ANTENNA COUPLER



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

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

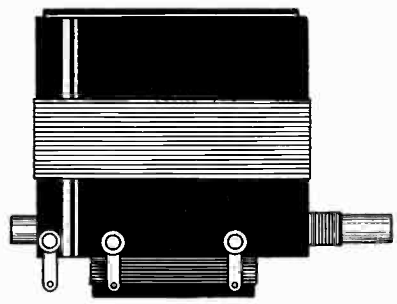
BERNARD TUNERS



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

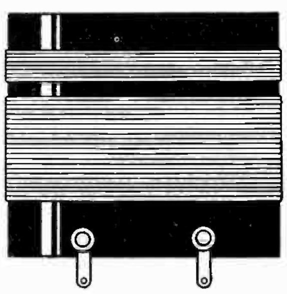
Bernard Tuner BT5A for .0005 mfd. for antenna coupling, the primary being fixed and the secondary tuned. This coil is used as input to the first screen grid radio frequency tube. Secondary has moving coil.
Cat. No. BT3A for .00035 mfd. ..$1.35

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



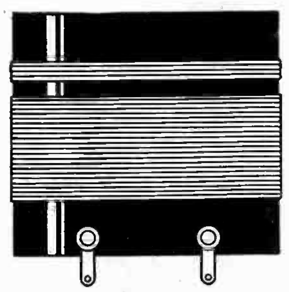
Cat. No. BT5B—$1.35
FOR .0005 MFD. CONDENSER

SG TRANSFORMER



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

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



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

DIAMOND PAIR

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

Antenna coil for any standard circuit, and one of the two coils constituting the Diamond Pair.
Cat. No. RF3 for .00035 .$0.65

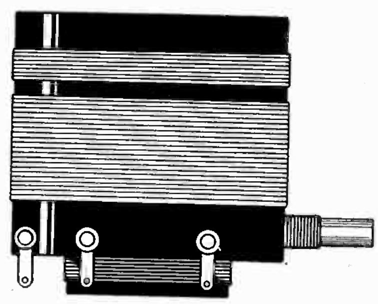
Cat. No. SGT5—$0.85
FOR .0005 MFD. CONDENSER

Interstage 3-circuit coil for any hookup where an untuned primary is in the plate circuit of a screen grid tube.
SGT3 for .00035 mfd...$0.90

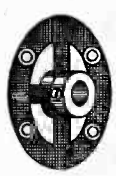
Order the Diamond Pair, Cat. DP5 for .0005 mfd. at $1.45

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

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



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



FL4 $0.30
Flexible insulated coupler for uniting coil or condenser shafts
Order Cat. FL4 at $0.30
Equalizing condenser, 80 mmfd., for connection across any tuning condenser where ganging is resorted to, or for equalizing independently tuned circuits to make dials track.
Order Cat. EQ80 at $0.35

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

For .0005 mfd. order T5 at $0.85

For .00035 order Cat. T3 at $0.90

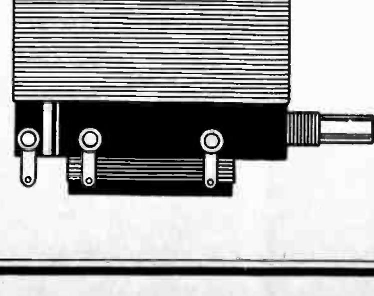
All coils have 2½" diameter, except the shielded coil, which is wound on 1¾".

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

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

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

STANDARD TUNER



Screen Grid Coil Company,
143 West 45th Street,
New York, N. Y. (Just East of Broadway.)

Enclosed please find $........... for which please send at once the following parts:

☐ Cat. No. .... at $ ....
☐ Cat. No. .... at $ ....
☐ Cat. No. .... at $ ....

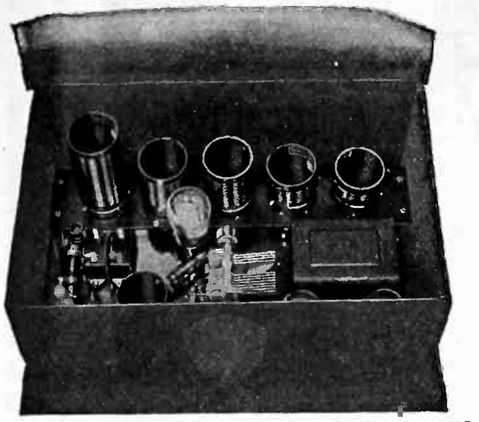
☐Please ship C. O. D.

Name ....

Address ....

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

Short Wave Circuit

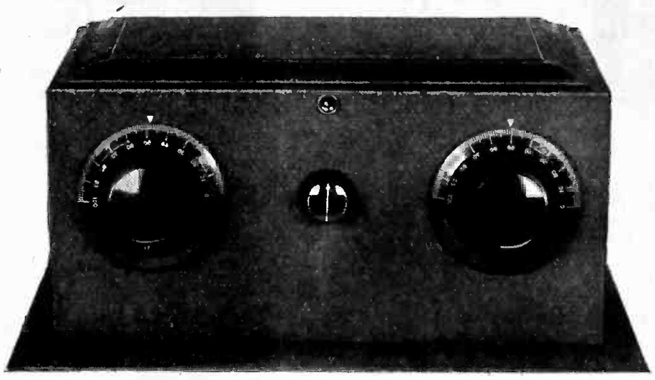


National Thrill Box, 4-tube short wave circuit, 15 to 535 meters, battery-operation of filaments; B supply, either batteries or eliminator.

Get a real kick out of listening to foreign stations on a real short-wave circuit, the National Thrill Box. Uses one 222 screen grid RF amplifier, one 200A detector, one 240 first audio and one 171A or 112A output. Single control. Buy the parts and build the circuit in two hours. Data sheet shows dial settings where foreign stations come in. Cat. SW4EF, all parts, including decorative brown steel cabinet, all six plug-in coils, list price $51.90 (less tubes). Your price $31.00.

Guaranty Radio Goods Co.
143 West 45th Street New York City

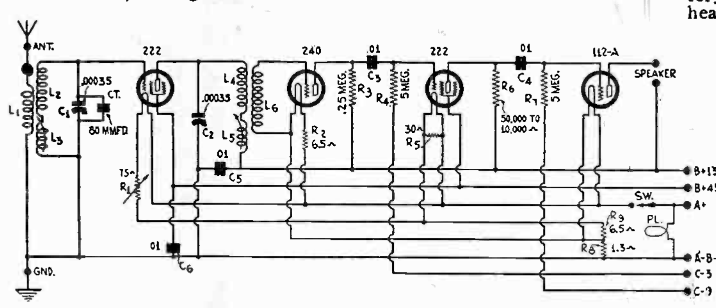
Tone That Thrills!



Build the HB Compact (Battery model)

$18.55

Front view of the HB Compact, battery model, the simple 4-tube receiver that works a speaker at high volume and produces tone that is of the very purest kind. Cabinet is only 15" wide, 9½" front to back, 7" high.



Follow this diagram of the HB Compact, battery model, when building this tone-marvelous receiver.

Everybody is delighted with the exquisite tone of the HB Compact, battery model. "Never heard anything like it," is the usual comment. The receiver uses a 222 screen grid tube for RF, 240 bias detector, 222 first audio and 112A power tube. Draws only .75 ampere filament, 18 milliampere plate current. Very economical to run. B batteries last 6 months or more. Plentifully selective and sensitive. Build this re-

LIST OF PARTS

[Check off what parts you want]

☐ L1L2L3—Antenna coil, BT3A	1.35
☐ L4L5L6—Interstage coil, BT3B	1.35
☐ C1, C2—Two .00035 mfd., brackets	2.00
☐ CT—Hammarlund 80 mmfd.	.35
☐ C3, C4, C5, C6—Four .01 mfd. mica fixed	1.40
☐ R1, SW—75 ohm switch rheostat	.80
☐ R2, R9—Two 6.5 ohm filament resistors	.50
☐ R3, R4, R6, R7—0.25, 5.0, 0.05 and 5.0 meg. with 4 mounts	1.65
☐ R5—30 ohm filament resistor	.45
☐ R8—1.3 ohm filament resistor	.20
☐ Ant., gnd., Sp. (+), Sp. (—)—Four posts	.40
☐ PL—Pilot lamp 6v. and bracket	.70
☐ Drilled, socketed steel subpanel 9½x14¼"	2.00
☐ Crinkle brown steel cabinet, 7x9½x15"	3.50
☐ Two metal links	.20
☐ Seven leads for battery cable	.70
☐ Two Dials	1.00
☐ All parts	$18.55
☐ Tubes: two 222., one 240, one 112A	4.39

The HB Compact, battery model, designed by Herman Bernard, has tone quality second to none. All who appreciate music will revel in the delightful tone of this amazing circuit.

Send in your order for parts today to Guaranty Radio Goods Co., 143 West 45th Street, New York, N. Y., just E. of B'way. Use Coupon.

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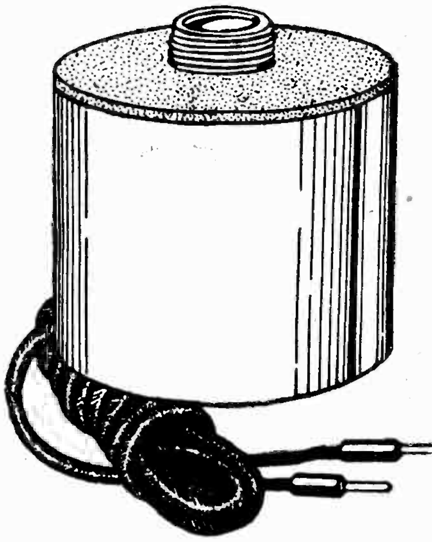
Address ....

City .... State ....

Guaranty Radio Goods Co., 143 West 45th St., New York.

Horn Unit $2.25



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

For Portable Use

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

Air-Column Horn

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

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

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

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Address ....

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FIVE-DAY MONEY-BACK GUARANTEE

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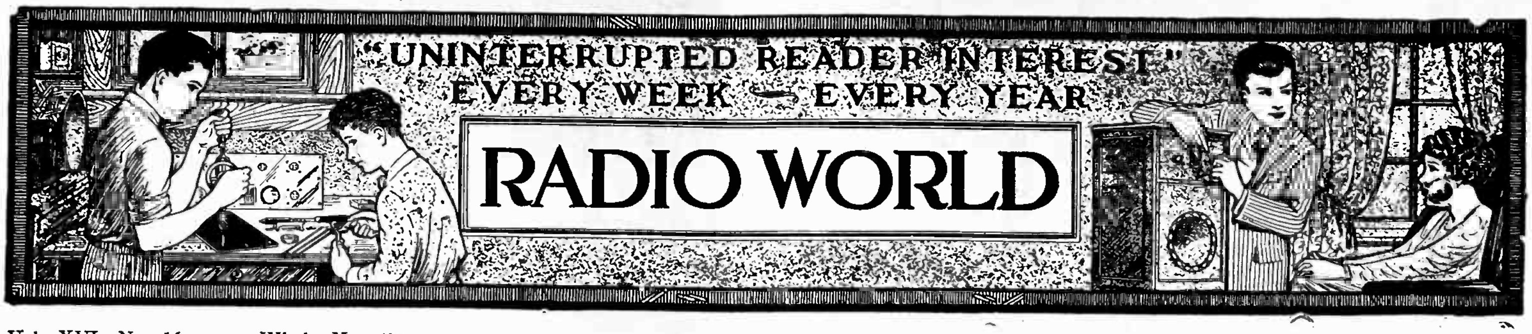

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Technical Accuracy Second to None
Latest Circuits and News
EIGHTH YEAR

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A Two Tube AC Tuner

Works Splendidly Into a Power Pack—Uses Bernard Tuners

By James H. Carroll

Contributing Editor

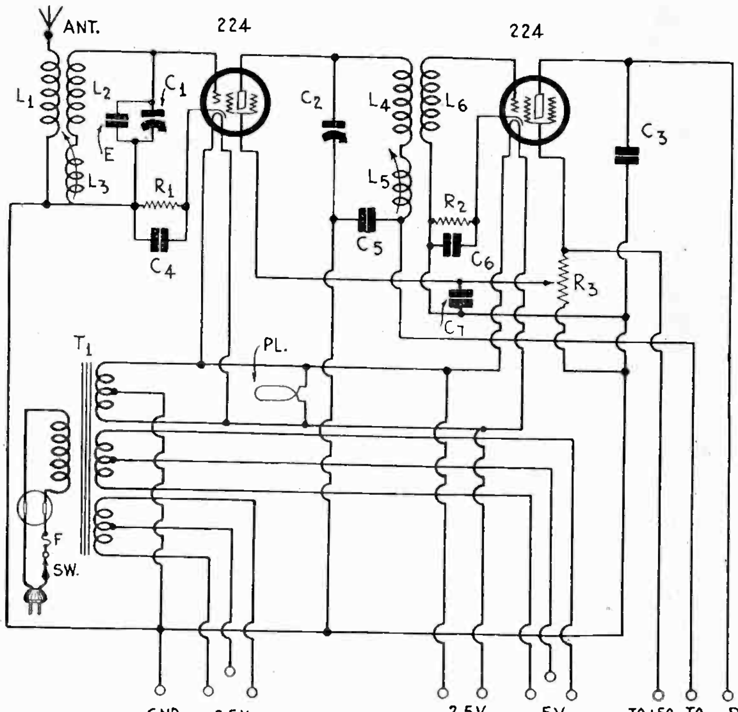

FIG. 1

DIAGRAM OF THE AC BERNARD TUNER, USING TWO SCREEN GRID TUBES, ONE FOR RADIO FREQUENCY AMPLIFICATION, THE OTHER FOR NEGATIVE BIAS DETECTION.

A TWO-TUBE A C tuner, fundamentally the same as the one for battery operation published last week, uses substantially the same parts, except that the sockets are of the five-prong UY type, and the filament transformer is added, besides resistors and by-pass condensers. This makes a dandy tuner to go with an AC power amplifier, and besides renders available 2.5 volts for operation of one or two 245 output tubes, or 5 volts for 112, 112A, 171 or 171A, singly or in matched pairs, and besides permits heating three other heater type tubes—224, 227 or 228—from the high current 2.5 volt winding. The B voltages must be supplied by the power amplifier.

The Bernard tuner assemblies, left and right types, are used, and in addition two extension shafts are employed. These provide a ¼-inch shaft at one end and take a ¼-inch shaft in the receptacle at the other end. The object of introducing these is to permit sufficient separation to enable the filament transformer to be moved close to the National modernistic color wheel drum dial.

A 7"x21" front panel is required, and this is obtainable all ready drilled. The tuner assemblies have aluminum bases, so no subpanel is necessary, the bases being elevated from the bottom of a table model cabinet to provide clearance for the socket lugs.

The Bernard tuners have a tuned inductance consisting of a fixed coil and a moving coil, an important object of this combination being to insure coverage of the complete band of broadcast wavelengths when resorting to the high-gain method of tuning the screen grid plate circuit. To obtain the fine results that this combination assures it is necessary to have the moving coils in proper position.

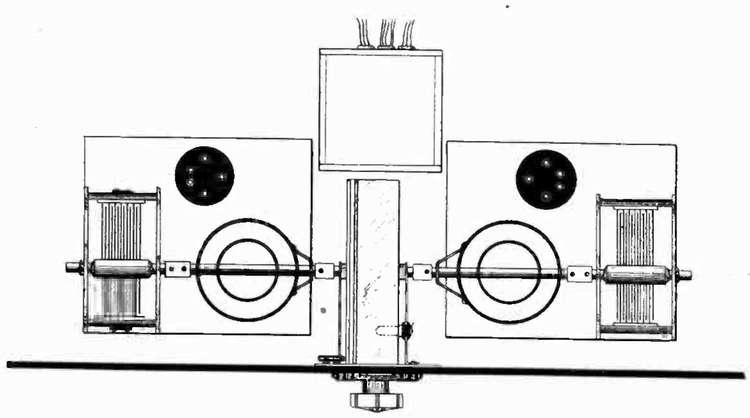

FIG. 2

THE TUNER ASSEMBLIES ARE PLACED TO LEFT AND RIGHT OF THE DRUM DIAL. THE FILAMENT TRANSFORMER IS PUT BEHIND THE DRUM.

You may complete the wiring and then pay attention to the position of the moving coils. Turn the dial to read 100 and have both moving coils parallel with the fixed winding, using only your eye as your guide. They may not be electrically parallel, for one may be bucking the fixed winding and the other aiding it, but this you will correct.

Tune in a station. Tune in several other stations. Notice whether they come in with a snap and provide good selectivity. Then see that if the entire wave band is tuned in. If the low wavelength stations come in with too much capacity of the tuning condensers in use, you will not be able to tune in the highest wavelength station. You should tune in 200 meters at 15 or lower and 500 meters at about 80. If the readings are much higher than this, reverse both moving coils by turning both around half a circle. Be sure though that when the condenser plates are totally enmeshed that the moving coils are parallel with the fixed windings. Now tune in the entire wave band.

As an extra precaution, turn only one of the coils around half way now. Should selectivity and volume improve, note whether the entire band is tuned in. If so you are all set, if not reverse both moving coils.

By making these tests you will have both moving coils aid the fixed windings at the high wavelengths and buck them at the low wavelengths.

The P lead from the detector goes to the first audio coupling unit, in the power pack, which should be a .1 meg. resistor. If you are using a first stage of transformer coupled audio you may introduce the resistor between the P lead from the tuner and the P post of the first audio transformer primary, placing an .01 mfd. condenser from the P lead of tuner to G of the first audio socket. The screen grid detector tube works best with a high impedance load, and this is a good way to provide it if you have a first stage transformer. If your first stage is resistance coupled, be sure the plate resistor is .1 meg.

[*More details next week.*]

Good Regulation Needed

It Improves Quality and Avoids Motorboating

By Brunsten Brunn

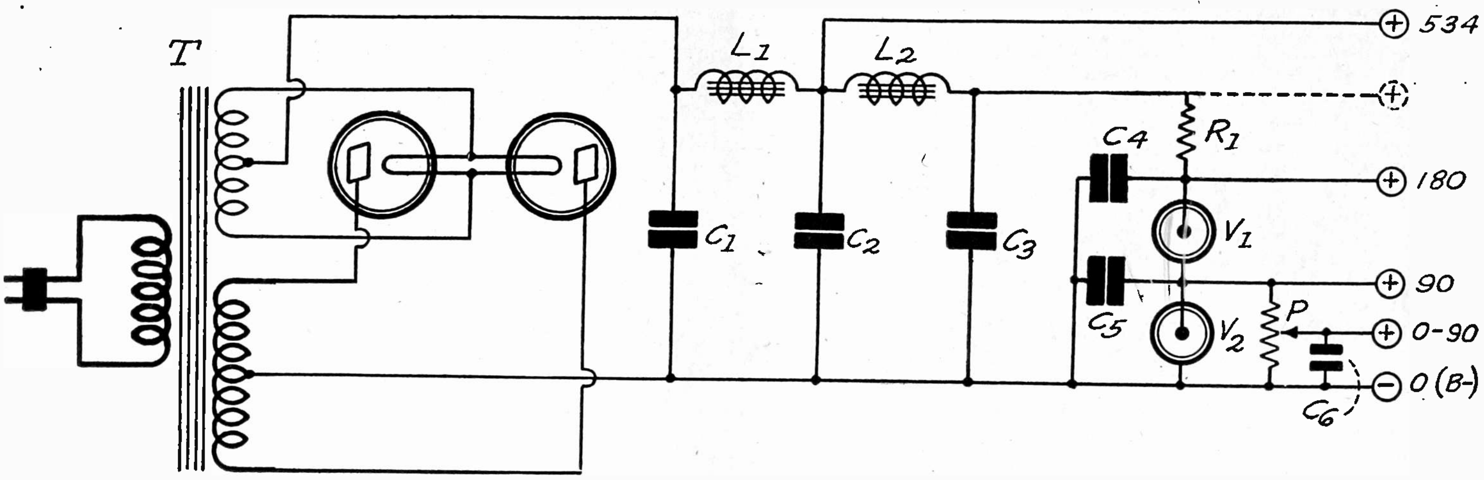

FIG. 1
POWER TUBE PLATE CURRENT IS MADE TO AVOID PASSING THROUGH L2.

THERE are many power amplifiers in which 250 type tubes are used in push-pull in the last stage. Such a circuit requires both high voltage and heavy current for operation. Moreover, it requires a steady plate voltage if good quality is to be obtained from it. This is particularly necessary when the same B supply is used to supply the plates of several other stages in the same amplifier. If the voltage is not kept steady the fluctuation indicates, as a rule, that the regulation is poor and that there is not sufficient by-pass capacity across the voltage taps on the filter and voltage divider.

To supply adequately such an amplifier it is necessary to use at least two 281 tubes in the rectifier. While the same current could be obtained with two or more 280 type rectifier tubes these do not withstand the high voltage and therefore they are not suitable for the high voltage supply. The 281 tubes have been designed especially for heavy duty service and they can be depended on.

VOLTAGE CONSTANCY

One method of improving the regulation, and hence the voltage constancy, is to connect the plate return of the two 250 power tubes so that the plate curren from these flows only through one of the chokes in the filter. This choke may be especially designed to carry heavy current without appreciable voltage drop and without much saturation of the core. The inductance of this coil, L1 in Fig. 1, need not be more than 10 or 20 henries because in a well-balanced push-pull circuit there is practically no change in the demand of current on the rectifier tube. When one tube in the stage relinquishes its demand for current the other tube takes it up in exactly the same proportion. But there will be some change because the stage cannot be completely balanced.

A small change in the current draw in the power amplifier does not do any damage provided that this change is not reflected back into the plate and grid circuits of the other amplifiers in the circuit. If it is motorboating will result or at least frequency distortion due to the tendency for the circuit to motorboat.

In Fig. 1 the feedback from the last stage to any of the preceding stages is prevented first by C2 and second by the high inductance choke coil L2. Then again, if any fluctuation in the current should get through the high inductance choke these fluctuations will be reduced by condenser C3.

REGULATOR TUBES USED

The greatest stabilizing influence in this circuit are the voltage regulator tubes V1 and V2 connected across the two 90 volt sections of the voltage divider between zero and 180 volts. If the plate current varies within certain limits, which are sufficiently wide to allow for nearly all fluctuations that may occur, the voltage across the sections remains at 90 volts each, or 180 volts across the two tubes. Suppose then, for example, that these taps be connected to the plate circuits in a resistance coupled amplifier. This type of circuit requires constancy to a high degree if motorboating is not to occur. Any fluctuations in the voltage divider or in the plate circuits of the tubes will be taken up by the voltage regulator tubes so that in effect the supply is equivalent to a voltage source with perfect regulation, or one in which the regulation is as good as that of a storage B battery. Motorboating cannot occur. Neither can any appreciable distortion occur on account of feedback for the feedback will be so small that even when amplified to a high degree the resulting change due to this feedback will be negligible.

The only reason voltage regulator tubes are not used in all B supplies is that the expense is not warranted in amplifiers intended for only a moderate power output. Then, also, the regulator tubes take current and when small rectifier tubes are used all the current that should be drawn from them is needed by the amplifier tubes in the circuit and by the voltage divider. When the amplifier is powerful, like one employing two 250 tubes, however, it is good economy to use the voltage regulator tubes.

INDIVIDUAL FILTERS

When a small B supply is used on a resistance coupled amplifier of high gain it is advisable to use individual filter resistances and condensers for each plate circuit. One method of doing this is illustrated in the Fig. 2. Here we have four terminals with a resistance between each and ground. There is also one condenser from each point to ground. Each one of these should be connected to a separate circuit in a resistance coupled amplifier or to radio frequency amplifiers. Of course, if the circuit contains fewer than four plate circuits that should be treated in the manner indicated it is not necessary to use all of them.

The resistances shown in this circuit are not coupling resistors at all. Their sole purpose is to prevent feedback. The coupling resistors are connected between the points shown and the plates of the tubes.

Many will no doubt ask what the values of the filter resistors should be to drop the voltage by a stated amount. The answer is based on the current that flows. It is of no use to specify the voltage drop desired without also specifying the current flowing, for if both are not given the value of the resistance cannot be given. However, in a resstance coupled amplifier in which the coupling resistors are 100,000 ohms or higher let the value of each of these resistors be 20,000 ohms and let the current be whatever it will. If there is too high a voltage drop in the resistors boost the applied voltage to make up for it.

It is of no value to use condensers across the resistors less than 2 mfd. if the circuits involved carry audio frequency current.

The voltage on the various tubes is raised or lowered by moving the potentiometer slider P up or down. When it is at point 6 the voltage is as high as the B supply can maintain.

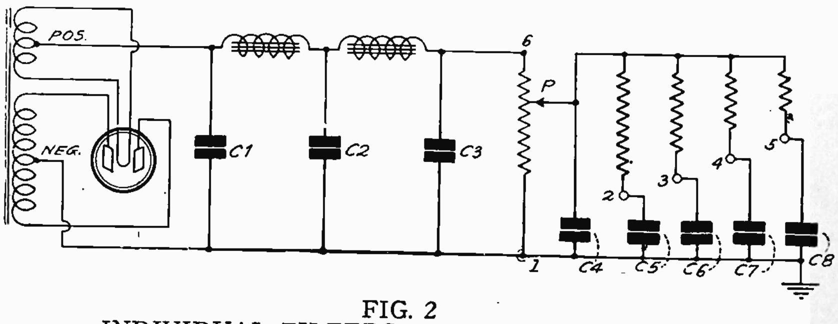

FIG. 2
INDIVIDUAL FILTERS TO STOP FEEDBACK

HB 55, to Work from AC

Two Stages of Shielded Screen Grid RF, Nega

By Herman

Managing

"I HAVE a B eliminator."

So say many radioists. They want AC operation, but would like to omit the expense of a new B supply, as they deem their B eliminator all right. Also they want push-pull audio. They can have these advantages. Fig. 1 shows the circuit.

It is understood that the current drain will be greater than what they have been accustomed to take from the B eliminator, hence the filtration will not be adequate, unless extra capacity is provided. That capacity is easily obtained compactly, and in large doses, by use of the Mershon electrolytic condenser. C10, C11, C12 and C13 are the anodes of a Q 2-8, 2-18 Mershon, C12 and C13 are 18 mfd. each, in parallel at the output, where they reduce hum and improve quality, especially on low notes, and C10 and C11 being 8 mfd. each. The smaller capacities are nearer the edge of the case.

EXCELLENT TUNER SECTION

The push-pull output consists of two 171A tubes. The undistorted power output is ample for any home. It is a fact that even a single 112A gives a large enough undistorted power output for home use, overloading being preventable by adjustment of a volume control that governs the signal amplitude ahead of the detector. Such a control is used in this circuit, even though 171As are used as output, since the proper location of a volume control in any circuit is ahead of the detector.

By using two stages of screen grid radio frequency amplification and a screen grid detector, the sensitivity and selectivity are excellent. The audio amplification is high, due to the screen grid tube used as detector, the resistance-coupled first stage coupled thereto, and the transformer-coupled push-pull output.

The six tubes used are three 224, one 227 and two 171A. A filament transformer heats the heaters of the screen grid tubes and the first audio tube, as well as the filaments of the output pair.

Since the transformer has three secondary windings of the, two of 2.5 volts at high current, one of 2.5 volts at low current and the other at 5 volts low current, the first audio stage and pilot lamp may be heated from the low current 2.5 volt winding. The other 2.5 volt winding serves the first three tubes, and the 5 volt winding, rated at 2 amperes, heats the filaments properly of the output pair.

BYPASS CONDENSER VALUES

Each stage has an individual biasing resistor, bypassed by a condenser of a capacity sufficient for the purpose. In the radio frequency level the two biasing resistor bypass condensers may be .01 mfd., for the detector and first audio they should be 1 mfd., while for the power tube stage no less than 4 mfd. should be used. The capacity used in the power tubes' stage is 8 mfd., as previously stated.

It will be noted that all plates receive the same applied voltage. But the effective plate voltages are different. The voltage on the radio frequency amplifiers is highest, since the voltate dropped in the primary of the RF transformers is least, due to their small DC resistance.

The greatest drop takes place in the detector circuit plate resistor. The plate current will be about .2 milliampere, or too low to give a reading on most milliammeters of a 0-20 or higher scale. This current at 180 volt total drop, shows that the total DC resistance of the load resistor, plate-to-cathode resistance and the biasing resistor R3 is is 900,000 ohms. This gibes with the rated resistance values of 800,000 ohms for the plate-to-cathode circuit, and .1 meg. for the load resistor A4. The value of the biasing resistor is 5,000 ohms, negligible in comparison to the other values.

INTERESTING DETECTOR CIRCUIT

The detector circuit is highly interesting. The 224 tube is worked as a negative bias detector, with medium value of bias about 5 volts. The plate current flows through this biasing resistor, R3, but so does the screen grid current.

The screen grid current preponderates, indeed is about four times as great as the plate current. Also the screen current is about the same regardless of the plate voltage, hence regardless of changes in plate current that are introduced by the modulation.

It is particularly fortunate to have some steady and relatively high value of current, as this acts as a bleeder to the biasing resistor. Instead of being a bleeder current in the strict sense, serving no other purpose, it is here, of course, the necessary screen grid current., flowing from B plus to screen grid (G post of socket) and to ground.

So it serves a purpose.

The first is its necessary purpose in connection with voltaging the screen grid, the second is in permitting the use of a smaller value of biasing resistor than otherwise. Whatever the circuit affords or permits, the biasing voltage, once selected, is a fixed quantity, and it may be provided in any of several ways. To produce the desired value, the higher the current through the biasing resistor, the lower the resistance value, in the familiar inverse ratio according to Ohm's law. So here we are able to use a lower resistor, hence present a lower impedance. This in turn makes a bypass condenser of any given value much more effective than if the same value were used across a higher resistance. Also, the lower impedance is an attribute in the quality performance of the detector, not to mention its sensitivity. This type of detector has good sensitivity and fine stability, a combination not too common, by the way.

SHIELDED COILS USED

To feed the detector two shielded stages of screen grid radio frequency amplifications are used. The third shielded coil is to couple the second RF stage to the detector. A three-gang condenser may be used, and trimmers adjusted at a low wavelength, then left thus.

In building the circuit, the condenser is placed facing the left, as the front panel is toward you, while behind the condenser are the three shielded coils and three sockets. A drum dial is used—the new National modernistic dial with color wheel—and to the right of this go the filament transformer and the Mershon. Behind these are the three remaining sockets and in the input and output audio transformers.

Illustrations of the layout are expected to be published next week, issue of January 11th.

A switch is shown in the primary lead of the filament transformer. This is a pendant switch. A dummy shaft and knob should be used for maintaining an even appearance of the front. The volume control is at a corresponding position at left. The front panel is only 7x21". And, by the way, the complete assemly (less the separate B eliminator) may be housed in a standard depth cabinet as only 8½" depth actually is required.

COIL DATA

Coils to fit into the prescribed round shields may be wound on 1¾" diameter, the tubing not more than 1¾" high. For .00035 mfd. the windings may be from 25 to 35 turns on all three primaries, and, after leaving ¼" space, 93 turns for all secondaries, using No. 29 enamelled wire throughout. The larger number of primary turns gives greater amplification at lesser selectivity, so if you want the most selectivity, use 25 turns. 25 turns.

At any event, use the same number of turns on all primaries. Otherwise the effective inductance of the secondaries as well

Right or

(1)—Tuning the primary of a radio frequency coupler following a screen grid tube results in a higher amplification than if the secondary is tuned.

(2)—The plate and the screen currents combined in a screen grid tube remain nearly constant as the signal voltage is varied.

(3)—Inductance of a coil depends on the number of turns only and does not depend on the length of the coil, the size of the wire, and the size of the form on which the wire is wound.

(4)—A screen grid tube is a good amplifier if the cap element is left open and the tube is used as a three-element tube.

(5)—The plate on a tube is at a higher steady potential than the battery end of the coupling resistor or transformer.

(6)—When one refers to the plate as the high potential end in respect to the signal voltage fluctuations one is talking nonsense.

(7)—The copper can on an electrolytic condenser is positive because it is connected to ground.

(8)—One of the reasons why trouble is experienced from motorboating in good receivers is that the power equipment is too small, that is, that coils have too low inductance and too high resistance and that by-pass condensers have too low capacity.

(9)—The band width of a band-pass filter tuner remains the same from one end of the scale to the other. That is to say, it is independent of the frequency.

(10)—The closer the coupling between the two equal tuned circuits in a band-pass filter the wider the transmission band.

ANSWERS

(1)—Right. This is because the impedance of a tuned circuit at the resonant frequency is very high and that such an impedance forces the tube to work efficiently. The lower the resistance in the series tuned circuit the higher is the parallel resonant resistance, and the higher is the load on the tube.

With 180 Volt B Eliminator

ive Bias Detector and 171 A Push-Pull Output

Bernard
ditor

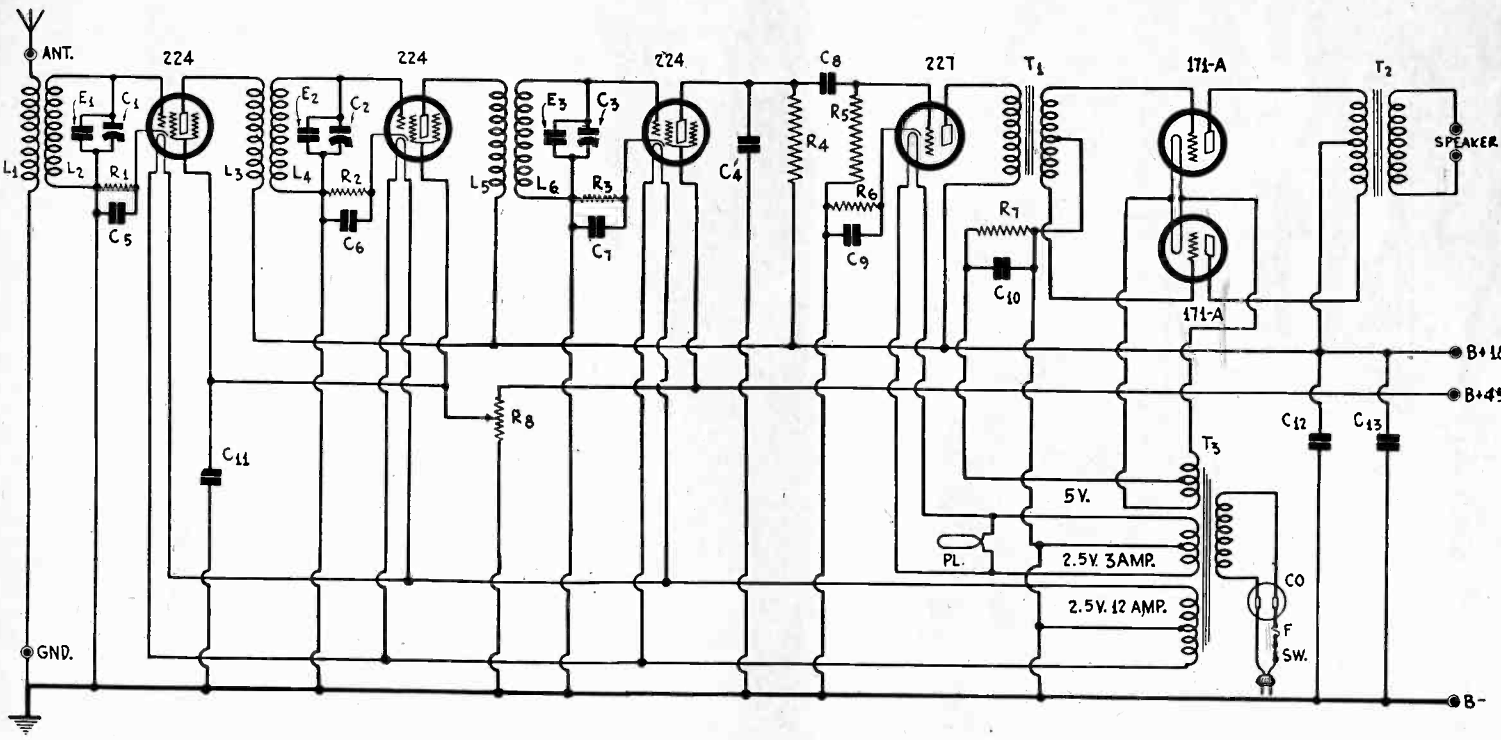

FIG. 1
AN ATTRACTIVE CIRCUIT FOR THOSE WHO HAVE A 180-VOLT B ELIMINATOR, AND DESIRE AN AC RECEIVER. PLUG THE B ELIMINATOR IN THE CONVENIENCE OUTLET CO.

as of the primaries will be staggered, and the tuned circuits at many settings will be slightly off resonance.

The effect of a larger number of primary turns, in respect to a fixed number of secondary turns, is to reduce the effective inductance of the secondary while of course increasing the effective inductance of the primaries. The decrease is due to the inductance loss through mutual coupling.

For .0005 mfd. the primaries may be as stated, the secondaries having 75 turns.

In connecting up to the B eliminator, note that the ground lead of the receiver is B minus, hence B minus of the eliminator must be connected to ground, which may be done simply by running B minus up to the set. Incidentally, B minus goes to no other point. It is actually C minus, of different values, all through this circuit.

The telling points of this circuit, to sum up, are:

(1) Screen grid radio frequency amplification, using shielded coils.
(2) Negative grid biased 224 detector.
(3) Push-pull output.
(4) AC operation.
(5) Good tone, sensitivity and selectivity.
(6) Stability.
(7) Compactness.

Vrong?

(2)—Right. The reason for this is that screen and the plate currents are nearly complementary. They always vary in opposite directions. Of course, there is some variation in the sum of the two.

(3)—Wrong. The inductance depends on the number of turns, the diameter of each turn, the size of the wire, and on the length of the coil. That is, the inductance depends on the relative positions of the turns.

(4)—Wrong. It does not amplify at all. The voltages must be adjusted to the proper values on all the elements or the tube will not work.

(5)—Wrong. The plate is at a lower potential than the battery side of the coupling device by the amount of drop in the coupler. If the coupler is resistance there is a very great difference of potential.

(6)—Wrong. While the answer in the preceding question would seem to indicate that the statement is true, the signal potential at the plate is actually higher in value than the signal potential at the batery end of the coupler. The battery end of the coupler is effectively grounded and so the signal potential there is zero.

(7)—Wrong. It is the negative which is grounded and the case of the condenser is the negative.

(8)—Right. The surest way of getting into this trouble is to use a cheap, inadequately by-passed B supply for a good receiver. The better the receiver the greater the trouble that is sure to follow, Likewise, the poorer the B supply the more trouble.

(9)—Wrong. The width of the pass band is directly proportional to the frequency when the coupling is inductive and it is inversely proportional when the coupling is capacitive. Hence, even with band-pass filters of the simple type, ten kilocycle selectivity throughout the scale of the tuner is not a reality.

(10)—Right. For low degrees of coupling the width of the band is practically proportional to the coupling.

LIST OF PARTS

L1L2, L3L4, L5L6—Three shielded radio frequency transformers .00035 mfd. (Three Cat. SH-3)
C1, C2, C3—One three-gang .00035 mfd. tuning condenser
E1, E2, E3—Three Hammarlund 80 mmfd. equalizing condensers
C4—One .00025 mfd. fixed condenser
C5, C6, C8—Three .01 mfd. condensers
C7, C9—Two 1 mfd. bypass condensers
C10, C11, C12, C13—Four Mershon condensers in one copper case, 8, 8, 18 and 18 mfd. respectively, with bracket (Cat. Q 2-8, 2-18 B).
R1, R2—Two electrad grid resistor strips, 400 ohms each
R3—One 5,000 ohm tubular resistor with mount
R4—One 0.1 Lynch metallized resistor, with mount
R5—One 5 meg. Lynch metallized grid leak, with mount
R6—2,000 ohm Electrad wire-wound Resistor, type B
R7—One 1.000 ohm Electrad wire wound resistor, type B
R8—One Electrad 25,000 ohm Super tonatrol, potentiometer type, with knob
Ant., Gnd., Speaker Minus, Speaker Plus—Four binding posts
T1—One push-pull input transformer
T2—One push-pull output transformer
T3—One filament transformer (Polo Cat. PFT)
PL—One National modernistic dial with 2.5 volt AC pilot lamp
F—One 2 ampere fuse with fuse clips
CO—One convenience outlet
SW—One AC pendant switch, with AC cable and male and female plug.
Three leads for B voltage cable
One drilled front panel, 7"x21"
One subpanel, with four UY sockets and two UX sockets
One dummy shaft, knob and bushing

What About Push-P

Some Fancy Schemes Prove Fallac

By Driblek

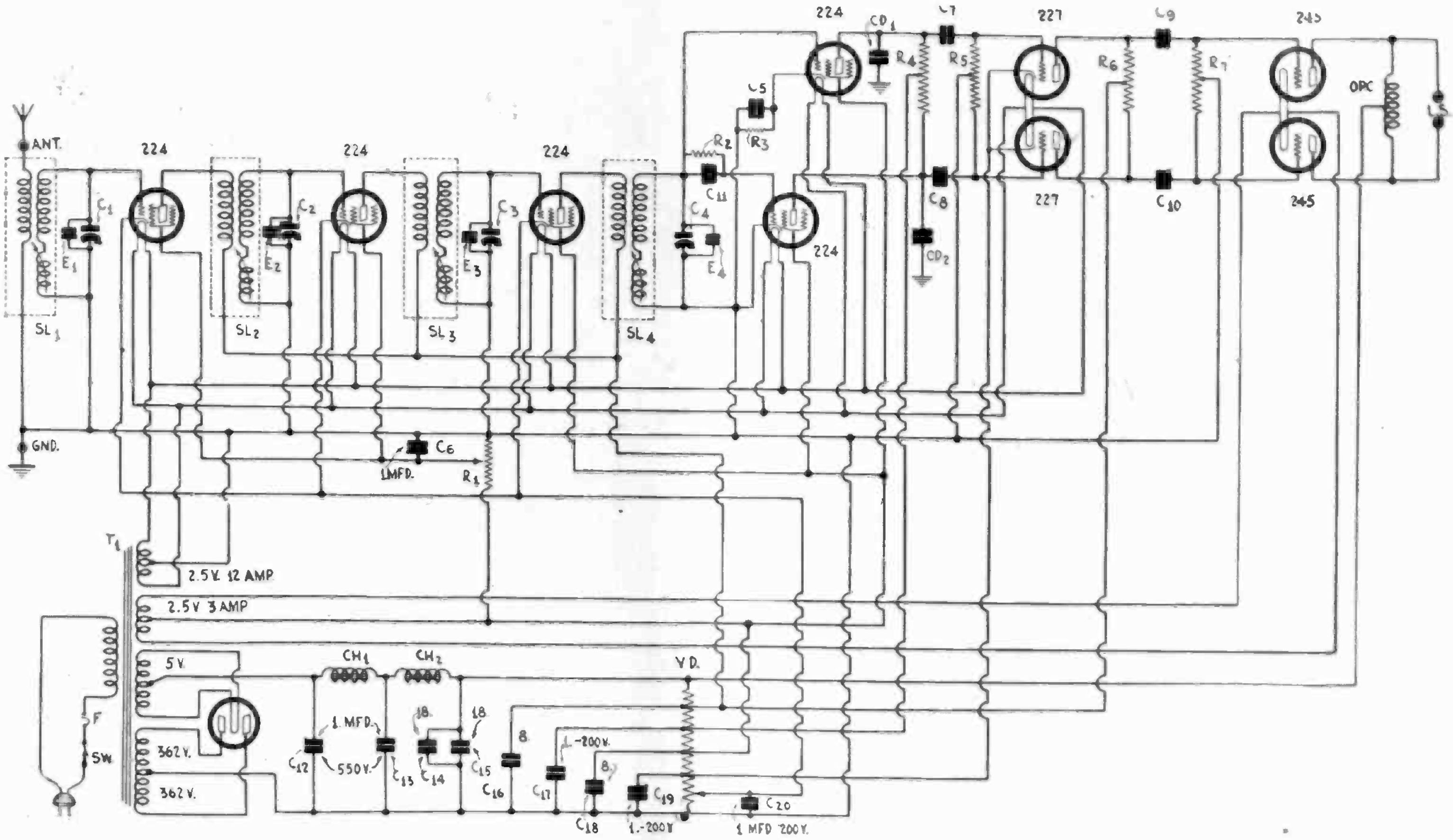

FIG. 1

IN THIS RECEIVING CIRCUIT A SUGGESTED NEW PUSH-PULL DETECTOR IS USED TO PERMIT THE USE OF RESISTANCE COUPLING BETWEEN THE DETECTOR AND THE PUSH-PULL AMPLIFIER. ONE DETECTOR TUBE OPERATES ON THE GRID BIAS PRINCIPLE AND THE OTHER ON THE GRID LEAK AND CONDENSER METHOD.

THE problem of coupling a detector tube to a push-pull amplifier by means of resistance is still unsolved. Various circuits purporting to solve the problem have been published in popular articles in radio magazines from time to time, but so far not one has been a complete and satisfactory solution, and some have not approached it.

The only suggestion offered which had any sound theoretic basis was published in RADIO WORLD, October 5th, 1929, and had previously been suggested in an English technical journal. That circuit made use of a phase inverter tube which took the output of the detector and reversed the phase by an angle of about 180 degrees before the voltage was impressed on one side of the resistance coupled push-pull amplifier. The other side of the push-pull amplifier was coupled directly to the detector in the usual way.

If the output of the phase inverter tube is adjusted so that its absolute value is equal to the direct output of the detector, the signal in the push-pull amplifier will be balanced as far as magnitude is concerned but not necessarily in respect to phase. The phase shift by the tube is not exactly 180 degrees for all frequencies. And, of course, if the phases in the two sides of the push-pull amplifier are not exactly 180 degrees apart much of the benefit of the push-pull action is lost.

ADJUSTING THE OUTPUT

Since the direct output of the detector in this circuit must be exactly equal in magnitude to the output of the phase inverter tube, it is clear that there must be no amplification whatsoever in the phase inverter tube. Neither should there be any distortion. The adjustment of the output to equality with that of the detector is a relatively simple matter, for it can be adjusted both by adjusting the input voltage to that tube and by adjusting the output coupling devices. But the adjustment must be effected so that there is no other phase shift than that introduced by the normal action of the tube. If there are condensers in the circuit, as there usually must be, there will be other phase shifts which will alter the phase relationship between the two sides of the push-pull amplifier from that of 180 degrees difference.

There are two ways in which phase shift is introduced. First, there are shunt capacities in the circuit, mostly those between the elements of the tube. These introduce lags in the high frequencies which may be sufficient to alter the 180 degree relationship greatly. Hence the circuit will not function well at the high audio frequencies. Second, there will be series condensers, used for blocking purposes, which will introduce shifts of phase at the very low frequencies. The lower the frequencies the greater this shift. Therefore the amplifier will not function well at the very low frequencies. There will, however, be a considerable frequency range in the middle register in which the shifts of phase will be negligible, and in this most important region the operation of the amplifier will be satisfactory.

POSSIBILITY WITH NON-REACTIVE CIRCUIT

Amplifiers in which there are no stopping condensers have been devised which are quite satisfactory. If the principle of these can be applied to this phase inverter circuit it would be possible to achieve true 180 degree phase difference for all except the very high audio frquencies at which the effect of the inter-electrode capacities becomes appreciable. The gain in such circuit would be substantial and it is hoped that it will be worked out soon by some one.

Another circuit has been suggested for solving the problem, one based on the difference between the grid bias detector and the leak-condenser detector. This idea is illustrated in the accompanying diagram.

It is well known that a grid bias detector modulates upward, that is, the plate current increases as the radio frequency signal voltage increases. The audio frequency signal is therefore in phase with the modulation in the radio frequency signal.

It is equally well known that the leak-condenser detector modulates downward, that is, the plate current decreases as the radio frequency signal voltages increases. Therefore the audio frequency signal is in opposite phase with the modulation of the radio frequency signal voltage.

Now, then, if one side of the push-pull resistance coupled amplifier be preceded by one type of detector and the other side of the amplifier by the other type of detector, the signals in the two sides

ull Resistance Audio?

ious, But Real Solution is Awaited

Hokanda

of the amplifier will be 180 degrees out of phase. At least one necessary condition for coupling a push-pull amplifier by means of resistance to a detector is then satisfied.

MAKING SIGNALS EQUAL

It remains to insure that the signals applied to the two sides of the amplifier are equal in magnitude. Suppose the input voltage to the two detector tubes be the same, as they will be when connected as in the diagram herewith. The equality of the outputs of the detectors then depends on the detecting efficiency of the two detectors. It is well known that the leak-condenser detector is more sensitive than the other. Hence the outputs will not be the same unless something is done to compensate for the difference in detecting efficiency.

One way would be to reduce the input to the more sensitive detector until the magnitudes of the outputs of the two were equal, which might be done with a potentiometer to the slider of which the grid of the more sensitive detector is connected. By adjusting the position of the slider any desired signal voltage could be impressed on the more sensitive tube. The potentiometer is not shown in the figure, but it could well be R2 if this is connected from C11 to the cathode instead of to the grid of the upper. The grid of the lower detector tube would then be removed from its connection to C11 and connected to the slider. By moving the slider down toward the cathode any desired reduction in the signal input to the lower detector could be obtained.

Another method of equating the output voltages of the two detector tubes would be to manipulate the output coupling resistances. For example, the upper portion of R4 could be made larger than the lower section. This would put a higher load on the less sensitive detector than on the other and consequently the input voltage on the upper side of the amplifier would be increased relatively to that of the other side.

USING DIFFERENT TUBES

Still another method of equating the outputs of the two detectors would be to use different detector tubes, making the grid bias detector more sensitive than the other. For example, the grid bias detector tube could be one of a high amplification constant and the other a general purpose tube. In the figure both detectors are screen grid tubes, but if this method of equating the outputs were used, only the upper would be a screen grid tube. The use of a high mu tube, either of the screen grid type or the three-element tube type, the load impedance method could well be used in addition as an equalizer, since the high mu tube normally takes a higher load impedance.

If it is necessary to equalize the volumes in the two sides of the amplifier more than is possible in the detector it is still not too late at the input of the first audio stage. The resistance R5, for example, may be a high resistance potentiometer with a slider for the grid bias connection. If this is moved toward the lower tube the greater part of the drop in the potentiometer will be impressed on the upper 227 tubes.

During the process of adjustment it is necessary to have some means of determining when the outputs of the two sides of the amplifier are equal. Possibly the best way is to use a vacuum tube voltmeter for measuring the input to the power tubes, that is, for measuring the signal voltages across the two sections of R7. In the absence of such a meter a headset or other sound producer can be put into the common plate lead of the output tube. When the signal intensity in this lead is minimum the amplifier is most nearly balanced.

MORE PHASE SHIFTS

Now suppose that the two detector circuits and the coupler following them have been adjusted so that the magnitudes of the input voltages to the two sides of the amplifier are equal, what is the assurance that the circuit will be truly push-pull? There is every assurance that it will not be exactly push-pull, but only approximately so.

There is practically no phase shift in the grid bias detector, for only the small input capacity between the grid and the cathode enters. This also enters in approximately the same way in the other circuit, but not quite. Any difference, however, due to this cause would be very small and negligible for all essential audio frequencies. But we have a small grid condenser and a leak across it in the other detector. This will introduce differences and these differences will change the relative phases of the two signals so that the output voltages will not be exactly 180 degrees out of phase.

Part of the phase shift at the higher frequencies can be compensated for by manipulating the sizes of the by-pass condensers CD1 and CD2, but the adjustment must be made experimentally for there is no other way of determining just what the proper values of the two condensers should be. While adjusting them one should listen to the highest audio notes present in the signal while the headset is coupled to the common plate lead in the power amplifier.

ANOTHER PUSH-PULL DETECTOR

There is another possibility for achieving push-pull detection in resistance coupling. Suppose one of the tubes is adjusted to detect on the lower bend of the grid voltage plate current curve. As the radio frequency signal increases the plate current increases, as was stated previously. Now let the other tube be adjusted to operate at the upper bend of the curve. As the radio frequency signal increases the plate current is decreased. Hence the two tubes will operate in opposite phase although the same signal is impressed on both simultaneously.

There are many objections to this scheme. One is that the detecting efficiency of the two tubes will not be the same, if the tubes are alike, because the curvatures at the upper and lower bends are not the same. Also, the tube operating at the upper bend will be positive part of every cycle and therefore it will draw grid current. This will place a load on the tuned circuit which will lower the selectivity. This fact, however, does not upset any phase relationship, except in so far as the inter-electrode capacities are changed by the changed operating conditions.

It is clear that many of the suggestions offered above are only applicable to tubes of the heater type except by the use of separate grid batteries.

RADIO FREQUENCY TUNER

The radio frequency amplifier in the diagram is shown in conjunction with the proposed push-pull detector to show the essential connections. This amplifier is exceptionally sensitive as well as selective so that a very strong signal is available for the detector and the audio amplifier.

Questions

(1)—State the two types of current. Give an example of each.

(2)—How does the input high frequency voltage get past the "barrier" of direct voltage in the plate circuit?

(3)—Does the detector output consist of audio or radio frequencies or both?

(4)—Does a tube function differently at audio than at radio frequencies?

(5)—Is a magnetic field set up in a resistor across which a pulsating direct voltage exists?

Answers

(1)—Alternating and direct. The carrier frequency of the broadcasting station is alternating current. The current in a flashlight fed by a dry cell is direct.

(2)—The radio frequency input to a tube is an alternating voltage of which the tube produces an enlarged copy in the form of pulsating direct plate current. When this pulsating current, which is of the same frequency as the alternating current, is passed through a coil, the electro-magnetic action restores the alternating condition.

(3)—Both. The radio frequency is usually detoured to ground, as only the audio frequency is desired.

(4)—No. The principle of operation is the same.

(5)—No.

Broadcast Sermon Brings $25,000 Bequest

Her receiving set gave Mrs. Virginia J. Kent, widow, her first contact with the Church of the Nazarene while she was staying at a hotel at Long Beach, Cal. After hearing the Rev. L. A. Reed's broadcast sermon, she discussed spiritual matters with the pastor.

When she died recently in Chicago she left $25,000 to the church at Long Beach.

Methods of Using Scr

Either Leak-Condenser, Low Negative

By Herbert

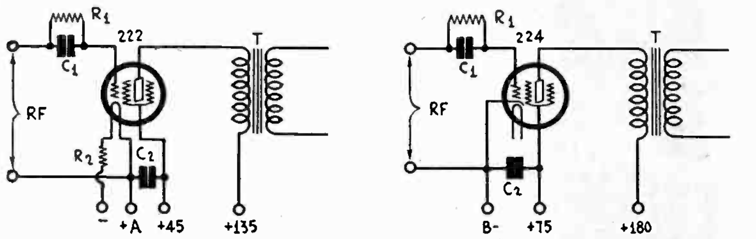

FIG. 1, FIG. 2
THESE TWO DIAGRAMS SHOW THE CONNECTIONS OF DC AND AC SCREEN GRID TUBES AS GRID LEAK, GRID CONDENSER DETECTORS.

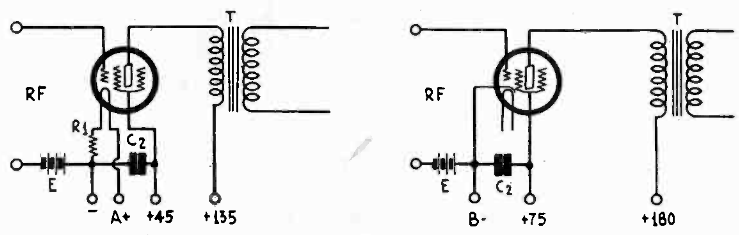

FIG. 5, FIG. 6
SCREEN GRID TUBES CAN ALSO BE USED AS GRID BIAS DETECTORS PROVIDED THE GRID BIAS CAN BE CHOSEN SUITABLY HIGH. THESE TWO CIRCUITS SHOW THE ESSENTIAL CONNECTIONS FOR THE DC AND AC TUBES.

MANY circuits for detection by means of screen grid tubes have been published, as the advantage of this tube as a detector are great. There are two different screen grid tubes, the battery type and the AC type, and each can be used in two ways, first as a screen grid tube and second as a space charge tube. Then again, either tube may be operated as a grid bias detector or as a leak-condenser detector. And again either may be used as a detector of weak signals or of strong signals. Therefore there is a large variety of circuit arrangements for obtaining detection by means of these tubes.

As a power, or strong signal detector, it is possible to get such a high output that it is not necessary to use a two-stage audio frequency amplifier in order to get a sufficient signal voltage to load up a power tube. With the weak signal arrangement, however, the output of the detector is not sufficient to load up the power tube without an extra audio amplifier, and one audio stage will not suffice.

USUAL CONSTANTS

When the screen grid tube is used as a weak-signal, leak-condenser detector the usual grid circuit constants and connections are employed, because as far as the grid circuit is concerned it behaves exactly like a three-element tube. The advantage of the screen grid tube over the three-element tubes comes from the fact that the screen grid tube is a better audio frequency amplifier. Detection occurs in the grid circuit, and the audio frequency voltage flucutations are amplified in the plate circuit just as if the tube were only used as an amplifier at audio frequency.

Referring to Fig. 1, which represents a 222 screen grid detector circuit, the value of R1 should be from 1 to 1.5 megohms and the condenser C1 should be .00025 mfd. for weak signals. The grid return, as shown, is made to the positive end of the filament. The indicated plate and screen grid voltages are of the usual values. The ballast R2, which should be 20 ohms for a filament voltage source of 6 volts, is connected in the negative leg, or it may be put in the positive provided that it be placed below the grid return. Condenser C2 operates mainly at audio frequency voltages and therefore it should not be smaller than about 2 mfd.

A weak signal detector for an AC screen grid tube is shown in Fig. 2. The grid leak R1 should be 1 meg., the grid condenser .00025 mfd., and the grid return should be made to the cathode. There is practically no difference, then, between the connections in the two cases, nor in the values of the circuit elements. The AC screen grid tube 224, is a considerably better audio amplifier than the DC tube and therefore for the same signal input the audio output from the AC detector should be considerably greater.

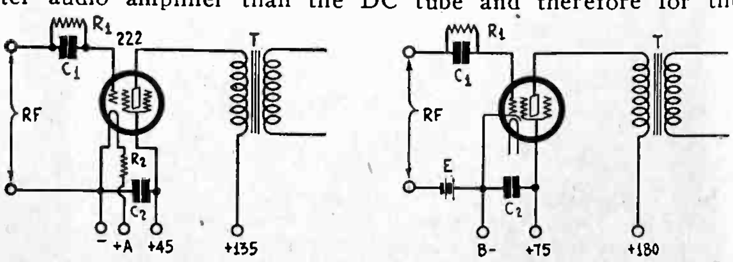

FIG. 3, FIG. 4
POWER DETECTION, OR STRONG SIGNAL DETECTION, CAN BE EFFECTED WITH SCREEN GRID TUBES IF THE GRID CONDENSER AND GRID LEAK BE CHOSEN SUITABLY, AND IF THE GRID RETURNS BE MADE AS SHOWN HERE.

POWER DETECTION

A strong signal detector using a 222 screen grid tube and grid leak and condenser is shown in Fig. 3. In this case the grid return is made to the negative end of the filament, the ballast resistor being placed in the positive leg. The value of the grid leak in this instance is only .25 megohm and the grid condenser capacity is only .0001 mfd. Thus both the condenser and the leak have been reduced in value.

The use of the AC screen grid tube in the same manner is shown in Fig. 4. The values of the grid leak and grid condenser are the same as in Fig. 3, that is, .25 megohm and .0001 mfd. The grid return, however, is made to minus one volt

Questions

WHICH TUBE SHOULD BE USED?

IN AN AMPLIFIER using battery tubes and transformer coupling what tube should be used ahead of the 171A push-pull amplifier?—P. W. C.

Either a 201A or a 112A. The 112A gives a little better results than the other becauses it has a lower plate resistance.

HOW DISCLESS TELEVISION WORKS

I READ recently about a television receiver in which no scanning disc was used. How does it work?—J. J. K.

There are several television systems which work without a scanning disc but perhaps you have in mind the cathode ray system. This works on the same principle as the Braun cathode ray oscillograph, exemplified by the Western Electric cathode ray oscillograph. This device is a modified form of vacuum tube. A narrow beam of electrons from a heated filament inside a large pear-shaped, evacuated tube is made to impinge on a phosphorescent screen. The intensity of this beam is modulated by the television signal. It only remains to distribute this beam over the phosphorescent screen so as to "paint" the picture. The distribution is done by voltages across electrodes between which the beam has to pass on its way from the filament to the screen. One set of electrodes causes the beam up and down across the screen and the other to move it back and forth. If the frequencies of the two voltages are adjusted properly, the beam will cover the entire screen in an orderly manner and will trace the picture. The light on the phosporescent screen is feeble, which is a disadvantage of the system. The advantages are compactness and high speed without lag.

EFFECT OF LARGE ZERO CAPACITY

WHAT is the effect of a large zero setting capacity on the range of a radio frequency tuner? Does it narrow the band or does it widen it? For a given variable portion of the tuning condenser can the inductance in the circuit be reduced to make up for a large zero setting capacity?—Wm. H. J.

The tuning range of a tuner depends on the ratio of the variable portion of the condenser to the minimum capacity. The greater this ratio the wider the tuning range. Hence if the variable portion has a given value the range will be smaller the larger the minimum capacity. It is for this reason that .0005 mfd. tuning condensers are usually recommended in preference to .00035 mfd. condensers.

een Tube as Detector

Bias or Power Detector May Be Employed

E. Hayden

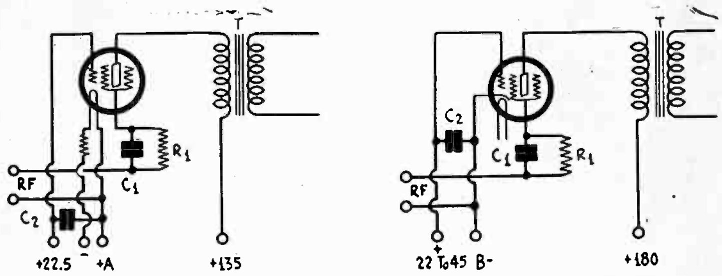

FIG. 7, FIG. 8

THE SCREEN GRID TUBES CAN ALSO BE USED AS SPACE CHARGE TUBES FOR DETECTION PURPOSES. THESE DIAGRAMS SHOW THE CONNECTIONS WHEN A GRID LEAK AND GRID CONDENSER ARE USED.

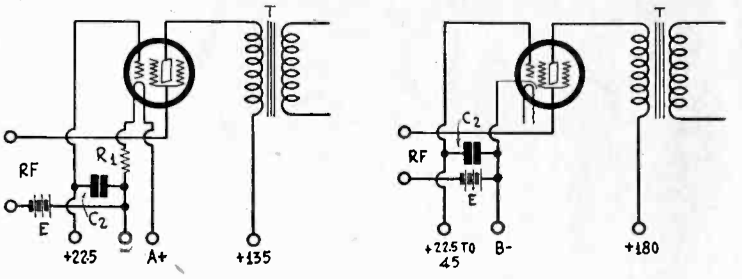

FIG. 9, FIG. 10

IF GRID BIAS DETECTION WITH THE SPACE CHARGE CONNECTION IS DESIRED, THESE TWO DIAGRAMS SHOW HOW THE TUBES SHOULD BE CONNECTED.

instead of to the cathode. Therefore a grid bias battery E is indicated, but this is merely to emphasize the need of a bias. There is no convenient battery of one volt. In an actual circuit the one volt bias would be obtained from a drop in a resistor.

Naturally, when power detection is used a much higher radio frequency signal voltage must be used to load up the detector to the overloading point. That is the principal difference between power and weak signal detection. Since the power detector is not so sensitive as the weak signal detector it becomes necessary to put another stage of amplification ahead of the detector. As to the total number of tubes in the receiver it makes no difference, because the weak signal detector requires an extra audio stage. The advantage of power detection comes from the fact that there is less distortion in a radio frequency amplifier and tuner than there is in an audio amplifier fier.

GRID BIAS DETECTION

Grid bias detection is more popular now than it has been previously. This is largely because more amplification is available in radio frequency amplifiers so that a high signal voltage may be impressed on the detector. When grid bias is used the grid condenser is omitted or else it is made as large as in audio frequency amplifiers. If a condenser is used a grid leak is used and this has about the same resistance as in audio frequency amplifiers.

The grid bias is much higher than in audio frequency amplifiers and depends on both the screen grid voltage and on the plate voltage. Usually the bias is adjusted until the plate current is less than one milliampere and often as low as one-tenth milliampere. The best bias for power detection is not necessarily the bias which gives greatest detecting efficiency.

In Fig. 5 is shown the circuit for a DC screen grid tube. In this the bias is supplied by the drop in R1 and by the voltage of the battery E. It is clear that the circuit is identical with that of an amplifier except that the bias is higher.

Fig. 6 shows the same circuit for an AC screen grid tube. This also is hooked up as an amplifier with the exception of the higher bias.

No by-pass condenser is shown in the plate circuit of any of the diagrams given above, but it is understood that it is used.

When a transformer is used for coupling the detector to the first amplifier there is usually sufficient distributed capacity in the primary to detour the radio frequency component in the plate current to make detection efficient, but when the tube is followed by a resistance coupler a condenser of not more than .0005 mfd. should be connected between the plate and the filament or the cathode. It is also understood that the high voltage leads are well by-passed.

SPACE CHARGE DETECTION

When the space charge connection is used the screen grid is used as control grid and the inner grid is connected to a positive voltage from 22.5 to 45 volts. Otherwise the circuits are the same as for screen grid uses of the tube. Figs. 7 and 8 show the DC and the AC screen grid tubes, respectively, connected in space charge fashion in grid leak and grid condenser detector circuits. The tube can be used in this fashion as a grid bias detector also, and if the grid bias is high enough it will stand a very high signal voltage.

Figs. 9 and 10 show the two tubes used as grid bias detectors with the space charge connection of the grids.

The space charge detector is very sensitive when used in this manner provided that the critical voltages are adjusted properly.

In every one of the preceding diagrams there is a condenser marked C2. Each works primarily at audio frequency and therefore should be large to be effective.

A point to bear in mind in connection with the 224 medium negative used as grid bias or high grid bias (power) detector, with individual biasing resistor, is that the screen and plate currents flow through the resistor. Hence the resistor may be 5,000 to 6,000 ohms or thereabouts, a relatively low value. The screen current is steady, so that the bias is relatively steady despite the variations in signal amplitude. This improves quality.

# of Interest

USING MOTOR-GENERATOR

IS it practical to use a motor-generator for powering a radio receiver, that is, to supply both the filament and the plate voltages? If so, what is necessary to eliminate the hum which necessarily is present in the output of such a device?—L. L. D.

It is entirely practical and is used in some of the finest radio receiver installations. There is one advantage in using a motor-generator to supply the plate voltage, and that is the constancy of the voltage. If a rectifier tube is used to supply the plate voltages the tube gradually deteriorates and the output of the receiver gradually grows worse. If a motor-generator is used there are only line voltage fluctuations which will change the output, but these are minimized. Any sudden voltage fluctuations will not appear as noises in the receiver because the motor-generator acts as a stabilizer. To remove the ripple an ordinary filter circuit is used, that is, series chokes and shunt condensers. As a rule, not as much filtering is necessary because there is less ripple in the output from the motor-generator than from the rectifier. There may be some difficulty in eliminating ripple from the filament current since this current may be heavy. The easiest way to remove it is to use electrolytic condensers of several thousand microfarads. Just a little inductance is usually sufficient in this circuit.

MEANING OF MICROVOLT PER METER

WHAT is the significance of the expression microvolts per meter? My idea is that if a wire one meter long is mounted vertically in the field of a wave the voltage induced therein gives one microvolt per meter.—J. K. M.

If you erect a wire one meter long the voltage induced therein by the radio wave gives the field strength and if the voltage is measured in microvolts, the result is the number of microvolts per meter. But it will not give one microvolt unless the field strength is one microvolt per meter. If you put up an antenna 10 meters long, counting only the actual height, and you get a voltage of one microvolt, the field strength is only one-tenth microvolt per meter. Field strengths are usually measured with a loop rather than with an open antenna. The effective height of the loop is used. Using an open antenna there is no way of knowing just what its effective height is but the effective height of a lop can be determined quite accurately with a ruler or meter stick.

Magnaformer Modernized

Negative Bias Modulation and Detection Improve Operation

By Hood Workman

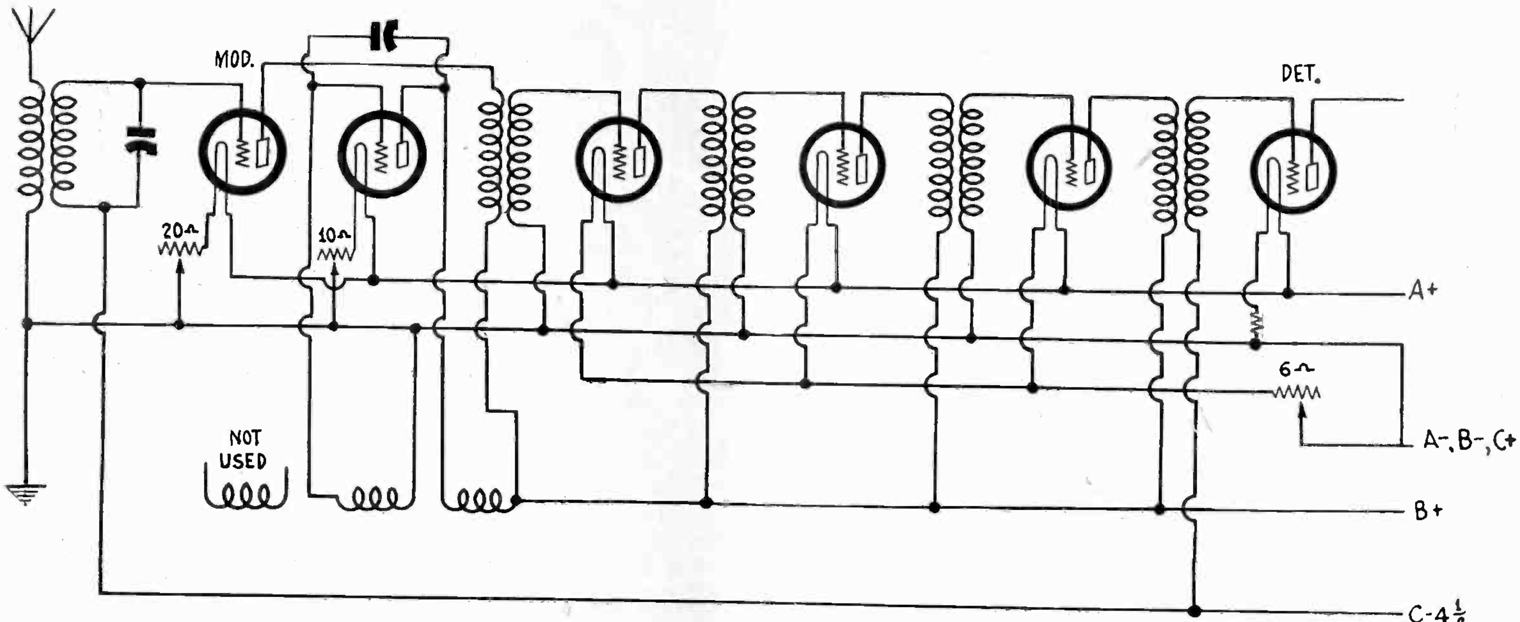

DIAGRAM OF THE TUNER CIRCUIT, INCLUDING INTERMEDIATE AMPLIFIER, OF A MAGNAFORMER 9-8, WHEN THAT RECEIVER IS SUBJECTED TO CERTAIN CHANGES FOR EASE OF OPERATION, IMPROVED STABILITY AND BETTER TONE QUALITY, WITHOUT ANY SACRIFICE OF SENSITIVITY.

THE Magnaformer 9-8 was one of the most popular receivers for kit construction in 1927 and a great number of these are in use. The circuit as originally presented required a loop for operation, but it is quite practical, and indeed advantageous, to use an antenna coupler. Also some other changes may be made to advantage, including the introduction of negatively biased grid circuits for the modulator and the detector.

The circuit has a switch which cuts in or out the fourth intermediate frequency stage. The coupler that feeds the detector should be removed, and likewise the socket whose plate circuit fed this coupler. Therefore the preceding coupler is made to feed into the detector.

At the place where the coupler was situated on the subpanel the new antenna coupler is placed. This may be any suitable coil, for instance, if a 2½" diameter tubing is handy, wind 14 turns, leave ½" space, and wind 55 turns, using No. 24 wire. For 1¾" diameter the turns may be 20 primary, ½" space, 67 secondary. Use No. 28 enamel wire. The first winding is for the aerial-ground circuit, the other for the input to the first tube, the modulator. Antenna and ground posts may be established where the loop jacks were.

CHANGED GRID RETURNS

All grid returns of the tuner, exclusive of the oscillator, are to be changed. The modulator and the detector grid returns go to minus 4½ volts of C battery. The intermediate stages are returned to negative A. Hence the potentiometer that was at left on the front panel is not used. Remove it, and in its place put a 20 ohm rheostat, which will be used as volume control.

The modulator and oscillator formerly were on one rheostat, but this is changed, so that this rheostat serves only the oscillator. A 6-ohm rheostat is used for giving the intermediate frequency tubes their best operating voltage. This is well under 5 volts for these tubes, even though they are 201A.

A 4 to 10 ohm fixed resistor is used to drop the A battery voltage for the detector. This resistor is shown in the negative leg, not designated by any constant, however, as it may be anything from 4 to 10 ohms.

The switch rheostat at right on the front panel is removed, and may be used in place of the 6 ohm rheostat shown in the diagram herewith. A toggle switch is placed in the vacated position, and a knob placed on the switch shaft to match the knob on the volume control rheostat at left.

In the position formerly occupied by the 9-8 switch, which would cut in and out the extra intermediate stage, a pilot bracket is put, with a 6 volt lamp. Connect this lamp across the oscillator filament.

Remove the connections to the pickup winding of the oscillator coil. Formerly the loop circuit was completed to A plus through this pickup winding, which coupled modulator and oscillator. We have dispensed with the grid leaks, and closed the clips of the two grid condensers, to short these condensers out of circuit, because we are using negative bias modulation and detection.

HOW TWO ARE COUPLED

We do not need the pickup winding of the oscillator, because the antenna coil is near enough to the oscillator, even when six inches away, or a little more, to provide adequate coupling between modulator and oscillator circuits. The coupling in any instance should be small, as the smaller it is the less the whistling when tuning in, and the better are the two circuits in independence of tuning.

The diagram does not show the audio channel, as this is not changed. The tubes, from left to right, as shown, are the modulat oscillator, first, second and third intermediate frequency amplifiers, and detector. The three stages of intermediate are entirely sufficient, as is proved by the fact the tubes of these stages must be worked well under 5 volts.

Under the new system the intermediate frequency amplifier will not oscillate, as the rheostat controlling the tubes in this channel is turned until there is no oscillation. Hence there is no necessity for swinging these grids positive to stop oscillation, a method that works all right, but which is not the wisest.

The sensitivity will be greater this way, because an aerial is used and because the intermediate frequency amplifier is always somewhat negatively biased. The negative bias modulator and detector work excellently but the voltage must be 4½ for about 45 volts on the plates, represented by B plus in the diagram.

In the receiver itself the tubes do not run in the order shown, since the oscillator is alone, near the front panel, but otherwise the schematic order is duplicated physically.

USE 240 AS MODULATOR

The modulator tube should be a high mu 240 instead of a 201a, as better sensitivity obtains. This holds true no matter which type of modulator hookup is used, even leak-condenser. The oscillator may be a 201A or a 112A, the 112A giving a steadier oscillation, with less whistling attending the tuning.

No filament voltage except that of the modulator for volume control need be touched after the settings are once made. Nor will the circuit be tricky in tuning. Repeat points will be diminished, due to lessened distortion. Tone quality will be improved, because the detector will not be overloaded, except on strongest locals, when the volume control can be adjusted to keep down the terrific volume to what a human ear can stand in a standard sized room.

LITTLE NEEDED FOR AERIAL

Only a small aerial is necessary. About 15 feet of wire under the carpet or around the moulding will give at least as great pickup as was obtained with the loop. If desired, an outdoor aerial may be used, but should not exceed 50 feet in most locations. Many who don't want to use an orthodox aerial may connect ground lead to the antenna post and leave the ground post blank.

Watch Condenser Mounting

When Building the HB33 or HB44, High-Gain Circuit

THE HB33, a high gain screen grid receiver, using three stages of tuned screen grid radio frequency amplification, tuned screen grid detector, first stage of resistance-coupled audio working into a 112A, and second stage transformer coupled audio working into 112A in push-pull, should be constructed from the pictorial diagram of the wiring published last week. The diagram shows the view of the top of the steel chassis, on which there is virtually no wiring, and then the bottom view of the chassis is presented, turned "backward," as it were, the front becoming the rear, so as to preserve the same relative right and left directions. This greatly simplifies the reading of the diagram, as leads take the same course in the diagram as in your receiver.

The large schematic diagram was published the previous week, issue of December 21st, and constructional details were given, principally in regard to mechanical rather than wiring problems, as it was stated the pictorial diagram would be published. This diagram last week disposes of the wiring problems at once.

HOW TO MOUNT CONDENSER

On the score of the mechanical problems, the details previously published are sufficient, except that a few words more should be stated concerning the mounting of the four gang tuning condenser. This has a capacity of .00035 mfd. when used without any metal tight against it, but if the condenser is mounted right to the subpanel the capacity mounts to .00042 mfd. This is a steady .00012 mfd. capacity addition, so the minimum capacity is heightened too, and full coverage of the wave band would not be assured, unless the precautions set forth Dec. 21st are taken. These will be repeated now with additions.

The subpanel or chassis has a row of holes down the center, consisting of four large holes and eight small ones. The large ones were intended to avoid any possibility of the stator of any section contacting with the subpanel and thus grounding the grid, hence shortening the input to the particular staged tuned by that section. To prevent this grid insulating washers might be used additionally, where the condenser is mounted so as to "hug" the subpanel, without elevation, but it is suggested that the problem be solved in another way, as outlined last week, that consisting of elevating the condenser ¼" from the subpanel.

Take two extruded fibre washers, each ⅛" high, and put them one atop the other, with their flat surfaces on the top of the subpanel and bottom of the condenser, respectively. Only eight such washers actually are needed, four being used at the two front holes for the condenser frame, and four at the rear. The holes are drilled in the subpanel, these being the small holes side by side near the front and near the rear, the large opening for clearance of the other stator being between the small holes.

ELEVATION OF ¼" IS SOLUTION

Now, it will be obvious that if the condenser is elevated ¼" that the stator screws concerning which some concern was expressed will be lifted ¼", also, and this brings them entirely out of any danger of touching the subpanel, and without resort to grid insulation.

Excellent rigidity is attained when this method of mounting the condenser is followed. The four other screws may be driven through the bottom of the subpanel to engage the frame of the condenser, without resort to bushings. Also this method dispenses with the necessity of removing at all the screws and incidental lock washers that go to the stators.

The object, of course, is to avoid the high capacity to ground existing if the condenser is mounted directly on the chassis without washers being used for elevation. It is a fact that elevation alone is the object sought, and not insulation, the fact the washers are insulated being accidental. They were available for the purpose and serve it well. Of course, the frame of the condenser has to be connected to the subpanel metallically, but this is attained not only through the screws that pass through these eight extruded washers, but also by the screws in conjunction with which no washers are used.

One not having the condenser and chassis before him might suppose that there is something complicated about this, but in fact it is all very simple when you come to build the receiver and have the parts right before you.

The same instructions regarding the mounting of the condenser apply to the HB44, which is the AC counterpart of the battery-operated HB33. Details concerning the HB 44 were published last week, and it is expected that in two weeks the pictorial diagram of the AC model will be printed the same size as the pictorial model of the HB33 herewith.

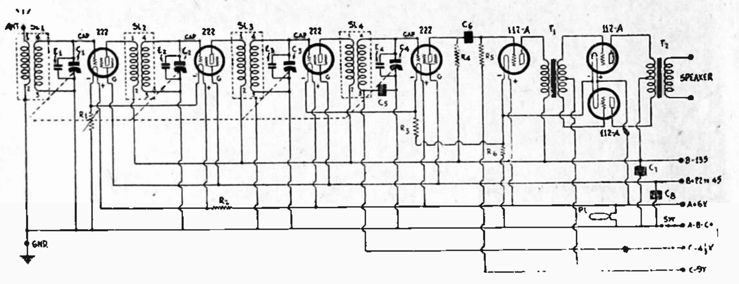

DIAGRAM OF THE HB33 CIRCUIT

DETAIL CONCERNING CABINET

As previously stated, the receiver may be operated outside the cabinet. But when you come to put it in the cabinet you will have to remove the blades of the condensers by loosening the set screws and pulling out the shaft. It is really the shaft you want to remove, but the blades must come out, too.

Notice that there is an adjusting screw, for tension, at rear of the condenser.

When the receiver is in the cabinet, replace the condenser blades and put the shaft back in place, also the round metal washer between the first section and the front of the frame. Now you should carefully center the assembly, so that by the eye test the moving blades will be exactly equi-distant from the stator blades between which they rotate.

If you tighten the tension adjustment screw at the rear of the condenser you push all the blades forward, toward the front, so that if you want more frictional resistance during the rotation incidental to tuning, and adjust for that purpose, realign the moving blades at center between stator blades. Otherwise you will not gain full value from the equalizing capacities built into the condenser.

So, in equalizing, it should not be necessary to drive the screw all the way down for any stage, but only part of the way, and if you find the opposite is required to achieve resonance, then the moving blades are not correctly centered in respect to the stator blades on either side of them, and correct this.

STATIONS FROM ALL OVER U. S.

Any lack of sensitivity or selectivity in the receiver may be ascribed to you misjudgment of the four gang condenser, so be certain that you get this right. It is easy enough, but unless you are forewarned you might make a mistake that would cause baffling lack of results, whereas you must know that from a well-designed receiver of this type, using four screen grid tubes in the tuner, you have a right to expect abnormal results, and if directions are carefully followed you certainly should be able to tune in quite easily stations from all over the country, including stations on high wavelengths that are not brought in, or not brought in well, on most receivers, since the sensitivity of the run of receivers falls off sharply at the higher wavelengths.

LIST OF PARTS

SL1, SL2, SL3, SL4—Four stage individually shielded coil cascades for .00035 mfd. (Cat. SH-3 of Screen Grid Coil Co.).
C1, C2, C3, C4—Four gang .00035 mfd. condenser with equalizers E1, E2, E3, E4.
C5, C6—Two .01 mfd. mica fixed condenser.
C7, C8—Two 1.0 mfd. bypass condensers 200 volt DC working voltage.
R1, Sw—30-ohm rheostat with switch, knob, insulators.
R2, R3—Two 6.0-ohm fixed filament resistors.
R4—One .05 meg. Lynch metallized resistor.
R5—One 5.0 meg. Lynch metallized resistor.
R6—One 1-ohm fixed filament resistor.
T1—One push-pull input transformer.
T2—One push-pull output transformer.
PL—Pilot lamp and bracelet.
Ant., Gnd. Speaker—Four binding posts.
One drilled steel cabinet, brown crinkle finish.
One vernier full-vision dial.
One flanged subpanel with seven UX sockets and one UY socket.
Four grid clip.
One 5-lead connector cable.

Microvolts per Meter—V

Field Strength Necessary to Produce a Giv

By J. E.

Techni

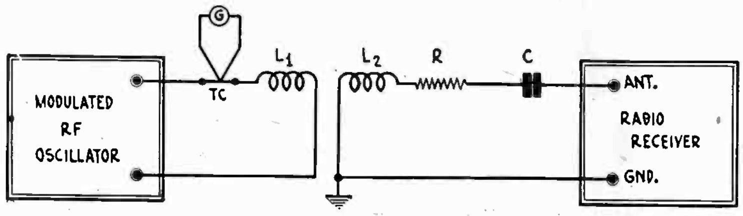

FIG. 1

AN ARRANGEMENT USED IN TESTING THE SENSITIVITY OF RADIO RECEIVERS. THE MODULATED OSCILLATOR IS COUPLED TO THE STANDARD ARTIFICIAL ANTENNA BY MEANS OF MUTUAL INDUCTANCE, WHICH MAY BE VARIED TO ADJUST THE INPUT.

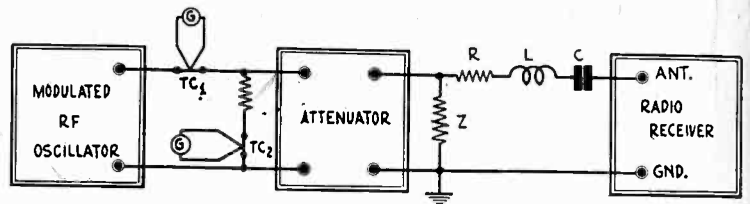

FIG. 2

IN THIS ARRANGEMENT FOR TESTING THE SENSITIVITY OF RECEIVERS AN ATTENNATOR IS USED FOR ADJUSTING THE INPUT TO THE STANDARD ANTENNA.

THE loudness with which a given broadcast station is received at any place with a given set depends on the field strength of the signal at that place. The field strength of that station at that particular place may vary from time to time, and for that reason the loudness of the signal varies also.

What is the meaning of field in this case? Let us begin by explaining the meaning of a steady electric field. Suppose the earth is at zero potential, an assumption which can always be made if we wish to start measuring voltage, that is, potential, at the ground. Then suppose there is a conductor parallel with ground, such as a large sheet of metal, which is kept at a potential 1,000 volts positive. Let this plate be a distance of 100 feet above the ground. Then the difference of potential between the earth and the charged plate is 1,000 volts. The field strength is the potential difference per unit length. If we use the foot as the unit of length the field strength in this assumed case is 10 volts per foot. It has this value everywhere between the ground and the charged plate for there is supposed to be nothing in the space between the earth and the plate which changes the rate of fall of potential.

VARIABLE FIELD STRENGTH

Now it may be that the rate of fall of potential is not uniform between the earth and the plate. There may be, for example, other conductors in the space which are charged at different potentials. These would alter the rate of change of potential. But still at any point the field can be measured in terms of volts per foot. At one point the field strength may be zero, at another point it may be 5 volts per foot, at still another it may be 500 volts per foot. When the rate of change of the potential is not uniform the intensity at any point is determined by taking the potential difference between two points very close together and dividing this voltage by the distance in feet between the two points.

Since electrical units, including those in radio, have been built up on the metric system of measurement it is customary to use the meter as the unit of length in making field strength measurements, or in some instances, the centimeter, which is the scientific unit of length. Hence field strengths relating to insulators are usually expressed in volts per centimeter. But field strengths of radio waves are expressed in microvolts per meter, and sometimes in millivolts per meter. The reason for using the meter in this instance is that the voltages involved are so small that if the centimeter were used inconveniently small numbers would be required to express the strength.

RADIO FIELD STRENGTHS

Radio wave field strengths are measured in the same manner as steady field strengths, although the voltage varies rapidly as time goes on. The ground may be taken as zero potential all the time. Then as a wave passes the voltage at a point above the ground varies through a certain range, measured with respect to ground. Whether the voltage at that point is positive or negative does not matter. At any instant the voltage at the point may be 500 millivolts. At another instant it may be zero. If the 500 millivolt potential is the maximum during a cycle this value is twice the amplitude of the wave and the amplitude of course is 250 millivolts. The effective value is .707 times 250, or 146.75 millivolts.

This, however, is not the field strength of the wave unless it happens that the chosen point was unit distance above the ground. Suppose the point is ten meters above the ground. Then the field strength is approximately 15 millivolts per meter. If the point is only one meter above the ground then the field strength is 146.75 millivolts per meter, but if that is the case a point ten meters up would have an effective voltage of nearly 1.5 volts. The field strength is always the number of voltage units difference in potential per unit vertical distance. When the voltage varies like that of a radio wave the effective voltage counts and this is .707 times the amplitude of the wave.

NO WIRE NECESSARY

It is not necessary that a wire be erected between two points in order that a potential difference may exist. When the radio wave passes the voltage exists whether there is a wire or not. The only function of the wire is to permit making use of the voltage difference that does exist. The potential difference between the ends of the antenna, say the ground and the high point, becomes an electromotive force in the wire which causes a current to flow. This current is greatest near the ground so that if the primary of a radio frequency transformer be placed in the antenna near the ground the greatest signal intensity will be transferred to the receiver.

In measuring the field intensity at any point a loop is used for pick-up rather than a vertical wire. It is possible to calculate the voltage that will be induced in a loop of known dimensions by any given field strength so the problem of measuring field strength is reduced to measuring the dimensions of the loop and later measuring the voltage induced in the loop. What is known as the effective height of the loop is used in place of the height of the antenna, and the effective height of the loop depends on the number of turns on it and on the area of each turn, or if the areas of the different turns vary the area of the mean turn is used.

SENSITIVITY OF RECEIVERS

The sensitivity of receivers is usually expressed by the number of microvolts per meter required to put out a standard audio signal when the set has been adjusted to its greatest sensitivity. Thus the more sensitive a receiver is the smaller the number of microvolts per meter will be required to express it. A very sensitive receiver might have a sensitivity of one microvolt per meter and a less sensitive set 10 microvolts per meter.

Since there are many variable factors affecting the output of a receiver it is necessary to use a standard input, which must be provided by a local oscillator. The wave emitted by this oscillator should be free from harmonics and it should be modulated 30 per cent. There must be a means of measuring the output of this oscillator, which is usually a thermocouple and a sensitive microammeter.

The output of this oscillator must be coupled to the receiver under test through an artificial antenna having standard characteristics. The standard antenna has an inductance of 20 microhenries, capacity in series with the inductance of 200 mmfd., and a total series resistance of 25 ohms. These are the average characteristics of an antenna four meters high, and this height is taken as standard.

CIRCUITS FOR MEASURING SENSITIVITY

One arrangement for measuring the sensitivity of a receiver is shown in Fig. 1. At the left is the modulated radio frequency oscillator. The output is measured with the thermocouple TC and the microammeter or galvanometer G. The signal is

'hat on Earth Are They?

Response Gauges Sensitivity of a Receiver

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ransferred to the artificial antenna circuit by means of mutual nductance between the coils L1 and L2. The field intensity is btained by the formula E=6.28fMI/h, in which E is the field trength in microvolts per meter, f the frequency of the fre- uency of the current in kilocycles per second, M is the mutual nductance in microhenries between coils L1 and L2, I is the urrent through L1 in microamperes, and h is the height of the ntenna, assumed to be the standard of 4 meters. The values f L2, R and C were given above for the standard artificial ntenna. R is the total resistance and therefore includes that f the coil L2.

In the circuit in Fig. 1 the signal intensity impressed on the eceiver can be varied either by varying the coupling between .1 and L2, that is, M or by varying the current through the rimary coil.

Another arrangement for measuring the sensitivity is shown n Fig. 2. This differs from the arrangement in Fig. 1 mainly n the manner in which the signal is attentuated, or reduced to he lowest value which gives a standard output signal. The nodulated oscillator is the same as in the preceding circuit and he output current is measured in the same way by means of he thermocouple TC1 and the galvanometer. The voltage across he input terminals of the attenuator is measured by a similar hermocouple TC2 and another galvanometer. The attenuator s usually of the resistor type. That is, it has certain series and hunt resistances which may be altered in number and value to educe the voltage across Z to any desired proportion of the neasured voltage across the corresponding input impedance.

FORMULA FOR INPUT SIGNAL

The values of L, C and R in this circuit are the same as the alues of L2, C and R in Fig. 1, namely, 20 microhenries, 200 nmfd. and 25 ohms, respectively. However, R includes the esistance of Z as well as that of L. The formula for the field ntensity in this instance is E=KZI/h, in which E is the field trength in microvolts per meter, K is the attentuation constant f the attenuator, Z the coupling impedance, I the current hrough the thermocouple TC1 measured in microamperes, and is the height of the antenna (4 meters).

It will be noticed that the input voltage to the receiver is the rop in Z. If the attenuator is calibrated in volts, the formula akes the form E=KV/h, in which K is the attenuation factor nd V is the voltage across the input impedance as measured by nermocouple TC2 and the second galvanometer. That is, the nput voltage is the product of the input impedance and the urrent in the thermocouple TC2. Since K is the antenuation actor the voltage across Z is KV. The reason the voltage is ot measured directly in Z is that this is so small that it can- ot be measured accurately with any available thermocouples. ccurate attenuators can be constructed out of non-inductive esistances or they can be purchased already calibrated.

LOOP RECEIVERS

When the receiver is made for loop reception the measuring evice takes a simple form, as shown in Fig. 3. The same modu- ted oscillator is used and the same current measuring device. he primary coil takes the form of a small loop L. This coil placed so that its center line passes through the center line f the receiver loop in the manner indicated. The two coils nay or may not be parallel, but if they are not, the angle be- ween them must be measured as this enters into the calcula- on.

With this arrangement the field intensity can be calculated ith the formula $E = 18{,}850NA^2I\cos B/(A^2+X^2)^{3/2}$, in which is the field intensity, N the number of turns on the coupling oil, A the radius of this coil in centimeters, I the current rough the coil in microamperes, and X the distance in centi- eters between L and the receiver loop, the center turn on each eing taken. The value of the cost term can be obtained from igonometric tables once the angle B has been found. If the ops are parallel the cosB term is unity and need not be nsidered. The value of E is given in microvolts per meter.

ASSUMED VALUES

It will be realized that these devices, particularly those in igs. 1 and 2, do not give the actual values of the field strength ecause of the assumed height of the antenna. But they do ve convenient and standardized methods for comparing com-

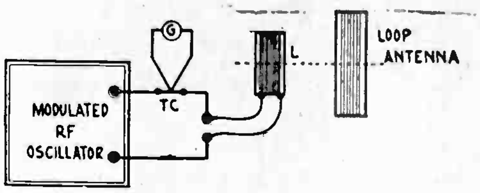

FIG. 3
WHEN THE RECEIVER TO BE TESTED HAS A LOOP THIS ARRANGEMENT IS USED IN TESTING THE SENSITIVITY OF THE RECEIVER.

mercial receivers. The loop method gives more definite indication of the field strength because there is no assumption of height.

It is clear that the circuit in Fig. 1 is the simpler of the two which are suitable for the ordinary receiver using an open antenna because the coil L1 is simpler and cheaper than the attenuator in Fig. 2. The only difficulty in Fig. 1 is to know what the mutual inductance is between the two coils. This, however can be calculated without a great deal of labor when the two coils are regular and placed with their centers on the same line. It can also be measured with simple means.

One way of varying the coupling is to rotate the smaller coil inside the other, or even outside. The mutual inductance for any setting of the rotor can then be calculated from measured inductance values of the two coils separately and the inductance when they are in series. For example, if the measured inductances of the two coils are L1 and L2 and the measured inductance of the two in series aiding is L3, the mutual inductance between them is (L3—(L1+L2))/2. If a dial is attached to the rotor coil L3 can be measured at several different settings of the dial, and the mutual inductance determined at each setting. A curve can be plotted of mutual inductance versus dial settings and thus the mutual inductance at any setting can be determined from a few measurements. Note that it is only necessary that the scale cover more than ninety degrees because the mutual inductance varies from zero to maximum while the rotor turns through this angle. Negative values of mutual inductance are of no interest in this case.

The values of L1 and L2 can be calculated with simple formulas because coil forms for which simple formulas are available can be selected.

STANDARD SIGNAL

The standard signal is one modulated 30 per cent with an audio frequency of 400 cycles per second which is free from harmonic content. The standard output is .05 watt in a resistance equal to the plate resistance of the tube used as power tube. That is, the product of the signal current squared and the resistance is supposed to be .05 watt.

If the power tube is followed by an output transformer the resistance to be connected to the secondary is to be equal to the reflected resistance of the tube as seen from the secondary of the transformer. The tube is to be operated so that the second harmonic in the signal does not exceed 5 per cent. It is assumed that the tube is large enough to put out the standard signal before it becomes overloaded.

VOLUME CONTROLS IN SCREEN GRID RECEIVERS

IN nearly all up-to-date screen grid receivers using the 224 type tube, I have noticed that the volume is controlled by varying the screen grid voltage with a potentiometer. Is there not a better volume control that could be used? I have tried it and have not had much luck with it. It seems to me that when the screen grid voltage is changed the efficiency of the tubes changes greatly.—W. H. S.

This method of controlling the volume is now used almost exclusively because there is no other satisfactory way of controlling the receivers. Yes, the efficiency of the screen grid tubes change when the screen grid voltage is varied, and that is just exactly the reason for changing it. The volume could be changed by changing the heater current in the tubes, just as is done in receivers using DC screen grid tubes, but the volume does not respond quickly enough to make the scheme satisfactory. If changing the screen grid voltage were not the most satisfactory method of controlling the volume it would not be used by all those who have designed outstanding receivers.

A Question and Answer Department conducted by Radio World's Technical Staff. Only Questions sent in by University Club Members are answered. Those not answered in these columns are answered by mail.

RADIO UNIVERSITY

Annual subscriptions are accepted at $6 for 52 numbers, with the privilege of obtaining answers to radio questions for the period of the subscription, but not if any other premium is obtained with the subscription.

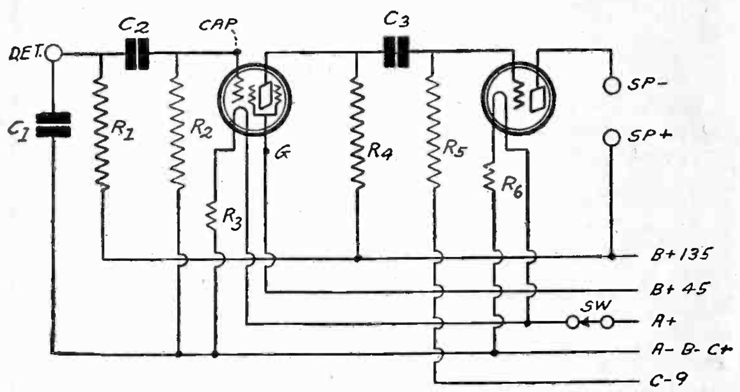

FIG. 817

A TWO-STAGE RESISTANCE COUPLING AMPLIFIER WHICH CAN BE USED WITH A RADIO RECEIVER FOR GETTING LOUDSPEAKER VOLUME, ALTHOUGH NO AUDIO TRANSFORMER IS USED IN THE CIRCUIT.

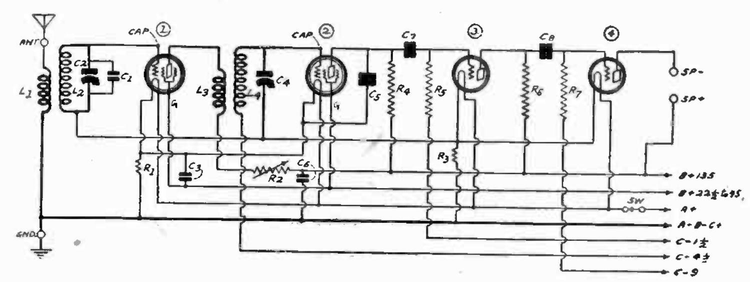

FIG. 818

A COMPLETE RADIO RECEIVER IN WHICH RESISTANCE COUPLING IS USED IN THE AUDIO AMPLIFIER. LOUDSPEAKER VOLUME WILL BE OBTAINED, ALTHOUGH NO TRANSFORMERS ARE USED.

LOUDSPEAKER VOLUME WITHOUT TRANSFORMERS

I HAVE been told that loudspeaker operation is impossible without the use of audio frequency transformers for coupling the audio stages. Is that correct? If not, please show circuits which will give loudspeaker volume without transformers—D. J. D.

You have been misinformed. The best audio frequency amplifiers do not contain any audio transformers at all. Have you not heard of resistance coupled amplifiers? In Fig. 817 is a typical audio frequency, resistance coupled amplifier of two stages which, when connected to a moderately sensitive receiver, will give you enough volume to operate the avrage loudspeaker. There is no limit to th volume that you can get from a resistance coupled circuit if you use large enough output tube and employ sufficient amplification. Fig. 818 shows you a complete radio receiver in which not a single audio transformer is used, yet it will give sufficient volume to operate almost any loudspeaker. For battery operation that is about as good a receiver as you can get without going into a great deal of expense.

AUTOMATIC VOLUME CONTROL

IS AN automatic volume control in a receiver really practical? If you think it is, please publish a circuit diagram of one or tell me where I can find such a diagram. I mean the type of volume control which operates at radio frequency, not the type which controls the amplification by the signal strength in the audio frequency level.—J. K.

There is a circuit diagram of the RCA 64 in Trouble Shooter's Manual by John F. Rider. This receiver has an automatic volume control of the type you ask for.

GREAT IMPROVEMENT IN SET

I BUILT a screen grid receiver the way you described it. but it did not work out as well as it was supposed to do. It was very selective, but it would only bring in local stations. Substitution of general purpose tubes cleared up the trouble. With 201A tubes the circuit is wonderful. Why does not receiver work with screen grid tubes?—A. C. C.

Either the tubes were defective or you did not use them right. If the circuit worked by merely substituting 201A tubes the connections were surely wrong before because the screen grid tubes require a different hook-up. Then again your voltages may not have been right. In most instances of failure the voltages are at fault.

MULTIPLE CONNECTION OF SPEAKERS

I WISH to connect several speakers to my push-pull, 250 tube power amplifier. Should I connect them in series or in parallel or in some other combination? The speakers are of different make.—O. G. H.

It is not an easy matter to connect speakers of different constants to the same output circuit. If they are connected in parallel the low impedance speakers will partly short-circuit the high impedance speakers; if they are connected in series the high impedance speakers will take most of the output power. In either case the impedances are not right for best transfer of energy from the tubes to the speakers. If the speakers are in series the load impedance is likely to be too high. and if they are in parallel it is likely to be too low.

Now if the speakers are connected in series parallel the resulting impedances is somewhat difficult to predict. If all the speakers are the same two in series and two in parallel will give the same impedance as a single speaker, and all will get the same amount of power. But if they are different one branch may have a much higher impedance than the other and the situation becomes about the same as if two speakers, one of low impedance and one of high, were connected in parallel. If two speakers are of a type which has one-half the impedance each than another speaker, the two low impedance speakers should be connected in series and then connected in parallel with the high impedance speaker. The total impedance of the three speakers will then be equal to that of one of the low impedance speakers. If the output impedance of the amplifier is such as to match this impedance all is well.

VACUUM TUBE VOLTMETER

WHAT type of indicating meter would you recommend for use with a vacuum tube voltmeter?—J. B. K.

That depends entirely upon what kind of vacuum tube voltmeter and for what purpose it is to be used. For measuring alternating voltages with accuracy, a sensitive microammeter is recommended, one having a sensitivity of at least 0-100 microamperes. Such a meter is desirable because the current required is so small that the tube used will last indefinitely without recalibration. For less accurate work a 0-1 milliammeter will do. If the instrument is not to be direct-reading it is possible to use any kind of indicating current meter. For different types of vacuum tube voltmeter look in back issues of Radio World where complete descriptions have been given of different types.

WINDING DATA ON SMALL COIL

PLEASE let me know how many turns of No. 28 enameled wire I should put on a 1.25 inch diameter to give an inductance which will cover the broadcast band with a .0005 mfd. tuning condenser.—F. D.

Use 84 turns and wind them without other spacing than that afforded by the insulation. The coil will be 1.135 inches long on the average. The thickness of the wire will vary a little.

BIAS RESISTOR FOR 245

I HAVE a voltage divider having a large number of taps and a total resistance of nearly 14,000 ohms. Would it be possible to use part of this resistance for grid bias resistor to serve a 245 power tube?—P. C. A.

If the taps are located at the right points it is possible. It is only necessary to connect B minus to a point 1,500 ohms from one end of the resistor and then connect the end of the 1,500 ohm section to the center tap of the filament for the 245 tube.

SCREENS USED AS BAFFLE

I HAVE in mind of building a receiver on a high panel and treat it somewhat like a highboy. The loudspeaker would be placed in the center. Then I plan to have swinging doors the length of the height of the panel, the width of each being equal to one-half of the width of the panel. In operation these doors will be swung open and placed so that they will act as a baffle board. The panel will be about five feet high and the total width with doors open will be about 36 inches. Would this arrangement work satisfactorily? In place of the swinging doors I was thinking that I might put screens on each side of the speaker. How would this arrangement work?—J. O. P.

SUPPLY CURRENT FOR DYNAMIC FIELD

WILL YOU kindly publish a circuit diagram of a current supply for a dynamic speaker requiring 90 volts for the field?
—E. R. H.

Fig. 819 is the circuit diagram of a simple B supply unit. This might be used, or part of it. Cut off everything to the right of C2 and connect the field winding across this condenser. This will work all right provided that the voltage is not too high. Of course, the voltage depends on the voltage across the secondary of the power transformer. If the voltage across each half is 110 volts you will have ample current and voltage for your dynamic field. It is difficult, though, to get a transformer of such low voltage, unless it is especially wound for the purpose. You might use the commercial transformer of lowest voltage which you can get and then limit the current in the field by a resistance in series with the field. To determine the value of resistance you need you must know the voltage at the out of the rectifier and the current required by the field. Suppose the voltage is across a resistance placed across C2 when a current of 40 milliamperes flow, and suppose further that the rated current of the speaker is 40 milliamperes and the voltage 90 volts. You must then put a resistance in series with the speaker to cut the voltage from 220 to 90 when a current of 40 milliamperes flow. That is, you must have a resistance equal to 130/.04, or 3,250 ohms. Hence, in this case get a variable resistance of 5,000 ohms, capable of carrying more than 40 milliamperes, and connected in series with the field. Then adjust it until the current in the speaker is 40 milliamperes or until the voltage across the field is 90 volts.

Either arrangement should work very well. Undoubtedly, something very attractive could be worked up along this line, as well as something very effective acoustically. If you build such a cabinet there would be room not only for an elaborate radio receiver but also for a phonograph, with record compartments and all. Not only that, but you might find room in it for a home movie outfit. The upper part of the panel might be used for the screen.

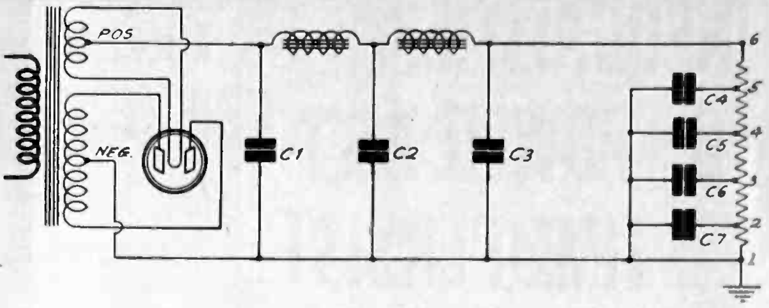

FIG. 819

A SIMPLE RECTIFIER AND FILTER CIRCUIT WHICH CAN BE USED FOR SUPPLYING THE FIELD OF A DYNAMC SPEAKER. ONLY ONE CHOKE AND TWO CONDENSERS NEED BE USED, BUT A RESISTANCE SHOULD BE CONNECTED IN SERIES WITH THE FIELD TO LIMIT THE CURRENT.

USE OF ELECTROLYTIC CONDENSER

YOU are always recommending the use of a large condenser across the grid bias resistor in the power stage, and I have found that it is a good idea to do so. In fact I want to use an electrolytic condenser. Now I am wondering whether it would be possible to use a section of the electrolytic condenser used in the power pack. I realize that the copper can is negative and that this is common for all the sections. It seems to me that some arrangement would be possible which would allow this use of the condenser.—A. D.

The way most receivers are connected it is possible to use one of the sections of the electrolytic condenser without any special arrangement. Connect the can to B minus and one of the sections to the mid tap of the filament transformer serving the power tube. The center tap is positive with respect to B minus by the drop in the grid bias resistor. One of the high capacity sections cannot be used for any better purpose.

CONNECTION OF PHONOGRAPH

I NOTICE in the AC model HIQ-30, described in the December 21 issue of RADIO WORLD that the phonograph pick-up unit is connected between the grid of the detector and ground, and that there is no provision made for opening the radio input circuit. Does not this circuit short-circuit the phonograph input?—A. B. W.

As was clearly explained in the article to which you refer, the short-circuit is prevented by the high resistance grid leak and the high impedance of the grid condenser. There is only a slight short-circuiting effect at the highest audio frequencies, but this is desirable to equalize the high and the low frequencies and to eliminate some of the scratch noises.

COMPARISON OF OUTPUT

WHICH will give the more output, a single 245 tube or two 112As in push-pull?—M. N. W.

With maximum recommended plate voltages on the tubes one 112A gives a maximum undistorted output of 300 milliwatts and two in push-pull would give about 1,000 milliwatts. A single 245 will give a maximum undistorted output of 1,600 milliwatts. It will require a much greater amplification ahead of the 245 than ahead of the 112A to get this maximum undistorted output.

DOES CARRIER FREQUENCY VARY?

IS IT a fact that the carrier frequency of a broadcast station varies when the signal is modulated, and that the degree of variation is greater the greater the degree of modulation?—W. H. H.

That is more or less the case. However, it depends on the kind of broadcasting station that is in question. Where a piezo crystal is used to control the frequency there is practically no variation in the frequency. Likewise where a master oscillator is used there is practically no variation, provided that there is no reaction between the modulator and the oscillator. In the old type broadcaster where the oscillator and the modulator were coupled directly together in the Heising circuit there was considerable frequency variation accompanying modulation.

EQUIPMENT FOR 25 CYCLE POWER

WHAT are the principal differences between power transformers intended for 60 cycle and 25 cycle work? If a transformer has been designed for 25 cycles can it be used on 60 cycles satisfactorily?—T. P. R.

The transformer made for 25-cycle work is usually built on a larger scale, and therefore it costs more than one made for 60-cycle work. The 25-cycle transformer has a larger core and more turns on the windings. If a transformer has been built for 25 cycles it can be used for 60-cycle work but one built for 60 cycles cannot be used for 25-cycle work.

MODULATION OF DIRECT CURRENT

COULD it be said correctly that the plate current in a vacuum tube is modulated by the radio or audio frequency current?
—M. Q.

Yes, it may be looked on in this manner. Modulation is a variation in the amplitude of a radio frequency current, but it could also be regarded as a variation in the "amplitude" of a steady current.

INEQUALITIES OF POWER AND TIME PERSIST

Washington.

The Senate has been informed by the Radio Commission that while the desired equality of power required by the Davis amendment to the radio law has been achieved as far as possible in the allocation of frequencies and time of station operation, there still exist inequalities in radio facilities.

"This was due," the Commission said, "first, to the fact that States have not availed themselves of the opportunity of obtaining their proportion of power, through lack of applications, and second, to the fact that some applications for power could not be approved. Had the necessary number of applications been received from stations located at suitable points or applications received for increases of power at existing stations at suitable points, this equality of power would have been accomplished."

N. Y. and N. J. Situations

The report stated that "in New York State, on March 28th, 1928, there were forty-eight stations operating day or night or both, while on November 27th, 1929, there were fifty-three, of which ten were national, twenty-eight regional and fifteen local stations. In New Jersey, in March, 1928, there were twenty-six stations, compared with fourteen in November, 1929, of which three were national, ten regional and one local.

"In March, 1928, New York State had thirty-four frequencies, which were reduced in November, 1929, to twenty-eight, of which ten were national, twelve regional and six local, In New Jersey, in March, 1928, there were eighteen frequencies, which were reduced in November, 1929, to seven, of which three were national, three regional and one local.

Wattage Comparison

"In March, 1928, New York State had 127,390 watts power, which was increased in November, 1929, to 162,765 watts, of which 145,000 watts were used on national frequencies, 16,750 on regional and 1,015 on local channels.

"New Jersey in March, 1928, had 54,175 watts, but this was reduced in November, 1929, to 14,850 watts, of which 10,000 watts were used on national frequencies, 4,750 on regional and 100 watts on local channels."

Webster and Segal Resign Legal Posts

Washington.

The resignation of Bethuel M. Webster. Jr., and Paul M. Segal, as general counsel and assistant general counsel, respectively, of the Federal Radio Commission, have become effective. They will enter private practice of law in Washington, Mr. Webster joining a prominent law firm while Mr. Segal will specialize individually in the practice of radio law.

Appointment of Thad. H. Brown, of Ohio, chief counsel of the Federal Power Commission, as general counsel of the Federal Radio Commission, to succeed Mr. Webster, was announced. He was president of the Cleveland Broadcasting Corporation, operating WJAY in Cleveland for seven months in 1927. He served in the World War.

Literature Wanted

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

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

Name ....

Address ....

City or town ....

State ....

Nathan Wagenfeld, 56 E. 1st St., New York City.
George C. Anderson, 2251 Gravois Ave., St. Louis, Mo.
Warren Caton, 3017 E. 16th Ave., Denver, Colo.
Geo. A. Mercer, 124 So. 13th St., Minneapolis, Minn.
W. C. Engel, 615 Griffon, Danville, Ill.
Abraham Coblenz, 601 East 138th St., New York City.
V. Bottoms, 178 Bartlett Ave., Toronto 4, Canada.
Chas. W. Yeager, 1316 S. Date Ave., Alhambra, Calif.
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Ralph Matan, 1321 H St., N. E., Washington, D. C.
G. E. A. Innes, 2570 Triumph St., Vancouver, B. C., Can.
David Steinmark, 3988 Amboy Rd., Great Kills, S. I., N. Y.
C. W. Berglund, 323 W. DeWald, Fort Wayne, Ind.
Vernon Estelle, 5712 Lafayette Ave., Chicago, Ill.
Dr. M. C. Spencer, 2214 N. Ballou St., Chicago, Ill.

SCHOOL OF AIR TO START SOON

A new plan of educational instruction by radio has been offered to Secretary of the Interior, Ray Lyman Wilbur, by the Columbia Broadcasting System of New York in conjunction with the Grigsby-Grunow Co., of Chicago, manufacturers of radio receivers. The tentative plan provides for a series of educational broadcasts to be presented for the school term beginning the first week in February.

The practical use of radio in the public schools of the country is a matter now under investigation by the Advisory Committee on Education by Radio, appointed by the Secretary of the Interior. The proposed experiment is a practical step in attempting to use the radio as a direct method of education.

This educational feature will be called "The American School of the Air" and will be broadcast one-half an hour, twice a week, Tuesday and Thursday afternoons, at 2.30 p.m., to junior high school pupils. Tuesdays will be devoted to the teaching and development of American history. Dramatic episodes relating to the economic, social and political life of the nation will go on the air. Thursday afternoons will be reserved for a more diversified program and will include American literature, political science, health and hygiene, American music and nature study. Leading educators all over the country have been called upon for suggestions. The expense of the programs will be borne by the Grigsby-Grunow Company and broadcast over the Columbia System.

MANY STATIONS SHOW A PROFIT, SENATE IS TOLD

Washington.

A report to the Senate by Paul M. Segal, assistant general counsel of the Radio Commission, shows that many broadcasting stations are coming out of "the red" and are at last making money, while others are self-supporting and most of them are breaking even. The report, based on a questionnaire, is to be used by the Senate on a method of assessing license fees upon users of the air to defray the administrative costs of radio. The following are extracts from the report:

"Only 340 of the approximately 610 stations thus far have answered that portion of the questionnaire relating to profits and losses over a given twelve-month period. An analysis of these returns, however, shows that eighty stations, ranging in power from 100 to 50,000 watts, lost more than $10,000 over the previous year, as compared to fifty-three stations which showed profits of more than $10,000.

54 Made, 36 Lost

"In the next monetary category, a favorable trade margin of between $5,000 and $10,000 was realized by fifty-four stations, as against thirty-six stations which lost to this extent. Thirty-five stations profited and twenty-three lost in the grade of $2,500 to $5,000, while $2,500 profits were shown by twenty-six stations, while thirty-five stations lost up to that amount.

"In the matter of broadcasting time the report showed that of the total of 1,252,802 hours consumed by all stations, the total time sold, exclusive of chain programs, is 410,426 hours, or about 33 per cent. The total time used for station programs and the promotion of good will for the broadcaster's own business is placed at 51 per cent. The average figures for the individual stations, of course, amount to identically the same in percentages.

Upkeep Costs Differ

"Statistics on the annual average gross operating costs of stations disclose strange trends. For example, the average cost of superpowered 50,000 watt stations is placed at $265,707.83, while stations using just half that power, spent an average of $468,266.41. Similarly, the average expenditure of a 350 watt station was $190,000, whereas a 250 watt station cost only $26,702.17, and a 500 watt station $27,907.52.

"Stations of 100 watts and under spent an average of $9,118.46 a year; 200 watts, $7,933.33; 750 watts, $99,193.71; 1,000 watts, $59,270.89; between 1,000 and 2,000 watts, $53,900; 5,000 watts, $115,268.58; 7,500 watts, $200,000; 10,000 watts, $117,676.45; 15,000 watts, $173,052, and 20,000 watts, $179,000."

Aerovox Asks $500,000 for Dubilier 'Threats'

The use of mineral oil as a cooling agent in the manufacture of electrical condensers forms the basis of a suit the Aerovox Wireless Corporation brings against the Dubilier Condenser Corporation on the recent patent No. 1,736,764, granted to Aerovox.

Aerovox is filing a countersuit against the Dubilier in another action for $500,000 damages, saying Dubilier intimidated Aerovox by alleging infringements of Dubilier patents.

HOOVER'S QUICK PEN SAVES LIFE OF COMMISSION

Washington.

President Hoover has signed the Dill-White bill, prolonging indefinitely the life of the Radio Commission as an administrative body.

But for this quick action by the President, the Commission would have become an appellate body on the first of this year, with regulatory authority devolving upon the Department of Commerce.

The bill also authorizes the Commission to appoint a chief engineer at $10,000, two assistants at $7,500 each, and such other engineering aids as it considers necessary.

Some radio leaders in Congress are said to regard the continuance of the present Radio Commission as a measure of expediency to bridge the gap until a communications agency with powers similar to those of the Interstate Commerce Commission can be established.

Several cases are now pending in the Court of Appeals of the District of Columbia in which broadcasters are attacking the authority of Congress to control radio facilities. The decisions of the court in these cases, when made, are expected to have important bearing on the provisions of any new radio measures.

Musicians Assured Radio Aids Them

Washington.

Peter W. Dykoma, Professor of Musical Education at Teachers College, Columbia University joins the distinguished ranks of those who see aid to musical education in radio and sound devices. The Professor asserts that the spread of radio, phonograph and "talkie" music should not be discouraged, despite the uncertainty it has created among musicians. He believes the increasing demand for music teachers will provide employment for many musicians now out of work. Among other statements, the Professor said:

"Even if it were possible to put a stop to the widespread use of 'canned music,' I seriously question whether it would be a wise move. It seems to me that it is immensely better for the great masses of people to have some music that is passably good than to have none at all. The music that we get from the phonograph, the radio, and the talking movies certainly is at least passably good, and it has improved marvelously in the last three or four years."

Depositions Ordered In Television Suit

Washington.

Justice Jennings Bailey in District of Columbia Supreme Court has issued an order that the Federal Radio Commission take depositions of twenty-two New Yorkers in the suit brought against Charles F. Jenkins, prominent television inventor, by Arthur D. Lord, a New York City broker suing Jenkins for $612,500 claimed to be due him as commission in the sale of the Jenkins patents to the Jenkins Television Corporation.

WABC Gives Up Site in Jersey

Washington.

Sam Pickard, vice-president of the Columbia Broadcasting System, owners of the key station WABC, has announced that the company has withdrawn its application to the Radio Commission for authority to locate a 50,000-watt transmitter for WABC at Columbia Bridge, N. J. The application already had been granted by the Commission. This is in answer to the complaint of the State of New Jersey that "foreign" stations were "invading" the State.

"The transmitter will not be located in New Jersey," Mr. Pickard declared, "because our company does not want to arouse the ill-will of the people of the State. We want to give the best service we can and thought the New Jersey site would suit our purposes. If the people of the State do not want it located there, it will go elsewhere."

The transmitter of WABC is now located west of Cross Bay Boulevard in Queens County, New York City, and uses 5,000 watts power. Mr. Pickard denied a report that the 50,000-watt transmitter would be located at the same place and that the power will be increased gradually in steps of 5,000 watts each.

LIMIT ON CHAIN FINALLY KILLED

Washington.

At its final meeting of 1929 the Radio Commission rescinded its chain broadcasting order. This rule would have prohibited sending the same program by chain stations within 300 miles of each other. The order was issued last September, but its effective date postponed several times. The Commission gave the following reasons for rescinding the order:

"To assure the uninterrupted broadcasting of high-class chain programs for the benefit of the general public" and "to afford adequate time to the Commission to investigate and determine whether chain programs are being unnecessarily duplicated, and to enable the Commission to determine what progress has been made toward the successful operation of two or more stations on the same frequency in synchronism, either by wire connection or otherwise."

The commission also said that it wanted "opportunity to determine whether chain broadcasting may be successfully carried on in the future with more economic use of frequencies than now employed."

WORTH THINKING OVER

Enters that lusty youngster, Master 1930, and introduces himself to radio and all the other arts, sciences and activities of the times. Give him a hearty welcome. Be not afraid of him. Take his hand and go out adventuring with him and let the world see that radio, though ages old in principle, still has far to go in practice and that there are greater worlds to conquer and greater things to be done for the eternal glory of the craft.

A THOUGHT FOR THE WEEK

IF Beethoven or Handel were of this age we might expect from either a radio-inspired composition that would go booming sonorously down the corridors of time. However, so far as America is concerned, we can always fall back on that good old "Rhapsody in Blue."

DAMROSCH WISE BUT STOKOWSKI "RADIO NOVICE"!

At last perfect symphonic transmission over the radio has been accomplished, according to Walter Damrosch, conductor. Mr. Damrosch expresses the following opinion after three years of intensive experimentation.

"We have had some of the greatest engineering minds of the country at work. They have accomplished wonders. In fact, I can say that hardly any technical difficulties remain. If under the new conditions the results of broadcasting a symphonic program are not satisfactory, the conductor himself is to blame.

"I understand Mr. Stokowski has not been completely satisfied with the results he has been getting over the air. He must not forget that while he is a distinguished veteran as a symphonic conductor, he is still a novice in the art of broadcasting. A knowledge of radio acoustics and the proper placement of the orchestra in relation to the microphone solves many of the seemingly mountainous difficulties that beset a conductor during his broadcasting novitiate.

Handicaps Eliminated

"Many of the old handicaps have been eliminated through the recent invention of the condenser microphone. It is no longer necessary to have several microphones placed in front of and above the orchestra. Instead we have one single microphone, so delicately constructed that it is able to transmit the softest pianissimos and withstand the loudest crescendoes.

"In former years radio engineers did not dare let the full force of a crescendo hit their instruments for fear they would be shattered. A conductor would work up to a grand climax—and then there would be no climax. When the man at the controls in the operating room saw one coming he would tone down the controls.

"The new condenser microphone makes this unnecessary. I can now conduct my orchestra just as I would at Carnegie Hall. Even the kettle-drums can be played exactly as the score indicates. The works of the masters can be heard just as they were intended by the composers.

Placement Solved

During the past three years I have experimented a great deal in the placement of the orchestra so that the tone color and properties of the different choirs be transmitted properly. At every rehearsal my assistant, Ernest La Prade, is in the operating room, noting every effect and suggesting changes when necessary. Sometimes, when a particularly delicate nuance is being worked upon, I myself go to the operating room and listen to the effect.

"We now know exactly where every instrument should be in relation to the microphone in order to produce the right effect. It has been like learning to move chessmen about, but we now know the secret of every move."

BLAN ISSUES A CHALLENGE

Blan, the Radio Man, 89 Cortlandt Street, New York City, challenges any other dealer in the country to match his stock of Hammarlund parts. This does not cover the Hammarlund-Roberts Hi-Q 30, but includes only the 1930 line of Hammarlund Mfg. Co.

1930 LIST OF STATIONS BY CALL LETTERS

With Location, Power, Frequency and Wavelength

[The transmitter location of each station is given, but where the studio is located in some other city or town, the studio location is given also, designated by the letter "S." Where two different powers are given, the larger is usually for daylight use only. "Kc" stands for frequency in kilocycles, "kw" for power in kilowatts, ""M" for wavelength in meters.]

Station Transmitter	*Power*	*kc.*	*M.*
WAAF—Chicago, Ill.	500	920	325.9
WAAM—Newark, N. J.	1&2kw.	1250	239.9
WAAT—Jersey City, N. J.	300	1070	280.2
WAAW—Omaha, Nebr.	500	660	454.3
WABC-WBOQ—Queens Co. N. Y.			
S.—New York City	5,000	860	348.6
WABI—Bangor, Me.	100	1200	249.9
WABO-WHEC—See WHEC-WABO			
WABZ—New Orleans, La.	100	1200	249.9
WADZ—Akron, Ohio	1kw.	1320	227.1
WAGM—Royal Oak, Mich.	50	1310	228.3
WAIU—Columbus, Ohio	500	640	468.5
WAPI—Birmingham, Ala.	5kw.	1140	263
WASH—Grand Rapids Twp., Mich.	500	1270	236.1
WBAA—W. Lafayette, Ind.	500	1400	214.2
WBAK—Harrisburg, Pa.	500	1430	209.7
WBAL—Glen Morris, Md.			
S—Baltimore, Md.	10kw.	1060	258.5
WBAP—Fort Worth, Texas	50kw.	800	374.8
WBAX—Wilkes-Barre, Pa.	100	1210	247.8
WBBC—Brooklyn, N. Y.	500	1400	214.2
WBBL—Richmond, Va.	100	1370	218.8
WBBM-WJBT—Glenview, Ill.			
S—Chicago, Ill.	25kw.	770	389.4
WBBR—Rossville, N. Y.	1kw.	1300	230.6
WBBY—Charleston, S. C.	75	1200	249.9
WBBZ—Ponca City, Okla.	100	1200	249.9
WBCM—Hampton Twp., Mich.			
S—Bay City, Mich.	500	1410	212.6
WBIS-WNAC—See WNAC-WBIS			
WBMS—Hackensack, N. J.	250	1450	206.8
WBNY—New York, N. Y.	250	1350	221.1
WBOQ-WABC—See WABC-WBOQ			
WBOW—Terre Haute, Ind.	100	1310	228.3
WBRC—Birmingham, Ala.	1kw.&500w.	930	322.4
WBRE—Wilkes-Barre, Pa.	100	1310	228.3
WBRL—Tilton, N. H.	500	1430	209.7
WBSO—Wellesley Hills, Mass.	250	920	325.9
WBT—Charlotte, N. C.	5kw.	1080	277.6
WBZ—E. Springfield, Mass.			
S—Springfield, Mass.	15kw.	990	302.8
WBZA—Boston, Mass.	500	990	302.8
WCAC—Storrs, Conn.	500	600	499.7
WCAD—Canton, N. Y.	500	1220	245.8
WCAE—Pittsburgh, Pa.	500	1220	245.8
WCAH—Columbus, Ohio	500	1430	209.7
WCAJ—Lincoln, Nebr.	500	590	508.2
WCAL—Northfield, Minn.	1kw.	1250	239.9
WCAM—Camden, N. J.	500	1280	234.2
WCAO—Baltimore, Md.	250	600	499.7
WCAP—Asbury Park, N. J.	500	1280	234.2
WCAT—Rapid City, S. D.	100	1200	249.9
WCAU—Byberry, Pa.			
S—Philadelphia, Pa.	10kw.	1170	256.3
WCAX—Burlington, Vt.	100	1200	249.9
WCAZ—Carthage, Ill.	50	1070	280.2
WCBA—Allentown, Pa.	250	1440	208.2
WCBD—Zion, Ill.	5kw.	1080	277.6
WCBM—Baltimore, Md.	100	1370	218.8
WCBS—Springfield, Ill.	250&100	1210	247.8
WCCO—Anoka, Minn.			
S—Minneapolis, Minn.	7½kw.	810	370.2
WCDA—Cliffside Park, N. J.			
S—New York City, N. Y.	250	1350	221.1
WCFL—Chicago, Ill.	1½kw.	970	309.1
WCGU—Coney Island, N. Y.	500	1400	214.2
WCKY—Crescent Springs, Ky.			
S—Covington, Ky.	5kw.	1480	202.6
WCLO—Kenosha, Wis.	100	1200	249.9
WCLS—Joliet, Ill.	100	1310	228.3
WCMA—Culver, Ind.	500	1400	214.2
WCOA—Pensacola, Fla.	500	1120	267.7
WCOC—Meridian, Miss.	1kw&500	880	340.7
WCOD—Harrisburg, Pa.			
(formerly WPRC)	100	1200	249.9
WCOH—Greenville, N. Y.			
S—Yonkers, N. Y.	100	1210	247.8
WCRW—Chicago, Ill.	100	1210	247.8
WCSH—Portland, Maine	500	940	319.0
WCSO—Springfield, Ohio.	500	1450	206.8
WDAE—Tampa, Fla.	1kw.	620	483.6
WDAF—Kansas City, Mo.	1kw.	610	491.5
WDAG—Amarillo, Texas	250	1410	212.6
WDAH—El Paso, Texas	100	1310	228.3
WDAY—W. Fargo, N. D.	1kw.	940	319
WDBJ—Roanoke, Va.	250&500	930	322.4
WDBO—Orlando, Fla.	1kw.	620	483.6
WDEL—Wilmington, Del.	250&350	1120	267.7
WDGY—Minneapolis, Minn.	1kw.	1180	254.1
WDOD—Chattanooga, Tenn.	2½&1kw.	1280	234.2
WDRC—New Haven, Conn.	500	1330	225.4
WDSU—New Orleans, La.	1kw.	1250	239.9
WDWF-WLSI—Cranston, R. I.	100	1210	247.8
WDZ—Tuscola, Ill.	100	1070	280.2
WEAF—Bellmore, N. Y.			
S—New York, N. Y.	50kw.	660	454.3
WEAI—Ithaca, N. Y.	500	1270	236.1
WEAN—Providence, R. I.	250&500	780	384.4
WEAO—Columbus, Ohio	750	570	526
WEAR—Cleveland, Ohio	1kw.	1070	280.2
WEBC—Superior, Wis.			
S—Duluth, Minn.	1kw.	1290	232.4
WEBE—Cambridge, Ohio.	100	1210	247.8
WEBQ—Harrisburg, Il.	100	1210	247.8
WEBR—Buffalo, N. Y.	200&100	1310	228.3
WEBW—Beloit, Wis.	350	560	535.4
WEDC—Chicago, Ill.	100	1210	247.8
WEDH—Erie, Pa.	30	1420	211.1
WEEI—Weymouth, Mass.			
S—Boston, Mass.	10kw.	590	508.2
WEHC—Emory, Va.	100	1370	218.8
WEHS—Evanston, Ill.	100	1500	199.9
WELK—Phila., Pa.	100	1370	218.8
WEMC—Berrien Springs, Mich.	1kw.	590	508.2
WENR-WBCN—Chicago, Ill.	50kw.	870	344.6
WEVD—Forest Hills, N. Y.			
S—New York City	500	1300	230.6
WEW—St. Louis, Mo.	1kw.	760	394.5
WFAA—Dallas, Texas	10kw.	800	374.5
WFAN—Philadelphia, Pa.	500	610	491.5
WFBC—Knoxville, Tenn.	50	1200	249.9
WFBE—Cincinnati, O.	100	1200	249.9
WFBG—Atoona, Pa.	100	1310	228.3
WFBJ—Collegeville, Minn.	100	1370	218.8
WFBL—Syracuse, N. Y.	750	900	331.1
WFBM—Indianapolis, Ind.	1kw.	1230	243.8
WFBR—Baltimore, Md.	250	1270	236.7
WFDF—Flint, Mich.	100	1310	228.3
WFI—Philadelphia, Pa.	500	560	535.4
WFIW—Hopkinsville, Ky.	1kw.	940	319
WFJC—Akron, Ohio	500	1450	206.8
WFKD—Wissinoming, Pa.			
S—Philadelphia, Pa.	50	1310	228.3
WFLA-WSUN—Clearwater, Fla.	1-2½kw.	900	331.1
WGAL—Lancaster, Pa.	15	1310	228.3
WGBB—Freeport, N. Y.	100	1210	247.8
WGBC—Memphis, Tenn.	500	1430	209.7
WGBF—Evansville, Ind.	500	630	475.9
WGBI—Scranton, Pa.	250	880	340.7
WGBS—Astoria, L. I., N. Y.			
S—New York City	500	600	499.7
WGCM—Gulfport, Miss.	100	1210	247.8
WGCP—Newark, N. J.	250	1250	239.9
WGES—Chicago, Ill.	500	1360	220.4
WGH—Newport News, Va.	100	1310	228.3
WGHP—Fraser, Mich.			
S—Detroit, Mich.	750	1240	241.8
WGL—Fort Wayne, Ind.	100	1370	218.8
WGMS-WLB—See WLB-WGMS			
WGN-WLIB—Elgin, Ill.			
S—Chicago, Ill.	25kw.	720	413
WGR—Amherst, N. Y.			
S—Buffalo, N. Y.	1kw.	550	545.1
WGST—Atlanta, Ga.	250	890	336.9
WGY—S. Schenectady, N. Y.	50kw.	790	379.5
WHA—Madison, Wis.	750	940	319
WHAD—Milwaukee, Wis.	250	1120	267.7
WHAM—Victor Twp. N. Y.			
S—Rochester, N. Y.	5kw.	1150	260.7
WHAP—Carlstadt, N. J.			
S—New York City	1kw.	1300	230.6
WHAS—Jeffersontown, Ky.			
S—Louisville, Ky.	10kw.	820	365.6
WHAZ—Troy, N. Y.	500	1300	230.6
WHB—Kansas City, Mo.	500	950	315.6
WHBC—Canton, Ohio	10	1200	249.9
WHBD—Mt. Orab, Ohio	100	1370	218.8
WHBJ—Hattiesburg, Miss.	100	1370	218.8
WHBF—Rock Island, Ill.	100	1210	247.8
WHBL—Sheboygan, Wis.	500	1410	212.6
WHBQ—Memphis, Tenn	100	1370	218.8
WHBU—Anderson, Ind.	100	1210	247.8
WHBY—West De Pere, Wis.			
S—Green Bay Wis.	100	1200	249.9
WHDF—Calumet, Mich.	100	1370	218.8
WHDH—Gloucester, Mass.	1kw.	830	361.2
WHDI—Minneapolis, Minn.	500	1180	254.1
WHEC-WABO—Rochester, N. Y.	500	1440	208.2
WHFC—Cicero, Ill.	100	1500	199.9
WHIS—Bluefield, W. Va.	100	1420	211.1
WHK—Cleveland, Ohio	1kw.	1390	215.7
WHN—New York, N. Y.	250	1010	296.9
WHO—Des Moines, Iowa	5kw.	1000	299.8
WHP—Lemoyne, Pa.			
S—Harrisburg, Pa.	500	1430	209.7
WIAS—Ottumwa, Iowa	100	1420	211.1
WIBA—Madison, Wis.	100	1210	247.8
WIBG—Elkins Park, Pa.	50	930	322.4
WIBM—Jackson, Mich.	100	1370	218.8
WIBO—Desplaines, Ill.			
S—Chicago, Ill.	1&1½kw.	560	535.4
WIBR—Steubenville, Ohio	50	1420	211.1
WIBS—Jersey City, N. J.	250	1450	206.8
WIBU—Poynette, Wis.	100	1310	228.3
WIBW—(near) Topeka, Kan.	1kw.-500w.	580	516.9
WIBX—Utica, N. Y.	100-300	1200	249.9
WICC—Easton, Conn.			
S—Bridgeport, Conn.	500	1190	252
WIL—St. Louis, Mo.	100-250	1200	249.9
WILL—Urbana, Ill.	250-500	890	336.9
WILM—Wilmington, Del.	100	1420	211.1
WIOD-WMBF—Miami Beach, Fla.	1kw.	560	535.4
WIP—Philadelphia, Pa.	500	610	491.5
WISN—Milwaukee, Wis.	250	1120	267.7
WJAC—Johnstown, Pa.	100	1310	228.3
(Formerly WHBP.)			
WJAD—Waco, Texas	1kw.	1240	241.8
WJAG—Norfolk, Nebr.	1kw.	1060	282.8
WJAK—Marion, Ind.	50	1310	228.3
WJAR—Providence, R. I.	250-400	890	336.9
WJAS—North Fayette Twp.			
S—Pittsburgh, Pa.	1kw.	1290	232.4
WJAX—Jacksonville, Fla.	1kw.	1260	238
WJAY—Cleveland, Ohio	500	610	491.5
WJAZ—Mt. Prospect, Ill.			
S—Chicago, Ill.	5kw.	1480	202.6
WJBC—La Salle, Ill.	100	1200	249.9
WJBI—Red Bank, N. J.	100	1210	247.8
WJBK—Ypsilanti, Mich.	50	1370	218.8
WJBL—Decatur, Ill.	100	1200	249.9
WJBO—New Orleans, La.	100	1420	211.1
WJBT-WBBM—See WBBM-WJBT			
WJBU—Lewisburg, Pa.	100	1210	247.8
WJBW—New Orleans, La.	30	1200	249.9
WJBY—Gadsden, Ala.	50	1210	247.8
WJDX—Jackson, Miss.	500-1kw.	1270	236.1
WJJD—Mooseheart, Ill.	20kw.	1130	265.3
WJKS—Gary, Ind.	500-1½kw.	1360	220.4
WJR—Sylvan Lake Village, Mich.			
S—Detroit, Mich.	5kw.	750	399.8
WJSV—Mt. Vernon Hills, Va.	10kw.	1460	205.4
WJW—Mansfield, Ohio			
(Formerly WLBV.)	100	1210	247.8
WJZ—Bound Brook, N. J.			
S—New York City, N. Y.	30kw.	760	394.5
WKAQ—San Juan, P. R.	500	890	336.9
WKAR—E. Lansing, Mich.	1kw.	1040	288.3
WKAV—Laconia, N. H.	100	1310	228.3
WKBB—Joliet, Ill.	100	1310	228.3
WKBC—Birmingham, Ala.	100	1310	228.3
WKBF—Indianapolis, Ind.	500	1400	214.2
WKBH—La Crosse, Wis.	1kw.	1380	217.3
WKBI—Chicago, Ill.	50	1500	199.9
WKBN—Youngstown, Ohio	500	570	526
WKBO—Jersey City, N. J.	250	1450	206.8
WKBP—Battle Creek, Mich.	50	1420	211.1
WKBQ—New York, N. Y.	250	1350	221.1
WKBS—Galesburg, Ill.	100	1310	228.3
WKBV—Connersville, Ind.	100-150	1500	199.9
WKBW—Amherst, N. Y.			
S—Buffalo, N. Y.	5kw.	1470	204
WKBZ—Ludington, Mich.	50	1500	199.9
WKEN—Grand Island, N. Y.			
S—Buffalo, N. Y.	1kw.	1040	288.3
WKJC—Lancaster, Pa.	100	1200	249.9
WKRC—Cincinnati, Ohio	500	550	545.1
WKY—Oklahoma City, Okla.	1kw.	900	331.1
WLAC—Nashville, Tenn.	5kw.	1490	201.2
WLAP—Louisville, Ky.	30	1200	249.9
WLB-WGMS—Minneapolis, Minn.	500	1250	239.9
WLBC—Muncie, Ind.	50	1310	228.3
WLBF—Kansas City, Kans.	100	1420	211.1
WLBG—Ettrick, Va.			
S—Petersburg, Va.	250		
WLBL—Stevens Pt., Wis.	2kw.	900	331.1
WLBL—Oil City, Pa.	1kw.&500	1260	238
WLBX—L. I. City, N. Y.	100	1500	199.9
WLBZ—Bangor, Maine	500	620	483.6
WCI—Ithaca, N. Y.	50	1210	247.8
WLEX—Lexington, Mass.	500	1360	220.4
WLEY—Lexington, Mass.	100-250	1420	211.1
WLIB-WGN—See WGN-WLIB.			
WLIT—Philadelphia, Pa.	500	560	535.4
WLOE—Chelsea, Mass.			
S—Boston, Mass.	100-250	1500	199.9
WLS—Crete, Ill.			
S—Chicago, Ill.	5kw.	870	344.6
WLSI-WDWF—See WDWF—WLSI.			
WLTH—Brooklyn, N. Y.	500	1400	214.2
WLW—Mason, Ohio			
S—Cincinnati	50kw.	700	428.3
WLWL—Kearny, N. J.			
S—New York City	5kw.	1100	272.6
WMAC—Cazenovia, N. Y.	250	570	526
WMAK—Martinsville, N. Y.			
S—Buffalo, N. Y.	750	900	331.1
WMAL—Washington, D. C.	250-500	630	475.9
WMAN—Columbus, Ohio	50	1210	247.8
WMAQ—Addison, Ill.			
S—Chicago	5kw.	670	447.5
WMAY—St. Louis, Mo.	100-250	1200	249.9
WMAZ—Macon, Ga.	250-500	890	336.9
WMBA—Newport, R. I.	100	1500	199.9
WMBC—Detroit, Mich.	100	1420	211.1
WMBD—Peoria Hts., Ill.	500w.-1kw.	1440	208.2
WMBF-WIOD—See WIOD-WMBF.			
WMBG—Richmond, Va.	100	1210	247.8
WMBH—Joplin, Mo.	100-200	1420	211.1
WMBI—Addison, Ill.			
S—Chicago	5kw.	1080	277.6
WMBJ—Pittsburgh, Pa.	100	1500	199.9
WMBO—Auburn, N. Y.	100	1370	218.8
WMBQ—Brooklyn, N. Y.	100	1500	199.9
WMBR—Tampa, Fla.	100	1210	247.8
WMC—Memphis, Tenn.	500-1kw.	780	384.4
WMCA—Hoboken, N. J.			
S—New York City, N. Y.	500	570	526
WMES—Boston, Mass	50	1500	199.9
WMMN—Fairmont, W. Va.	250-500	890	336.9
WMPC—Lapeer, Mich.	100	1500	199.9
WMRJ—Jamaica, N. Y.	10	1420	211.1
WMSG—New York, N. Y.	250	1350	221.1
WMT—Waterloo, Iowa	250	600	499.7
WNAC-WBIS—Quincy, Mass.			
S—Boston, Mass.	1kw.	1230	243.8
WNAD—Norman, Okla.	500	1010	296.9
WNAT—Philadelphia, Pa.	100	1310	228.3
WNAX—Yankton, S. Dak.	1kw.	570	526
WNBF—Binghamton, N. Y.	50	1500	199.9
WNBH—New Bedford, Mass.	100	1310	228.3
WNBJ—Knoxville, Tenn.	50	1310	228.3
WNBO—Washington, Pa.	100	1200	249.9
WNBR—Memphis, Tenn.	500	1430	209.7
WNBW—Carbondale, Pa.	10	1200	249.9
WNBZ—Saranac Lake, N. Y.	50	1290	232.4
WNJ—Newark, N. J.	250	1450	206.8
WNOX—Knoxville, Tenn.	1kw.	560	535.4
WNRC—Greensboro, N. C.	250	1440	208.2
WNYC—New York, N. Y.	500	570	526
WOAI—San Antonio, Texas	50	1190	252
WOAN—Lawrenceburg, Tenn.	500	600	499.7
WOAX—Trenton, N. J.	500	1280	234.2
WOBT—Union City, Tenn.	100-250	1310	228.3
WOBU—(near) Charleston	250	580	516.9
WOC—Davenport, Iowa	5kw.	1000	299.8
WOCL—Jamestown, N. Y.	25	1210	247.8
WODA—Paterson, N. J.	1kw.	1250	239.9
WODX—Springhill, Ala.			
S—Mobile, Ala.	500	1410	212.6
WOI—Ames, Iowa	5kw.	560	535.4
WOKO—Mt. Beacon, N. Y.			
S—Poughkeepsie, N. Y.	500	1440	208.2
WOL—Washington, D. C.	100	1310	228.3
WOMT—Manitowoc, Wis.	100	1210	247.8
WOOD—Furnwood, Mich.			
S—Grand Rapids, Mich.	500	1270	236.1
WOPI—Bristol, Tenn.	100	1500	199.9
WOQ—Kansas City, Mo.	1kw.	610	491.5

(Continued on next page)

Station Transmitter	Power	kc.	M.
WOR—Kearny, N. J.			
S—Newark, N. J.	5kw.	710	422.3
WORC—Auburn, Mass.			
S—Worcester, Mass.	100	1200	249.9
(formerly WKBE)			
WORD—Batavia, Ill.			
S—Chicago, Ill	5kw.	1480	202.6
WOS—Jefferson City, Mo.	500-1kw.	630	475.9
WOV—Secaucus, N. J.			
S—New York City	1kw.	1130	265.3
WOW—Omaha, Neb.	1kw.	590	508.2
WOWO—Ft. Wayne, Ind.	10kw.	1160	258.5
WPAP-WQAO—See WQAO-WPAP			
WPAW—Pawtucket, R. I.	100	1210	247.8
WPCC—Chicago, Ill.	500	560	535.4
WPCH—Hoboken, N. J.			
S—New York City	500	810	370.2
WPEN—Philadelphia, Pa.	100-250	1500	199.9
(formerly WPSW)			
WPG—Atlantic City, N. J.	5kw.	1100	272.6
WPOE—Patchogue, N. Y.	30-100	1420	211.1
WPOR-WTAR—See WTAR-WPOR			
WPSC—State College, Pa.	500	1230	243.8
WPTF—Raleigh, N. C.	1kw.	680	440.9
WQAM—Miami, Fla.	1kw.	1240	241.8
WQAN—Scranton, Pa.	250	880	340.7
WQAO-WPAP—Cliffside, N. J.			
S—New York City, N. Y.	250	1010	296.9
WQBC—Utica, Miss.	300	1360	220.4
WQBZ—Weirton, W. Va.	60	1420	211.1
WRAF—LaPorte, Ind.	100	1200	249.9
WRAK—Erie, Pa.	50	1370	218.8
WRAW—Reading, Pa.	100	1310	228.3
WRAX—Philadelphia, Pa.	250	1020	293.9
WRBI—Tifton, Ga.	20	1310	228.3
WRBJ—Hattiesburg, Miss.	10	1500	199.9
WRBL—Columbus, Ga.	50	1200	249.9
WRBQ—Greenville, Miss.	100	1210	247.8
WRBT—Wilmington, N. C.	100	1370	218.8
WRBU—Gastonia, N. C.	100	1210	247.8
WRC—Washington, D. C.	500	950	315.6
WREC—Whitehaven, Tenn.			
S—Memphis, Tenn.	500&1kw.	600	499.7
WREN—Lawrence, Kans.	1kw.	1220	245.8
WRHM—Fridley, Minn.			
S—Minneapolis, Minn.	1kw.	1250	239.9
WRJN—Racine, Wis.	100	1370	218.8
WRK—Hamilton, Ohio	100	1310	228.3
WRNY—Coytesville, N. J.			
S—New York City, N. Y.	250	1010	296.9
WRR—Dallas, Texas	500	1280	234.2
WRUF—Gainesville, Fla.	5kw.	1470	204
WRVA—Mechanicsville, Va.			
S—Richmond, Va.	5kw.	1110	270.1
WSAI—Mason, Ohio			
S—Cincinnati, Ohio	500	1330	225.4
WSAJ—Grove City, Pa.	100	1310	228.3
WSAN—Allentown, Pa.	250	1440	208.2
WSAR—Fall River, Mass.	250	1450	206.8
WSAZ—Huntington, W. Va.	250	580	516.9
WSB—Atlanta, Ga.	1kw.	740	405.2
WSBC—Chicago, Ill.	100	1210	247.8
WSBT—South Bend, Ind.	500	1230	243.8
WSDA-WSGH—See WSGH-WSDA			
WSFA—Montgomery, Ala	500	1410	212.6
WSGH-WSDA—Brooklyn, N. Y.	500	1400	214.2
WSIX—Springfield, Tenn.	100	1210	247.8
WSJS—Winston-Salem, N. C.	100	1310	228.3
(formerly WJDZ)			
WSM—Nashville, Tenn.	5kw.	650	461.3
WSMB—New Orleans, La.	500	1320	227.1
WSMK—Dayton, Ohio	200	1380	217.3
WSOA—Deerfield, Ill.			
S—Chicago, Ill.	5kw.	1480	202.6
WSPD—Toledo, Ohio	500&1kw.	1240	241.8
WSSH—Boston, Mass.	100&250	1420	211.1
WSUI—Iowa City, Iowa	500	600	499.7
WSUN-WFLA—See WFLA-WSUN			
WSVS—Buffalo, N. Y.	50	1370	218.8
WSYR—Syracuse, N. Y.	250	570	526
WTAD—Quincy, Ill.	500	1440	208.2
WTAG—Worcester, Mass.	250	580	516.9
WTAM—Brecksville Village, Ohio			
S—Cleveland, Ohio	50kw.	1070	280.2
WTAQ—Township of Washington, Wis.			
S—Eau Claire, Wis.	1kw.	1330	225.4
WTAR-WPOR—Norfolk, Va.	500	780	384.4
WTAW—College Station, Texas	500	1120	267.7
WTAX—Streator, Ill.	50	1210	247.8
WTBO—Cumberland, Md.	50	1420	211.1
WTFI—Toccoa, Ga.	250	1450	206.8
WTIC—Avon, Conn.			
S—Hartford, Conn.	50kw.	1060	282.8
WTMJ—Brookfield, Wis.			
S—Milwaukee, Wis.	1kw.&2½kw.	620	483.6
WTNT—Nashville, Tenn.	5kw.	1490	201.2
(formerly WBAW)			
WTOC—Savannah, Ga.	500	1260	238
WWAE—Hammond, Ind.	100	1200	249.9
WWJ—Detroit, Mich.	1kw.	920	325.9
WWL—New Orleans, La.	5kw.	850	352.7
WWNC—Asheville, N. C.	1kw.	570	526
WWRL—Woodside, N. Y.	100	1500	199.9
WWVA—Wheeling, W. Va.	5kw.	1160	258.5
KCRC—Enid, Okla.	100&250	1370	218.8
KDB—Santa Barbara, Calif.	100	1500	199.9
KDFN—Casper, Wyo.	100	1210	247.8
KDKA—Wilkins Township, Pa.			
S—Pittsburgh, Pa.	50kw.	980	305.9
KDLR—Devils Lake, N. D.	100	1210	247.8
KDYL—Salt Lake City, Utah	1kw.	1290	232.4
KECA—Los Angeles, Calif.	1kw.	1000	299.8
(formerly KPLA)			
KEJK—Beverly Hills, Calif.	500	1170	256.3
KELW—Burbank, Calif.	500	780	384.4
KEX—Portland, Ore.	5kw.	1180	254.1
KFAB—Lincoln, Neb.	5kw.	770	389.4
KFBB—Great Falls, Mont.	500	1360	220.4
KFBK—Sacramento, Calif.	100	1310	228.3
KFBL—Everett, Wash.	50	1370	218.8
KFDM—Beaumont, Texas	500	560	535.4
KFDY—Brookings, S. D.	500&1kw.	550	545.1
KFEL—Denver, Colo.	250	640	475.9
KFEQ—St. Joseph, Mo.	2½kw.	560	535.4
KFGQ—Boone, Iowa	100	1310	228.3
KFH—Wichita, Kans.	500	1300	230.6
KFHA—Gunnison, Colo.	50	1200	249.9
KFI—Los Angeles, Calif.	5kw.	640	468.5
KFIF—Portland, Ore.	100	1420	211.1
KFIO—Spokane, Wash.	100	1230	243.8
KFIZ—Fond du Lac, Wis.	100	1420	211.1
KFJB—Marshalltown, Iowa	100	1200	249.9
KFJF—Oklahoma City, Okla.	5kw.	1470	204
KFJI—Astoria, Ore.	100	1370	218.8
KFJM—Grand Forks, N. D.	100	1370	218.8
KFJR—Portland, Ore.	500	1300	230.6
KFJY—Fort Dodge, Iowa	100	1310	228.3
KFJZ—Fort Worth, Texas	100	1370	218.8
KFKA—Greeley, Colo.	500&1kw.	880	340.7
KFKB—Milford, Kans.	5kw.	1050	285.5
KFKU—Lawrence, Kans.	1kw.	1220	245.8
KFKX-KYW—See KYW-KFKX			
KFLV—Rockford, Ill.	500	1410	212.6
KFLX—Galveston, Texas	100	1370	218.8
KFMX—Northfield, Minn.	1kw.	1250	239.9
KFNF—Shenandoah, Iowa	500&1kw.	890	336.9
KFOR—Lincoln, Nebr.	100&250	1210	247.8
KFOX—Long Beach, Calif.	1kw.	1250	239.9
KFPL—Dublin, Texas	15	1310	228.3
KFPM—Greenville, Texas	15	1310	228.3
KFPW—Siloam Springs, Ark.	50	1340	223.7
KFPY—Spokane, Wash.	1kw.&500	1340	223.7
KFQA-KMOX—See KMOX-KFQA			
KFQD—Anchorage, Alaska	100	1230	243.8
KFQU—Holy City, Calif.	100	1420	211.1
KFQW—Seattle, Wash.	100	1420	211.1
KFQZ—Hollywood, Calif.			
S—Los Angeles, Calif.	250	860	348.6
KFRC—San Francisco, Calif.	1kw.	610	491.5
KFRU—Columbia, Mo.	500	630	475.9
KFSD—San Diego, Calif.	500&1kw.	600	499.7
KFSG—Los Angeles, Calif.	500	1120	267.7
KFUI—Juneau, Alaska	10	1310	228.3
KFUL—Galveston, Texas	500	1290	232.4
KFUM—Colorado Springs, Colo.	1kw.	1270	236.1
KFUO—Clayton, Mo.	500&1kw.	550	545.1
KFUP—Denver, Colo.	100	1310	228.3
KFVD—Culver City, Calif.	250	710	422.3
KFVS—Cape Girardeau, Mo.	100	1210	247.8
KFWB—Hollywood, Calif.	1kw.	950	315.6
KFWF—St. Louis, Mo.	100	1200	249.9
KFWI—San Francisco, Calif.	500	930	322.4
KFWM—Richmond, Calif.	500&1kw.	930	322.4
KFXD—Jerome, Idaho	50	1420	211.1
KFXF—Denver, Colo.	250	630	475.9
KFXJ—Edgewater, Colo.	50	1310	228.3
KFXM—San Bernardino, Calif.	100	1200	249.9
(formerly KFWC)			
KFXR—Oklahoma City, Okla.	100	1310	228.3
KFXY—Flagstaff, Ariz.	100	1420	211.1
KFYO—Abilene, Texas	100&250	1420	211.1
KFYR—Bismarck, N. D.	500	550	545.1
KGA—Spokane, Wash.	5kw.	1470	204
KGAR—Tuscon, Ariz.	100	1370	218.8
KGB—San Diego, Calif.	250	1360	220.4
KGBU—Ketchikan, Alaska	500	900	331.1
KGBX—St. Joseph, Mo.	100	1310	228.3
KGBZ—York, Nebr.	500&1kw.	930	322.4
KGCA—Decorah, Iowa	50	1270	236.1
KGCI—San Antonio, Texas	100	1370	218.8
KGCR—Watertown, S. D.	100	1210	247.8
KGCU—Mandan, N. D.	100	1200	249.9
KGCX—Wolf Point, Mont.	100&250	1310	228.3
KGDA—Dell Rapids, S. D.	50	1370	218.8
KGDE—Fergus Falls, Minn.	50	1200	249.9
KGDM—Stockton, Calif.	250	1100	272.6
KGDY—Oldham, S. D.	15	1200	249.9
KGEF—Los Angeles, Calif.	1kw.	1300	230.6
KGEK—Yuma, Colo.	50	1200	249.9
KGER—Long Beach, Calif.	250	1370	218.8
KGEW—Fort Morgan, Colo.	100	1200	249.9
KGEZ—Kalispell, Mont.	100	1310	228.3
KGFF—Alva, Okla.	100	1420	211.1
KGFG—Oklahoma City, Okla.	100	1370	218.8
KGFI—Corpus Christi, Texas	100	1500	199.9
KGFJ—Los Angeles, Calif.	100	1420	211.1
KGFK—Hallock, Minn.	50	1200	249.9
KGFL—Raton, N. Mex.	50	1370	218.8
KGFW—Ravenna, Nebr.	50	1310	228.3
KGFX—Pierre, S. D.	200	580	516.9
KGGC—San Francisco, Calif.	50	1420	211.1
KGGF—Picher, Okla.	500	1010	296.9
KGGM—Albuquerque, N. Mex.	250&500	1230	243.8
KGHF—Pueblo, Colo.	250	1320	227.1
KGHI—Little Rock, Ark.	100	1200	249.9
KGHL—Billings, Mont.	500	950	315.6
KGHX—Richmond, Texas	50	1500	199.9
KGIQ—Twin Falls, Idaho	250	1320	227.1
KGIR—Butte, Mont.	250	1360	220.4
KGIW—Trinidad, Colo.	100	1420	211.1
KGIX—Las Vegas, Nev.	100	1420	211.1
KGJF—Little Rock, Ark.	250	890	336.9
KGKB—Brownwood, Texas	100	1500	199.9
KGKL—San Angelo, Texas	100	1370	218.8
KGKO—Wichita Falls, Texas	250&500	570	526
KGKX—Sandpoint, Idaho	15	1420	211.1
KGO—Oakland, Calif.	7½kw.	70	379.5
KGRC—San Antonio, Texas	100	1370	218.8
KGRS—Amarillo, Texas	1kw.	1410	212.6
KGU—Honolulu, Hawaii	500	940	319
KGW—Portland, Ore.	1kw.	620	483.6
KGY—Lacey, Wash	10&50	1200	249.9
KHJ—Los Angeles, Calif.	1kw.	900	331.1
KHQ—Spokane, Wash.	1kw.	590	508.2
KICK—Red Oak, Iowa	100	1420	211.1
KID—Idaho Falls, Idaho	250	1320	227.1
KIDO—Boise, Idaho	1kw.	1250	239.9
KIT—Yakima, Wash.	50	1310	228.3
KJBS—San Francisco, Calif.	100	1070	280.2
KJR—Seattle, Wash.	5kw.	970	309.1
KLCN—Blytheville, Ark.	50	1290	232.4
KLO—Ogden, Utah	100&200	1370	218.8
KLPM—Minot, N. D.	100	1420	211.1
KLRA—Little Rock, Ark.	1kw.	1390	215.7
KLS—Oakland, Calif.	250	1440	208.2
KLX—Oakland, Calif.	500	880	340.7
KLZ—Denver, Colo.	1kw.	560	535.4
KMA—Shenandoah, Iowa	500&1kw.	930	322.4
KMBC—Independence, Mo.			
S—Kansas City, Mo.	1&2½kw.	950	315.6
KMED—Medford, Ore.	50	1310	228.3
KMIC—Inglewood, Calif.	500	1120	267.7
KMJ—Fresno, Calif.	100	1210	247.8
KMMJ—Clay Center, Nebr.	1kw.	740	405.2
KMO—Tacoma, Wash.	1kw&500	860	348.6
KMOX-KFQA—Kirkwood, Mo.			
S—St. Louis, Mo.	5kw.	1090	257.1
KMTR—Hollywood, Calif.	500	570	526
KNX—Los Angles, Calif.			
S—Hollywood, Calif.	5kw.	1050	285.5
KOA—Denver, Colo.	12½kw.	830	361.2
KOAC—Corvallis, Ore.	1kw.	550	545.1
KOB—State College New Mexico	10kw.	1180	254.1
KOCW—Chickasha, Okla.	250&500	1400	214.2
KOH—Reno, Nev.	100	1370	218.8
KOIL—Council Bluffs, Iowa	1kw.	1260	238
KOIN—Sylvan, Ore.			
S—Portland, Ore.	1kw.	940	319
KOL—Seattle, Wash.	1kw.	1270	236.1
KOMO—Seattle, Wash.	1kw.	920	325.9
KOOS—Marshfield, Ore.	50	1370	218.8
KORE—Eugene, Ore.	100	1420	211.1
KOY—Phoenix, Ariz.	500	1390	215.7
KPCB—Seattle, Wash.	50	1210	247.8
KPJM—Prescott, Ariz.	100	1500	199.9
KPO—San Francisco, Calif.	5kw.	680	440.9
KPOF—Denver, Colo.	500	880	340.7
KPPC—Pasadena, Calif.	50	1200	249.9
KPQ—Seattle, Wash.	100	1210	247.8
KPRC—Sugarland, Texas			
S—Houston, Texas	1kw&2½kw	920	325.9
KPSN—Pasadena, Calif.	1kw.	950	315.6
KPWF—Westminster, Calif.	5 to 10 kw.	1490	201.2
KQV—Pittsburgh, Pa.	500	1380	217.3
KQW—San Jose, Calif.	500	1010	296.9
KRE—Berkeley, Calif.	100	1370	218.8
KREG—Pasadena, Calif.	100	1500	199.9
KREP—Phoenix, Ariz.	500	620	483.6
(formerly KFAD)			
KRGV—Harlingen, Texas	500	1260	238
KRLD—Dallas, Texas	10kw.	1040	288.3
KRMD—Shreveport, La.	50	1310	228.3
KRSC—Seattle, Wash	50	1120	267.7
KSAC—Manhattan, Kans.	500&1kw	580	516.9
KSAT—Birdsville, Texas			
S—Fort Worth, Texas	1kw.	1240	241.8
(formerly KTAT)			
KSCJ—Sioux City, Iowa	1kw.	1330	225.4
KSD—St. Louis, Mo.	500	550	545.1
KSEI—Pocatello, Idaho	250	900	331.1
KSL—Salt Lake City, Utah	5kw.	1130	265.3
KSMR—Santa Maria, Calif.	100	1200	249.9
KSO—Clarinda, Iowa	500	1380	217.3
KSOO—Sioux Falls, S. D.	2kw.	1110	270.1
KSTP—Westcott, Minn.			
S—St. Paul, Minn.	10kw.	1460	205.4
KTAB—Oakland, Calif.	1kw.	560	535.4
KTAP—San Antonio, Texas	100	1420	211.1
KTBI—Los Angeles, Calif.	750	1300	230.6
KTBR—Portland, Ore.	500	1300	230.6
KTBS—Shreveport, La.	1kw.	1450	206.8
KTHS—Hot Springs Nat'l Park, Ark.	10kw.	1040	288.3
KTM—Santa Monica, Calif.			
S—Los Angeles, Calif.	500	780	384.4
KTNT—Muscatine, Iowa	5kw.	1170	256.3
KTSA—San Antonio, Texas	1&2kw.	1290	232.4
KTSL—Cedar Grove, La.			
S—Shreveport, La.	100	1310	228.3
KTSM—El Paso, Texas	100	1310	228.3
KTUE—Houston, Texas	5	1420	211.1
KTW—Seattle, Wash	1kw.	1270	236.1
KUJ—Longview, Wash.	10	1500	199.9
KUOA—Fayetteville, Ark.	1kw.	1390	215.7
KUSD—Vermillion, S. D.	500&750	890	336.9
KUT—Austin, Texas	500	1120	267.7
KVEP—Portland, Ore.	15	1500	199.9
(formerly KWBS)			
KVI—Des Moines, Wash.			
S—Tacoma, Wash.	1kw.	760	394.5
KVL—Seattle, Wash	100	1370	218.8
KVOA—Tucson, Ariz.	500	1260	238
KVOO—Tulsa, Okla.	5kw.	1140	263
KVOS—Bellingham, Wash.	100	1200	249.9
KWCR—Cedar Rapids, Iowa	100	1310	228.3
KWEA—Shreveport, La.	100	1210	247.8
KWG—Stockton, Calif.	100	1200	249.9
KWJJ—Portland, Ore.	500	1060	282.8
KWK—St. Louis, Mo.	1kw.	1350	221.1
KWKC—Kansas City, Mo.	100	1370	218.8
KWKH—Kennonwood, La.	10kw.	850	352.7
KWLC—Decorah, Iowa	100	1270	236.1
KWSC—Pullman, Wash.	500	1220	245.8
KWWG—Brownsville, Texas	500	1260	238
KXA—Seattle, Wash.	500	570	526
KXL—Portland, Ore.	100	1420	211.8
KXO—El Centro, Calif.	100	1200	249.9
KXRO—Aberdeen, Wash.	75	1310	228.3
KYA—San Francisco	500	1230	243.8
KYW-KFKX—Chicago, Ill.	5kw.	1020	293.9
KYWA—Chicago, Ill.	500	1020	293.9

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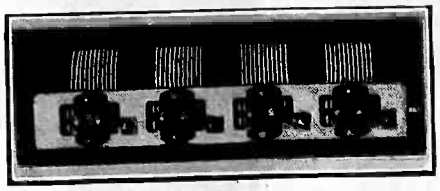

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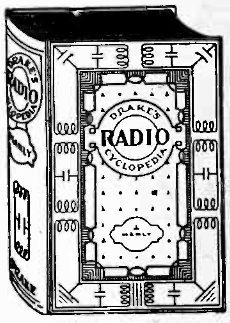
A reference work that has subjects classified in alphabetical order.



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159 Concern service men, 129 help the set builder, 162 help the experimenter, 155 interest the student 75 assist in sales work, 73 interest set owners.

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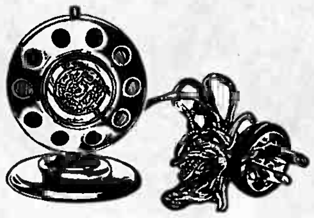
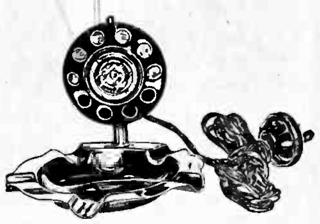


Model A lighter, microphone design, with 5-ft. AC cable and plug. Works on 110 volts, AC any frequency and on direct current. ....Price $1.00



Model B lighter, microphone design, on tray, with 5-ft AC cable and plug. Works on 110 volt AC, any frequency, and on direct current. Exactly the same lighter as the other, only tray is added. Price..............$1.50

This lighter is instantaneous. Hold button down only long enough to light a cigar or cigarette. The two models are furnished in attractive sprayed finish. Both are very compact! For instance, the tray is only 4½" in diameter. Use these lighters in your home and for holiday gifts.

The heater element is renewable.

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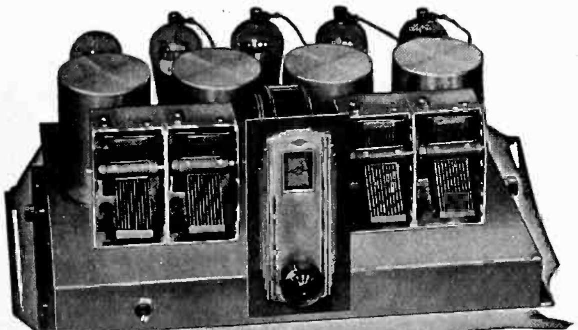
NATIONAL
SCREEN GRID TUNER



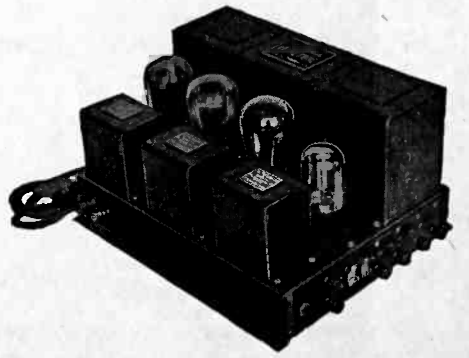
The most sensitive tuned radio frequency tuner so far developed, the MB-29 is long on distant reception, and penetrates seemingly unsurmountable barriers to reception. On the MB-29 the stations come in no matter where you are. The MB-29, designed by James Millen and Prof. Glen H. Browning, is the choice of the most discriminating. It is designed only for AC operation, uses four stages of screen grid RF and a power detector (227). Use 135 to 180 volts on the detector. Testimonials from radio's hardest-boiled experts prove this is the circuit of circuits. Buy the parts and find fullest radio delight. You will be sure nobody else has a tuner as good as yours, unless he too has an MB-29. Complete component parts for National Screen Grid Tuner MB-29, mounted on frosted aluminum chassis, including rainbow modernistic drum dial HC. Order catalog No. MB-29-K, list price, less tubes, $69.50. Your price **$40.00**

MB-29

Push-Pull Amplifier

The National Velvetone Push-Pull Power Amplifier (shown at right) consists of an AC-operated filament-plate supply, with two stage transformer audio amplifier and output transformer built in. Made only for 110-V., 50-60 cycles. Sold only in completely wired form, licensed under RCA patents.

The new Power Amplifier has been developed and built to get the very most out of the MB-29. It is a combination power supply and audio amplifier, using a 280 tube for a rectifier, one stage of transformer audio with a 227 tube and a stage of push pull amplification with two 245s. It furnishes all power for itself and for the MB-29, as well as the audio channel. Order catalog PPPA, list price, completely wired and equipped with phonograph jack, (less tubes) $97.50. Your price. **$55.00**



View of National Velvetone Push-Pull Power Amplifier, an expertly made A, B and C supply and audio amplifier, producing marvelous tone quality.

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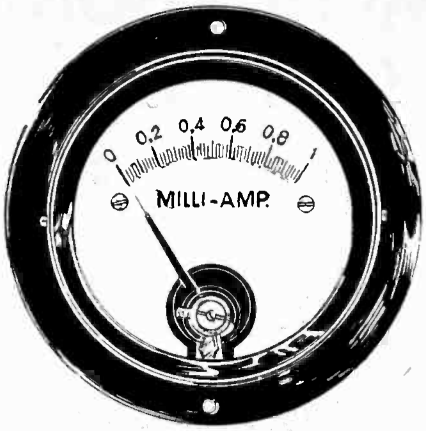
O-1 MA, $5.95



Here is a 0-1 milliammeter, accurate to plus or minus 1% clearly legible to two-one hundredths of a milliampere at any reading (20 microamperes). This expertly made precision instrument is offered at the lowest price so far for a 0-1 ma. Order Cat. FO-1 at $5.95. C. O. D. orders accepted.

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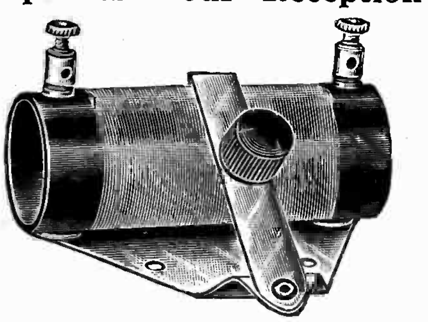
AERIAL TUNER

Improves Your Reception



Remove aerial lead from set. Connect aerial instead to one of the binding posts of the Aerial Tuner. Connect the other binding post of the Aerial Tuner to antenna post of your set. Then move the lever of the Aerial Tuner until any weak station comes in loudest. The lever need not be moved for every different frequency tuned in. The Aerial Tuner acts as an antenna loading coil and puts the antenna's frequency at any frequency in the broadcast band that you desire to build up. Price, 85c.

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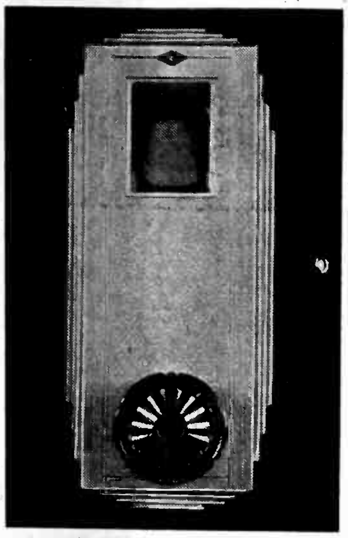

Modernize the appearance of your receiver by installing the brilliant new National dial, with color wheel built in, so that as you turn the dial knob one color after another floods the screen on which the dial numbers are read. On this screen the numbers are projected, so that you get the same dial reading from any position of the eye. This is just what DX hunters want—laboratory precision of dial reading.

The escutcheon is of modernistic design. The Velvet Vernier mechanism drives the drum superbly.

Order today. Remit with order and we pay cartage. Shipments day following receipt of order.

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Enclosed please find $3.13 for which please send me dial marked below:

☐ Cat. HC6, National modernistic drum dial, with color wheel built in, pilot bracket, 6-volt pilot lamp for storage battery or A eliminator sets; hardware; instructions $3.13
☐ Cat. HC2½, same as above, but with 2½-volt AC pilot lamp 3.13
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NATIONAL

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

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

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

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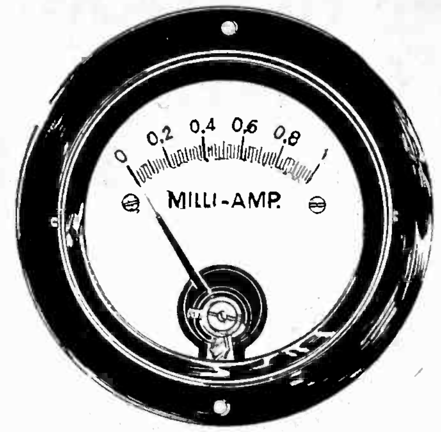

Here is a 0-1 milliammeter, accurate to plus or minus 1% clearly legible to two-one hundredths of a milliampere at any reading (20 microamperes). This expertly made precision instrument is offered at the lowest price so far for a 0-1 ma. Order Cat. FO-1 at $5.95. C. O. D. orders accepted.

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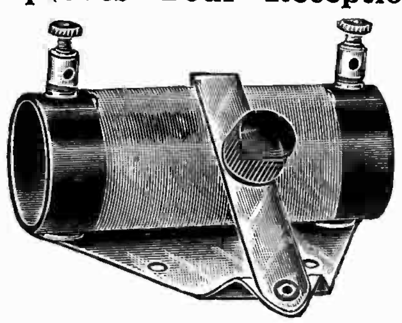
Improves Your Reception



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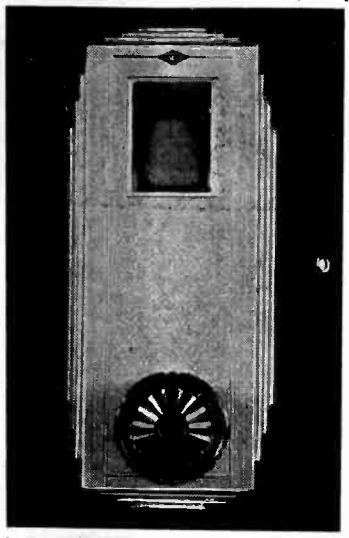

Modernize the appearance of your receiver by installing the brilliant new National dial, with color wheel built in, so that as you turn the dial knob one color after another floods the screen on which the dial numbers are read. On this screen the numbers are projected, so that you get the same dial reading from any position of the eye. This is just what DX hunters want—laboratory precision of dial reading.

The escutcheon is of modernistic design. The Velvet Vernier mechanism drives the drum superbly.

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

Latest Model National Velvet-B, Type 3580, in handsome crackle finish black metal casing, for use with sets up to and including six tubes. Input 105-120 volts AC, 50 to 60 cycles. Output 180 volts maximum at 35 milliamperes. Three variable output intermediate voltages. (Det., RF, AF). Eliminator has excellent filter system to eliminate hum, including 30 henry choke and 18 mfd. Mershon condenser. No motorboating!
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- ☐ 112A power tube .... .78
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A FOUR METER TESTER with five auxiliary meters. All have single scales. No confusion taking readings. The four meter readings show at a glance the plate voltage, filament voltage, grid bias voltage, plate milliamperes and grid change. These nine meters tell everything a radio service man should know in testing A.C. and D.C. sets. With it the latest designed sets and tubes are fully tested, including the plate, grid, cathode and filament of screen grid 224 A. C. tubes, 250 power tubes, and both plates of rectifier tubes. Other meters may be added.

The simplest of all testers to use. Not a switch or binding post to manipulate. The meters are all instantly interchangeable. Only one push button for grid condition. The three A.C. voltmeters are repulsion type 0-6, 0-15, 0-150. The three D.C. voltmeters have high resistance, 0-8, 0-50, 0-500. The three D. C. Milliammeters are 0-10, 0-50, 0-300. A.C. Voltmeters may be used as milliammeters for testing rectifier tubes, thereby obtaining more accurate readings.

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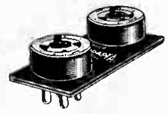

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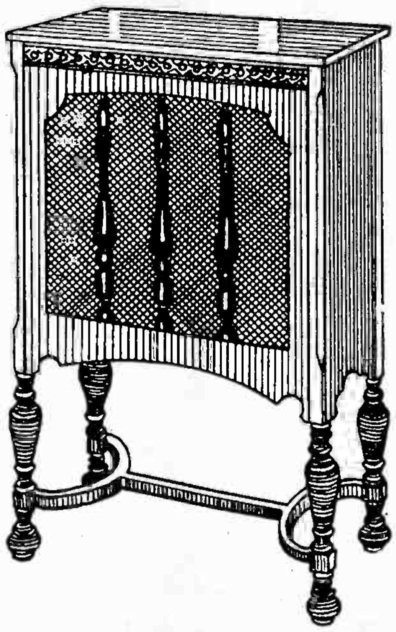
With Molded Wood Horn of 8 ft. tone travel (exponential type) with baffle and horn motor built in. Extraordinary bargain.

$12.00



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

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(as described and specified by Herman Bernard)
Check off which parts you desire. All parts sold separately.

- ☐ C1—One .00025 mfd. mica condenser .... .21
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- ☐ PPIT—One push-pull input transformer 3.41
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- ☐ Roll of heavy insulated hookup wire for power work.
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Ferranti AF5CC push-pull input instead of above input transformer 9.60

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GIVES YOU A FINE UNDERSTANDING OF the SUPER-HETERODYNE

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

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

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

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- ☐ T1—Push-pull input transformer 2.50
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- ☐ R—One 6.5 ohm filament resistor .... .25
- ☐ R1, Sw—One 75 ohm switched rheostat .... .80
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- ☐ Oct. 5th, Three-Tube Single Dial Speaker Set, by Jack Tully.
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- ☐ R2—One 6.5 ohm. filament resistor .... .25
- ☐ R3—One 5 meg. grid leak .... .30
- ☐ R4—One 4 ohm. filament resistor .... .20
- ☐ C3, C4—Two .01 mfd. mica dielectric fixed condensers .... .70
- ☐ C5—One .00025 mfd. mica dielectric fixed condenser with clips .... .25
- ☐ C6—One .00025 mfd. mica dielectric fixed condensers .... .20
- ☐ SW—One A battery switch .... .40
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- ☐ All parts $20.60
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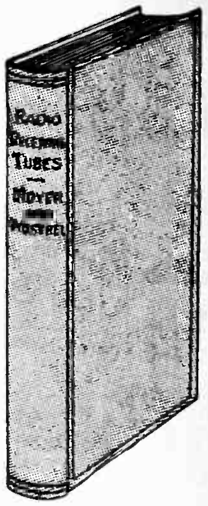

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The Multi-Tap Voltage Divider has a total resistance value of 13,850 ohms, in the following steps: 3,000, 4,500, 2,000, 800, 700, 600, 550, 500, 450, 400, 200, 100 and 50 ohms. With the zero voltage lug the total number of useful lugs is fourteen. The resistances stated are those between respective lugs and are to be added together to constitute 13,850 ohms total.

A conservative rating of the Multi-Tap Voltage Divider is 50 watts, continuous use. The unit is serviceable in all installations where the total current drain does not exceed 125 milliamperes.

Extreme care has been exercised in the manufacture of the Multi-Tap Voltage Divider. It is mounted on brackets insulated from the resistance wire and that afford horizontal mounting of the unit on baseboards and subpanels.

There long has been a need for obtaining any necessary intermediate voltage, including all biasing voltages, from a Multi-Tap Voltage Divider, but each lug has to be put on individually by hand, and soldered, so that manufacturing difficulties have left the market barren of such a device until now.

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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. If a B supply feeds a receiver with two-stage audio amplifier, the last stage a single-sided 245, then the voltages would be 250 maximum for the power tube, 180, 135, 75, 50, 40, 35, 30, 25, 16, 10, 6 and 3. By making suitable connection of grid returns the lower voltages may be used for negative bias or even for positive voltage on the plates.

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.

Order Cat. MTVD at $3.95.

Polo Engineering Laboratories,
143 W. 45th St., N. Y. City.
Gentlemen: Enclosed please find $3.95 for which please send at once one Multi-Tap Voltage Divider, 13,850 ohms, 14 taps, mounted on brackets, 50 watt rating; Cat. MTVD.

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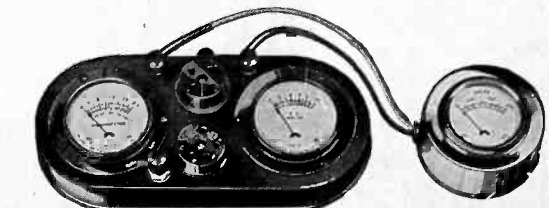
2-meter assembly, cable plugs, Cat. 215 @ $7.06
0-600 AC-DC meter alone, Cat. M600 @ $4.95



$11.00
As Illustrated

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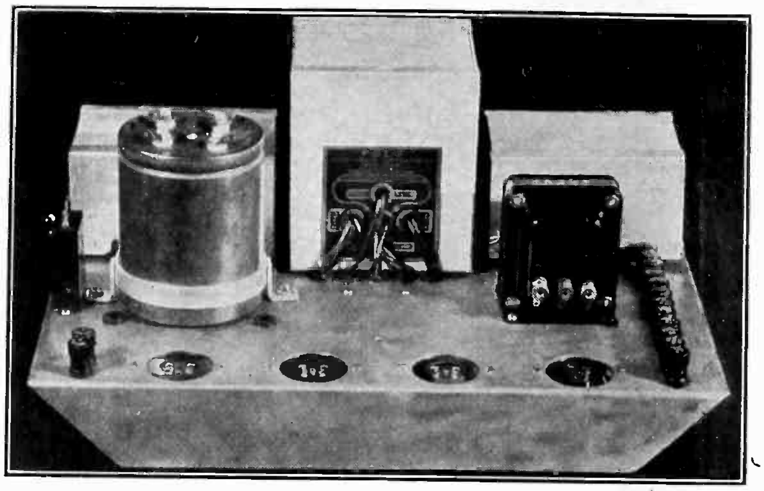
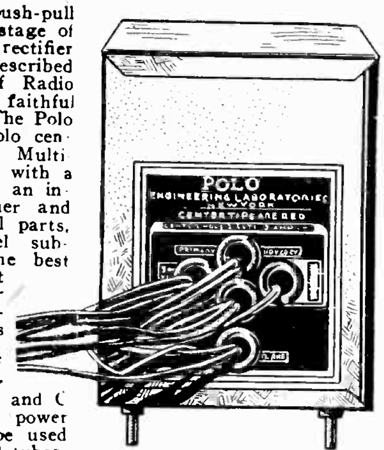
Power Amplifier Equipment

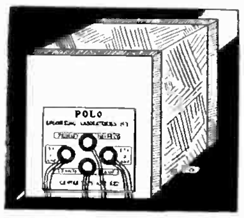


At left is illustrated a push-pull power amplifier, using a first stage of resistance coupled audio, 280 rectifier and two 245s in push-pull, as described in the November 2d issue of Radio World. Abounding volume and faithful tone reproduction are assured. The Polo Filament-Plate Supply, two Polo center-tapped audio chokes and a Multi Tap Voltage Divider are used, with a Q 2-8, 2-18 Mershon condenser, an input push-pull audio transformer and auxiliary equipment. The total parts, including cadmium-plated steel subpanel, come to $43.57 net, the best power amplifier for that modest amount. Provision is made for phonograph pickup plug insertion. Thirteen output voltages are provided, including 300, 180, 75, 50 and an assortment of nine different voltages under 50 available for bias. All A, B and C voltages are provided for the power amplifier and for a tuner to be used with it employing 227, 224 or 228 tubes. Order Cat. **PO-245-PA @ $43.57 net,** for 50-60 cycles, 110 volts. [For 25 cycles order PO-245-PA-25 @ $48.57. For 40 cycles order PO-245-PA-40 @ $46.07.]

Subpanel alone, cat. SPO @ $3.50



Polo 245 Filament Plate Supply (less chokes) has four windings, all save primary center-tapped (red), is 4⅛" wide, 5" high, 4" front to back. Weight, 9 lbs. Filament windings, 2.5 v. at 12 amps., 2.5 v. at 3 amps. (for 245 filaments), 5 v. at 2 amps. for 280 rectifier, and 724 v. @ 80 m.a., center-tapped. Order Cat. PFPS @ $7.50.
[For 25 cycles order Cat. PFPS-25 @ $12.00.]
[For 40 cycles order Cat. PFPS-40 @ $10.00.]



Polo Filament Transformer Only, four windings, consists of 50-60 cycles 110 v. winding, 2½ v. at 12 amps., 2½ v. at 3 amps., 5 v. at 2 amps. All windings, save primary, are center-tapped (red). Size, 4⅝" high x 3¾" wide x 3" front to back. Weight, 6 lbs. Order Cat. PFT @ $4.25.
[For 25 cycles order PFT-25 @ $7.00; for 40 cycles order PFT-40 @ $6.25.]

By-pass Condensers

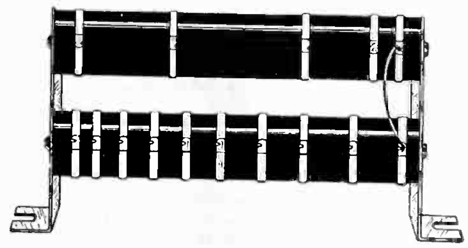
For by-passing B+ leads to ground or C minus from 200 v. post or less, where current is less than 10 m.a., 1 mfd. paper dielectric condensers are useful. Order LV-1 @ ....$0.50 ea.

Filter Condensers

For high voltage filtration next to the rectifier, use 1 or 2 mfd. The 2 mfd. makes the output voltage a little higher.
Order Cat. HV-1 (1,000 v. DC, 550 v. AC)..........$1.76
Order Cat. HV-2 (1,000 v. DC, 550 v. AC)...........$3.52

Filament-Plate-Choke Block

Same as Filament-Plate Supply, except that two 50 henry chokes are built in. Six windings: primary, 110 v., 50-60 cycles; 2.5 v. at 12 amps.; 2.5 v. at 3 amps.; 5 v. at 2 amps.; 724 v. at 80 m.a.; choke. All AC windings center-tapped (red), except primary. Connect either end of a choke to one end of other choke for midsection. Order Cat. P-245-FPCH @..$10.00
[For 40 cycles order P-245-FPCH-40 @ $13.50.]
[For 25 cycles order P-245-FPCH-25 @ $14.50.]



Two rugged, expertly engineered wire-wound, enamelled resistors, mounted in series, one atop the other, with fourteen useful lugs, providing all necessary choice of voltages without the uncertainty of adjustable variable resistance.

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

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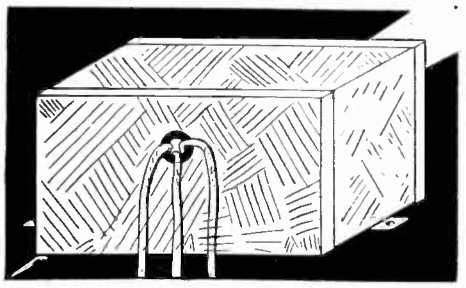
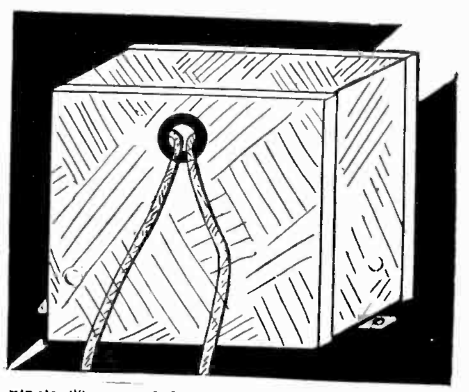
If push-pull is used, the current in the biasing section is almost doubled, so the midtap of the power tubes' filament winding would go to a lug about half way down.

Order Cat. MTVD at $3.95.



Center-tapped double choke, 125 m.a. rating, 30 henrys in each section. Used for filtering B supply or for a push-pull output impedance, where speaker cords go directly to plates of tubes. Center tap is red. Order Cat. PDC @ $3.71.



Single 30 henry 100 m.a. choke for filtered output (where condenser is used additionally) or for added filtration of a B supply. Order Cat. PSC @ $2.50.

ACOUSTICAL ENGINEERING ASSOCIATES,
143 West 45th St., N. Y. City.
(Just East of Broadway.)

Please ship at once the following:

Quantity	Cat. No.	Product	Price
☐	PO-245-PA	Power amp. parts, 50-60 c.	$43.57
☐	PO-245-PA-40	Same, 40 cycles	46.07
☐	PO-245-PA-25	Same, 25 cycles	48.57
☐	PFPS	Fil. plate supply, 50-60 c.	7.50
☐	PFPS-40	Same, 40 cycles	10.00
☐	PFPS-25	Same, 25 cycles	12.00
☐	PFT	Fil. trans., 50-60 c.	4.25
☐	PFT-40	Same, 40 cycles	6.25
☐	PFT-25	Same, 25 cycles	7.00
☐	P-245-FPCH	Power-filter block	10.00
☐	P-245-FPCH-40	Same for 40 cycles	13.50
☐	P-245-FPCH-25	Same for 25 cycles	14.50
☐	PDC	Single choke	2.50
☐	PSC	Multi-tap volt. div.	3.95
☐	MTVD	Double c.-t. choke	3.71
☐	Q2-8, 2-18B	Mershon with bracket	5.15
☐	LV-1	200 v., 1 mfd. by-pass cond	.50
☐	HV-1	1,000 v., 1 mfd. filter cond.	1.76
☐	HV-2	1,000 v., 2 mfd. filter cond.	3.52
☐	SPO	Subpanel	3.50

☐ Enclosed please find check—money order—for the above. [Note: Canadian remittance must be by postal or express money order.]

☐ Please ship C.O.D.

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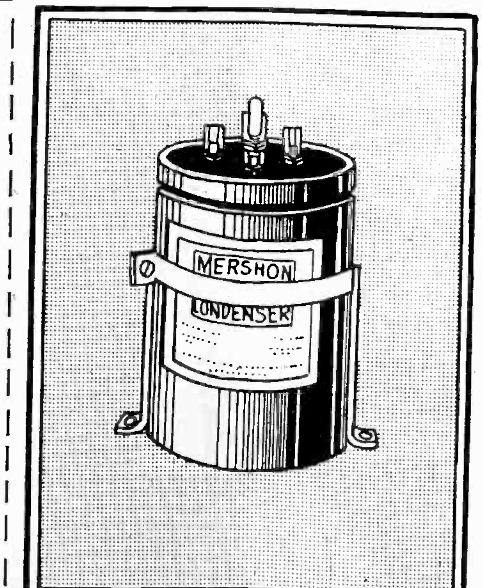
5-DAY MONEY-BACK GUARANTEE!



The Mershon electrolytic condenser, 415 volts DC, for filtering circuits of B supplies. Q 2-8, 2-18 has four capacities in one copper casing: two of 8 mfd. and two of 18 mfd. The copper case is negative. The smaller capacities are nearer the edge of the case. The vent cap should not be disturbed, and the electrolyte needs no refilling or replacement.

Mershon electrolytic condensers are instantly self-healing. Momentary voltages as high as 1,000 volts will cause no particular harm to the condenser unless the current is high enough to cause heating, or the high voltage is applied constantly over a long period.

High capacity is valuable especially for the last condenser of a filter section, and in by-passing, from intermediate B+ to ground or C+ to C—, for enabling a good audio amplifier to deliver true reproduction of low notes. Suitably large capacities also stop motor-boating.

Recent improvements in Mershons have reduced the leakage current to only 1.5 to 2 mils total per 10 mfd. at 300 volts, and less at lower voltages. This indicates a life of 20 years or more, barring heavy abuse.

In B supplies Mershons are always used "after" the rectifier tube or tubes, hence where the current is direct. They cannot be used on alternating current. Rated 415 v. DC.

The Mershon comes supplied with special mounting bracket. Order Q 2-8, 2-18 B @ **$5.15**