September 21, 1929 | N. Y. SHOW NUMBER | 15c Per Copy

RADIO WORLD

REG. U.S. PAT. OFF.

The First and Only National Radio Weekly

391st Consecutive Issue—EIGHTH YEAR

LISTS OF STATIONS

(1) U. S. Short Wave.

(2) Foreign Short Wave, with Hours on the Air.

(3) U. S. Broadcast Stations by Frequency and Wavelength.

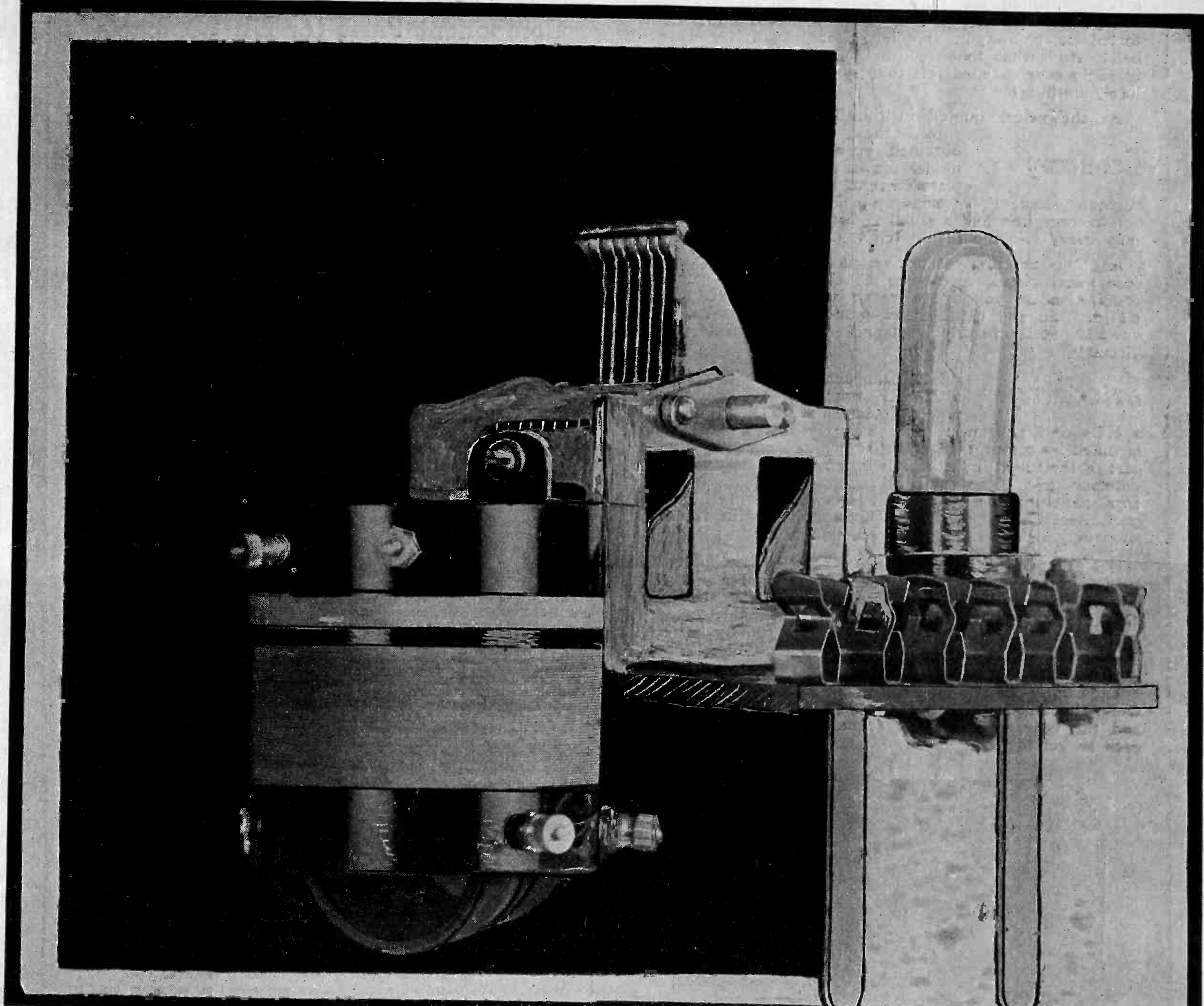
(4) U. S. Broadcast Stations Alphabetically by Call Letters.

(5) Canadian Broadcast Stations.

(6) National Broadcasting Company, with Wave and Frequency.

(7) Columbia Broadcasting System, with Wave and Frequency.

SCHOOLBOY'S ONE-TUBE CIRCUIT



See Page 10 for Article for Novices on How to Built This Circuit.

AC MODEL HB COMPACT | NEW DETECTOR SYSTEM | OHM'S LAW

Surpassing Results from HB Compact!

Screen Grid Circuit for AC or Battery Operation Is a Knockout!

THE screen grid tubes, both AC and battery types, 222 and 224, promised much. They could be used to provide actual amplification of 150 per stage, as compared with 8 per stage for a general purpose tube. If only the screen grid tube could be used at full practical amplification! Then a few tubes would do the work of many! At radio frequencies it was found that tuning the plate circuit put the mule kick into the set. But the whole wave band could not be tuned in. So Herman Bernard invented a coil—the Bernard dynamic tuner—that accomplished the trick. Full amplification plus full wave-band coverage! That's why his HB Compacts, only four tubes (plus a 280 in the AC model) perform like eight-tube sets! The sensitivity is incredibly high.

Sensitivity

It would be far short of an accomplishment to hook indifferent audio onto a grid leak-condenser detector. So in both models he used a power detector two resistance audio stages, producing undistorted volume exceeding that of any ordinary two-stage audio amplifier, amplification sufficient to load up the power tube in each instance. And in the case of the AC model HB Compact it is a 245, with 1,600 miliwatts maximum undistorted power output, standing neough gaff for a small hall! And what tone realism! Breath-taking! Nothing in radio ever excelled this tone quality! Nothing! Absolutely nothing!

Realism

As the prices quoted in the list of component parts show, these advantages may be obtained economically. The battery model draws only 21 milliamperes of plate current, .664 amperes of filament current. Large B batteries woud last a year at that rate, for average use, and a small A battery require recharging only every two months to ten weeks!

Economy

And this amazingly sensitive, most thrilling and utterly economical circuit gives you all the selectivity you will require, unless you live close to a powerful broadcasting station. So you get a super-abundance of results, in an unusual but thoroughly tried and tested, positively proven circuit!

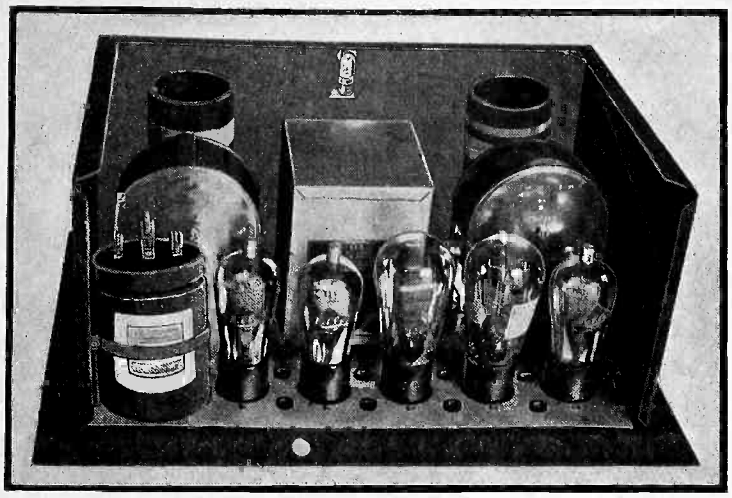
Selectivity

HB Compact, battery model, uses a 222 RF amplifier, a 240 (high mu) power detector, a 222 first audio and a 112A or 171A power tube. The RF tube's plate circuit is tuned by a new type coil that has a moving segment as part of the tuned inductance, with step-up ratio to untuned detector grid. The audio is resistance-coupled. A 7x14" front panel may be used, with baseboard, but the HB Compact Steel Cabinet, decorated brown, with satin aluminum subpanel, sockets affixed, is recommended.

HB Compact, AC model, uses a 224 RF amplifier, a 224 space charge power detector, a 224 first audio and a 245 output tube, with 280 rectifier. Except for the space charge feature, not suitable in the battery model, and the larger power tube, not economically powered by batteries, the two models are fundamentally the same. The AC model is still more sensitive, however.

The same steel cabinet is recommended for the AC model, while the aluminum subpanel has the five sockets affixed and the type of each tube (except detector) printed on each socket.

Front view of the HB Compact. The view is the same for AC or battery model. For batteries the switch is built in the rheostat. For AC a pendant switch is used at rear, in the AC cable.



View of the HB Compact AC Model, the tubes being, left to right: 224 detector, 224 first AF, 245 power tube, 280 rectifier and 224 RF. The subpanel is only 9½x14¼", yet everything save the speaker is in this small space!

Component Parts for HB Compacts

AC MODEL

L1L2L3—Bernard Antenna Tuner BT5A	$2.50
L4L5L6—Bernard Interstage Tuner BT5B	2.50
CT—One 80 mmfd. equalizer	.35
C1, C2—Two .0005 Dustproof @ $2.50	5.00
C, C3, C4, C5—Four o01 mfd. @ .35	1.40
C7—One 1 mfd. 500V AC	.85
C8, C9, C10, C11—Mershon Q2-8, 2-18B	5.75
C12, C13—Two 1 mfd. 200 V. DC @ .50	1.00
R—One 25,000 ohm wire-wound pot	1.50
R1, R2, R3, R4—.5, 1.0, .05 5.0 meg. @ .35	1.40
T1—Polo 245 Power Supply Cat. P245PS	10.00
2500, 4400, 774, 50, 8 (20 watt) Voltage Divider	1.75
PL—Bracket and 2.5 v. AC lamp	.70
OC, C6—Output choke, 2 mfd. 500 v. AC cond.	3.85
SP—, SP+—Two binding posts @ .10	.20
Three National grid clips @ .06	.18
F—One 1 amp. cart. fuse with base	.50
Aluminum socketed subpanel, 9½x14¼", 8 brackets	3.25
Steel cabinet, crackled brown finish, 7x15x9½	4.00
3 Insulating washers @ .03	.09
Two full-vision dials with pointers @ 75c	1.50
One AC pendant switch, double opening	.40
One 12 ft. length AC cable	.72
Two rolls Corwico braidite @ .35	.70
Two flexible couplers (links) @ .35	.70
	$50.79

Kelly tubes: Three 224 @ $3, one 245 @ $2.25, one 280 @ $1.75 .... $13.00

[National Company's coils, soon to be released Cat. BTS5, BTP5 @ $5 each, may be used instead of BT5A and BT5B listed above @ $2.50 each. National Velvet Vernier full-vision dials, instead of plain dials listed above, counterclockwise, @ $1.75 each.]

BATTERY MODEL

L1L2L3—One Bernard Tuner for antenna circuit, for .0005 mfd. tuning (BT5A of Screen Grid Coil Co.)	$2.50
L4L5L6—One Bernard Tuner for screen grid interstage coupling, for .0005 mfd. tuning (BT5B of Screen Grid Coil Co.)	2.50
C1, C2—Two .0005 mfd. Dustproof tuning condensers @ $2.50	5.00
CT—One Hammarlund 80 mmfd. equalizing condenser	.35
C3, C4, C5—Three .01 mfd. mica fixtd condensers @ .40	1.20
R1—One .25 meg. metallized resistors	.30
R2, R4—Two 5.0 meg. metallized resistors @ .30	.60
R3—One .075 meg. metallized resistor	.40
R5, SW—One 75-ohm rheostat with switch attached	.80
R6—Two resistors, one 1.3 ohms, the other 6.5 ohms (both)	.45
Ant., Gnd., Sp.—, Sp.+. Four binding posts (all)	.40
One drilled steel cabinet 7" high, 9½" front to back, 15" wide	4.00
Two dials with pointers (both)	1.50
One pilot light bracket with 6-volt DC lamp.	
One 9½x14¼" satin finish aluminum subpanel with sockets affixed, and supplied with insulated bushings, supporting brackets, and resistor clips	2.00
Two insulated links (flexible couplers) (both)	.70
One 7-lead battery cable	.50
	$23.20

Kelly tubes: Two 22, one 240, one 112A or 171A, total **$9.20.**

[National oils for the battery model, vernier condensers, see note under AC Model.]

[The HB Compacts were designed and built by Herman Bernard. The battery model was described in the August 24th, 31st, September 7th and 14th issues of Radio World.]

[The AC Model is now being described. See page 6 et seq. of this issue.]

RADIO WORLD BOOK SERVICE

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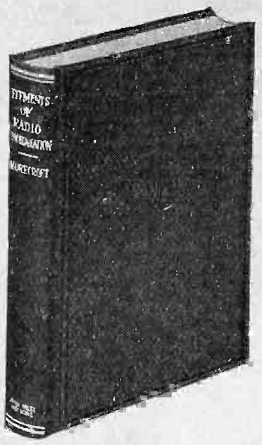
"Elements of Radio Communication"



The latest book by Prof. John H. Morecroft, of the Engineering Department of Columbia University, and past president of the Institute of Radio Engineers, is his "Elements of Radio Communication," a book for the novice to enjoy. We regard this as the best elementary book to inform you authoritatively on the technical phases of radio in plain language, without requirement of mathematical knowledge. The book is a complete course on the elements of radio, containing much material never before published. It has 226 pages, 170 illustrations and a complete index. Just out, it is the book of the year in radio. Cloth bound. Order Cat. ME @ $3.00

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MOYER and WOSTREL

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The need for an elementary book on radio tubes that answers all the important questions has been filled by James A. Moyer, Director of University Extension, Massachusetts Department of Education, and John F. Wostrel, Instructor in Radio Engineering, Division of University Extension, Massachusetts Department of Education.

This new book is a complete discussion of tube principles, functions and uses, thoroughly up-to-date. In this book the essential principles underlying the operation of vacuum tubes are explained in as non-technical a manner as is consistent with accuracy. The book covers the construction, action, reactivation, testing and use of vacuum tubes as well as specifications for vacuum tubes and applications for distant control of industrial processes and precision measurements. 297 pages, cloth bound. Order Cat. MWT @..................................$2.50

By the same authors:

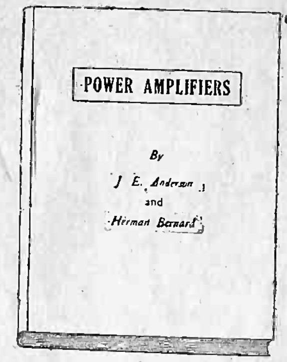
"Practical Radio," including the testing of radio receiving sets, 378 pages, 223 illustrations. Cloth bound. Order Cat. MWPR @ $2.50

"Practical Radio Construction and Repairing," 319 pages, a companion volume. Order Cat. MWPRC @.............$2.00

[NOTE: *The standard book on tubes for advanced students is "The Thermionic Vacuum Tube," by Hendrik Van der Bijl. Order Cat. VDB @*..................................$5.00]

ANDERSON and BERNARD

"Power Amplifiers"



Here is the *first* book to be published on the subject of "Power Amplifiers." Now printing, it is certain to fill a void in radio literature. The whole subject is fully covered in a masterful theoretical discussion of audio amplifiers and power supplies, supplemented by constructional chapters, with complete wiring diagrams and specification of parts. Learn while you build! J. E. Anderson, M. A., technical editor of RADIO WORLD, and Herman Bernard, LL. B., managing editor of RADIO WORLD, both of the Institute of Radio Engineers, have explained fully the phenomena of power amplifiers. Learn all about motorboating and its cures, push-pull theory and practice, grid bias methods and effects, vacuum tubes in audio circuits, AC and battery type AF amplifiers, phase relationships, common impedance, filter systems, by-pass condenser effects, necessities for tone quality, values of coupling constants, and a host of other topics associated with power amplification, including speech amplifiers and "talkie" installations.

More than 200 pages and more than 100 illustrations are devoted to an analysis of this outstanding radio subject. "Power Amplifiers" is authoritative, original and comprehensive. It is free from the traditional errors that have crept into this subject. The theoretical part of the book can be understood by most novices, while the constructional part, that capitalizes the previously imparted knowledge, is thoroughly understandable by anybody. There is virtually no mathematics in the book. Cloth bound. Order Cat. PAM @..$3.50

RIDER

"Service Man's Manual"

Two new books by John F. Rider, R. E., Member, Institute of Radio Engineers, constitute the series grouped by him under the heading "Service Man's Manual." Part I is "Mathematics of Radio." Part II is "Trouble Shooter's Manual."

The value of one of these books is more than doubled by the possession of the other.

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Polo 245 Power Supply

Scientifically Engineered, It Insures Superb Performance

THE Polo 245 Power Supply consists of a filament transformer, a high-voltage (plate) winding and two separate chokes, all built in a single cadmium-plated steel casing, for powering 224, 227, 228 and 245 tubes. The output may be a single 245 or two 245s in push-pull, because the chokes are large enough and strong enough to handle 100 milliamperes, while the power tube filament winding will easily take care of the two 245s. The entire supply is exceedingly compact and will fit in a cabinet that has the usual 7" high front panel. The high-voltage winding is of sufficiently high AC voltage to produce full 300 volts when the maximum direct current through any part of a voltage-dividing resistor is 80 ma. Of the 300 volts 250 are applied to the output tube's plate and 50 to its grid for negative bias.

All windings except the primary (110 volts, 50 to 60 cycles) are center-tapped, including the 5-volt winding for the 280 rectifier tube. The impedance bridge method is used for establishing the electrical center. Taking the positive rectifier voltage from the center of the 5-volt winding, instead of from either side of the filament, is a small extra advantage, but shows an extra stroke of careful workmanship to insure superb performance.

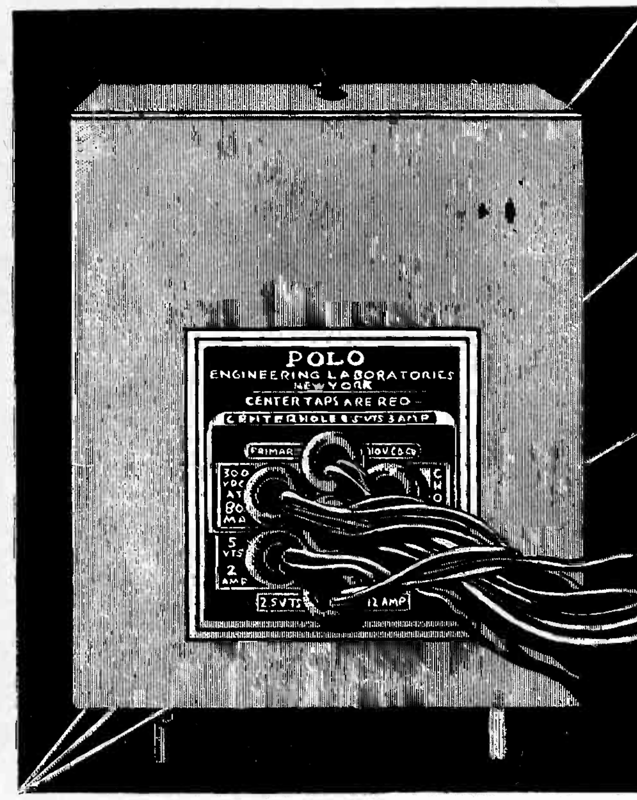
Another interesting point is that the high-current winding for all the 2.5-volt AC tubes to be used in a receiver or amplifier is rated at 12 amperes. This means that six heater type tubes may be worked well within the limits of the winding (total of 10.5 amperes used), while seven tubes may be used with the permissible excess of only .25 ampere over the rating (total 12.25 amperes). Of course the two or three other tubes (280, 245) are additionally supplied, from their individual windings. Hence a total of ten tubes may be worked (including 245 push-pull and 280 rectifier).

This is no mere estimate, but a scientific fact. The wire used on this 12-ampere winding is the equivalent of No. 9. Please read our chief engineer's report herewith.

The two chokes are 50 henries each, and each choke is on a saparate core.

The 245 Power Supply weights 16 pounds. The shipping weight is 17 pounds.

For 40-cycle current, 110 volts, a special supply 2" higher, is made. Cat. P245, S40 (Code Cyclone). Price $13.50.



The 245 Power Supply, with chokes, is made also for 25 cycles, 110 volts. Only this particular combination is made for 25 cycles, although the filament-plate supply (less chokes) and the filament supply (less chokes and high-voltage winding) are made for 40 cycles.

For 25 cycles order Cat. No. P245 S 25 4⅝" wide x 5⅛" front to back x 9⅛" high. Shipping weight 25 lbs. (Code Cypress) at....................$14.50

Polo 245 Power Supply, including two chokes built in, size 4⅝" wide x 5⅛" front to back, 6⅛" high. Cat. No. P245 PS 110 volts, 50-60 cycles (code Cyclops)....................$10.00

Cat. No. P245, S40, for 40 cycles, 110 volts; size 4⅝" wide x 5⅛" front to back, by 8⅛" high (code Cyclone)............$13.50

Chief Engineer's Report on Polo 245 Power Supply

By Walter J. McCord, Chief Engineer

Every precaution has been taken to produce a 245 power supply of superb performance, and in proof thereof I take pleasure in submitting for close study by engineering minds the specifications followed, with advice to novices.

(1)—Overall dimensions of the casing, 4⅝" wide x 5⅛" front to back x 6⅛" high.

(2)—Filament and plate secondary windings as follows: 724 volts at 100 mils, center tapped at 362; 5 volts at 2 amperes, center tapped; 2.5 volts at 3 amperes, center tapped; 2.5 volts at 12 amperes, center tapped.

(3)—Two 50-henry chokes, DC resistance of each, 420 ohms.

(4)—Primary draw with all secondaries worked at maximum, 88 watts.

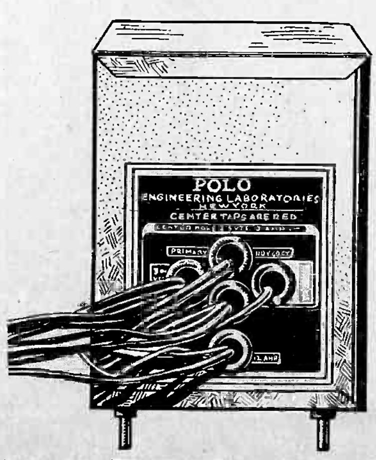
(5)—One transformer core with 1" x 1¾" cross-section; window opening 2⅛" x ¾". Two choke cores with ⅞" x 1¾" cross-section; window opening ½" x 1¾"; .014" air gap. The laminations are stamped from high-grade Silicon sheet steel having 1.92 watts loss per pound. The joints in the transformer are all overlapping, holding the magnetic leakage to a minimum.

(6)—Size of wire and resistance of each winding as follows: Primary—No. 24 wire, DC resistance, 5.2 ohms. Plate Sec.—No. 30 wire, DC resistance, 104.5 ohms. 5 v.—No. 18 wire, DC resistance, .102 ohms. 2½ v., 3 a.—No. 18 wire, DC resistance, .051 ohm. 2½ v., 12 a.— .059 x .180 rectangular wire (equals approximately No. 9 wire), DC resistance, .008 ohm.

(7)—Total weight of block 16 lbs.

(8)—Casing is made of sheet steel and is cadmium plated. Four ¾" mounting screws are placed in the bottom, permitting the block to be mounted to the base, in a very small space, as no space is required for mounting flanges.

(9)—Care should be taken in connecting the leads so that none of the secondaries is shorted. A shorted secondary, either a direct short or through a defective condenser, soon will burn out a transformer. Care should be taken also in connecting the primary to the proper current. The primary should be connected to 110 v. 50-60 cycles AC, never to 220 volts, neither should it be operated on a line voltage of 130 or over.



Polo 245 Filament Plate Supply (less chokes) is 4½" wide, 5" high, 4" front to back. Weight 9 lbs.

FILAMENT-PLATE SUPPLY

The Polo 245 Power Supply, less the two built-in chokes, is available to those desiring to utilize chokes they now have, and who do not find the compactness afforded by the consolidated unit absolutely necessary.

The Filament-Plate Supply has the same voltages on the secondaries, at the same ratings, as does the unit that includes the chokes.

Polo Filament-Plate Supply, consisting of five windings; primary 110 v., 50-60 cycles. Cat. No. PFPS (code Cymbal), $7.50.

Same as above, except for 40 cycles 110 v. AC. and a little greater height. Cat. P40 FPS (code Cylinder), $10.00.

FILAMENT SUPPLY

A filament transformer only, in a smaller container than any of the others, but with the same voltage and current ratings, provides 2.5 v. at 3 amperes, 2.5 v. at 12 amperes, 5 v. at 2 amperes.

The Polo Filament Transformer, consisting of four windings as described; primary, 110 v. 50-60 cycles. Cat. No. PFT (code Cyclist) $4.25.

Same as above, except for 40 cycle, 110 v. AC, Cat. P40 FT (code Cyanide), $6.25.

NO C. O. D. ORDERS.

Polo Engineering Laboratories, 57 Dey St., N. Y. City. Enclosed please find $——, for which ship at once the following:

P245 PS (code Cyclops)........................$10.00
P245 S40 (code Cyclone)........................ 13.50
P245 S25 (Code Cypress)........................ 14.50
PFT (code Cyclist).............................. 4.25
P40 FT (code Cyanide)........................... 6.25
PFPS (code Cymbal).............................. 7.50
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The AC Model Screen-Grid H B Compact

Using Three 224s, One 245 and One 280

By Herman Bernard
Managing Editor

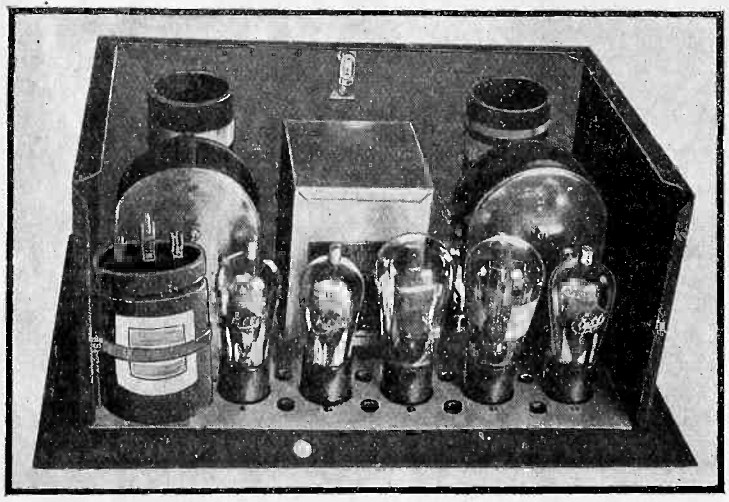

FIG. 1
ALL PARTS FOR THE AC MODEL HB COMPACT FIT INTO A 7X15X9½" STEEL CABINET. THE BERNARD DYNAMIC TUNERS ARE ON THE FRONT PANEL. THE TUBES, RIGHT TO LEFT, ARE 224RF, 280, 245, 224 FIRST AF AND 224 DETECTOR.

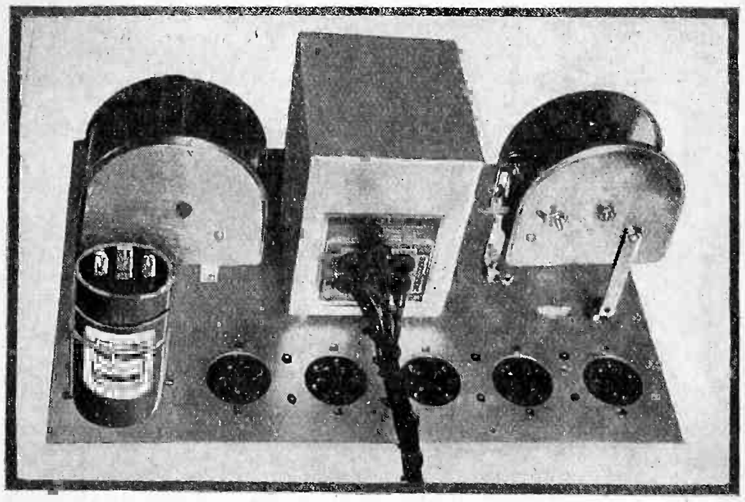

FIG. 2
DETAIL OF METHOD OF MOUNTING THE TUNING CONDENSERS. AT BACK THERE IS ONLY ONE SIDE BRACKET, BUT IN FRONT (NOT SHOWN) ARE ONE MAIN BRACKET FOR THE SINGLE HOLE MOUNTING FIXTURE AND TWO SUBSIDIARY BRACKETS.

[*Here is the AC Model of the HB Compact, a 4–1 receiver, that is, using four receiver tubes and one rectifier. In performance it is outstanding, being notable for sensitivity and tone. By use of the dynamic coil invented by the author, known as the Bernard tuner, the high amplification constant of the screen grid RF tube is fully capitalized, yet the entire range of broadcast frequencies is tuned in. This alone is a feat, as tuning the plate circuit provides the high amplification, yet defeats full coverage of the broadcast frequency range unless Bernard tuners are used. While the circuit is modest in the number of tubes, and the size of the installation, the amazing sensitivity and thrilling tone may be said to be immodest, since they so greatly exceed the customary bounds. The B supply, so important in any AC receiver, is the subject of especially careful attention, the filtration being excellent, and the voltages correct. The successful use of space charge detection is another glowing advantage, increasing the volume fourfold over what it would be otherwise.—Editor.*]

CONSTRUCTION of the AC model of the HB Compact is highly advisable where the place of reception is equipped with 110 volt AC, 50-60 cycles. Not only is the advantage of utter convenience enjoyed, but a larger maximum undistorted power output is assured. Besides, the circuit is extraordinary, presenting a new combination of attractions that include tuned plate circuit with its high amplification, full coverage of the wavelength band nevertheless being assured by the use of a new tuning system, while space charge detection at once is made practical and valuable.

Those who have no AC supply should build the battery model, following the diagrams and constructional text as published in the August 24th, 31st, September 7th and 14th issues, but those having AC had better build the AC model, because it is more economical to operate, is even more sensitive, and delivers a larger undistorted power output.

The combined use of a tuned RF plate circuit and a space charge detector accounts for the heigthened sensitivity. The attainment of proper detection is admittedly one of he prime considerations. The biasing voltage on the detector is critical, but once correctly established, no further attention need be paid to it.

All in a 7x15x9½ inch Cabinet

No more room is taken by the AC model than by the battery model, in fact, the same 7x15x9½" steel cabinet serves for both. To achieve excellent results, while adhering to such compactness for the AC model, required the relocation of party twenty-seven times, until they were so arranged that everything worked perfectly. When the receiver finally was developed to this point and the last lead soldered, the switch was turned "on," and the performance not only left nothing to be desired, but gave one a new realization of the stirring development of radio to one step this side of the ideal.

Outstanding is the tone quality of this receiver, with a relatively even amplification also at radio frequencies. This combination, ordinarily difficult to achieve, was made easy by the

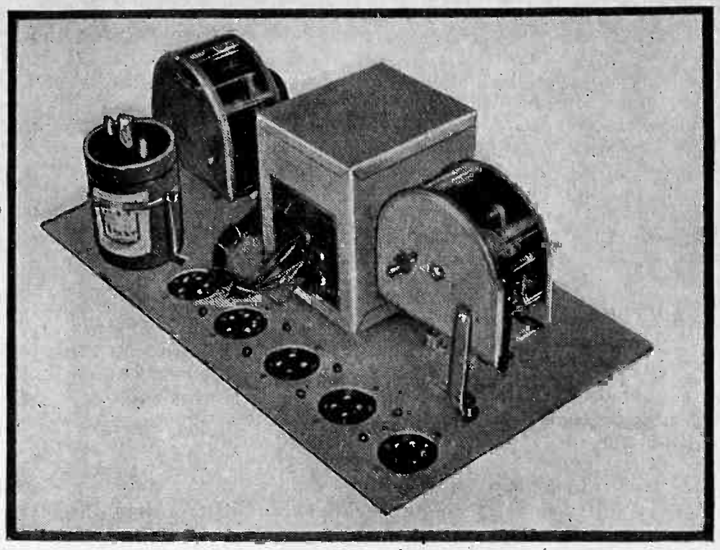

FIG. 3
ANGULAR VIEW OF THE ALUMINUM SUBPANEL WITH TUNING CONDENSERS, POLO 245 POWER SUPPLY.

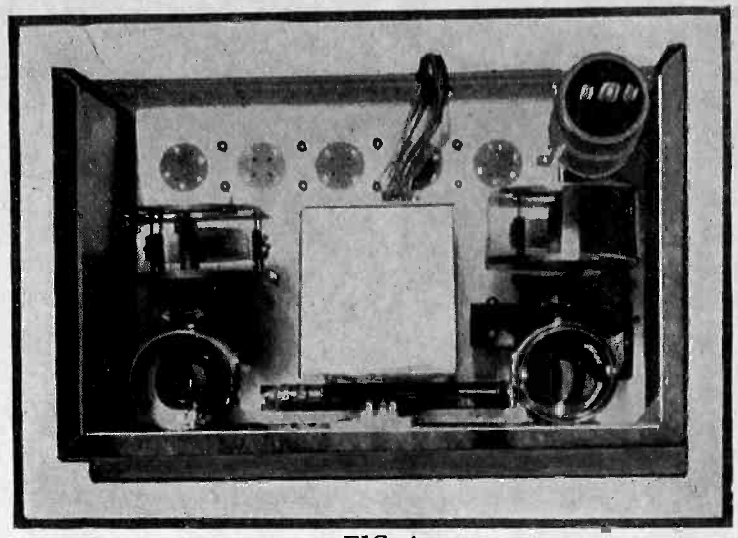

FIG. 4
THE VOLTAGE DIVIDER IS SHOWN IN POSITON BETWEEN THE FRONT PANEL AND THE POLO 245 POWER SUPPLY.

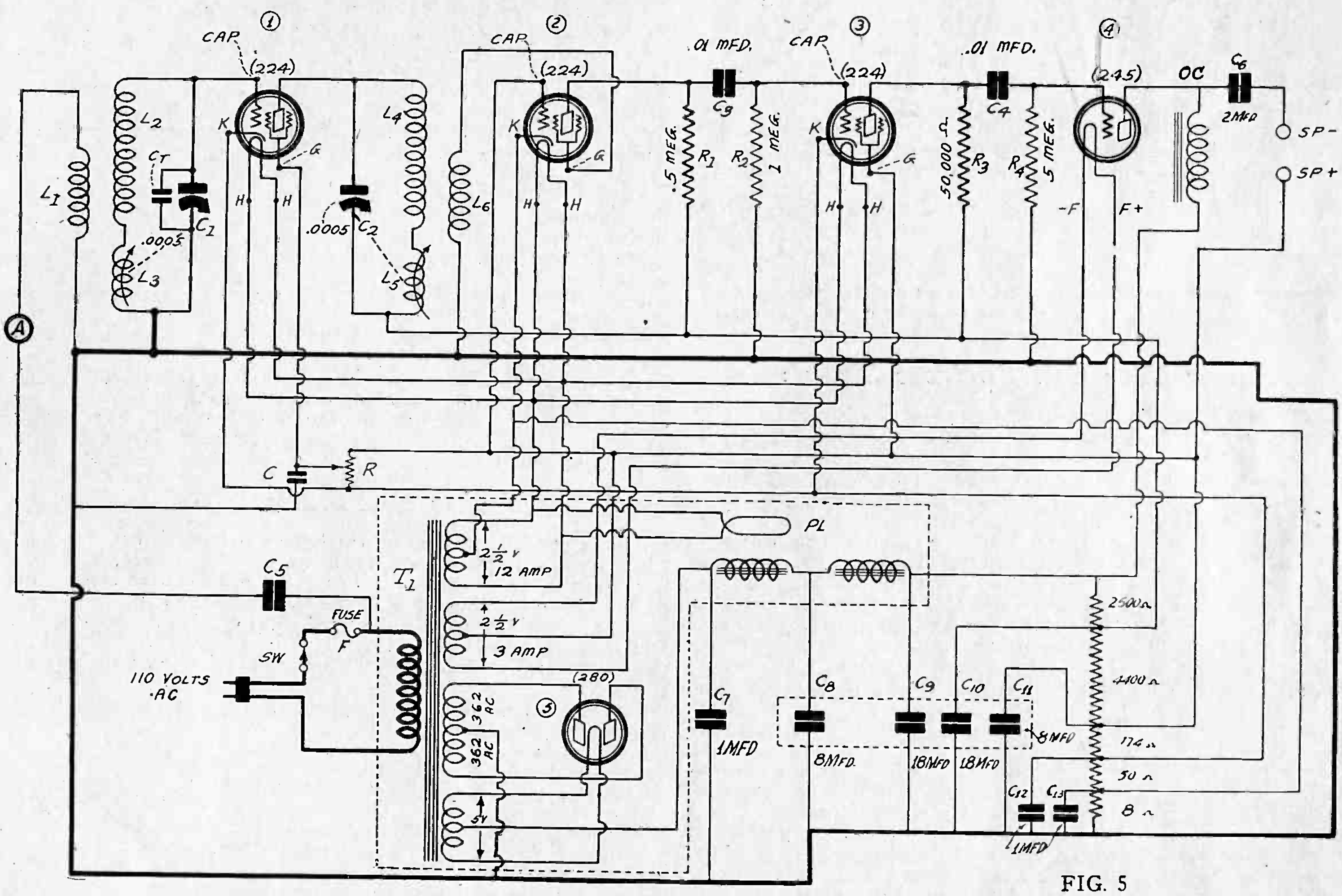

FIG. 5

LIST OF PARTS

L1, L2, L3—One Bernard dynamic tuner for antenna stage (BTS5 of National Co., or BT5A of Screen Grid Coil Co.).

L4, L5, L6—One Bernard dynamic tuner for screen grid interstate coupling (BTP5 of National Co., BT5B of Screen Grid Coil Co.).

CT—One .80 mmfd. equalizer.

C1, C2—Two .0005 mfd. Dustproof tuning condensers

C, C3, C4, C5—Four .01 mfd. mica dielecrtic condensers.

C7—One 1 mfd. filter condenser, 500 volts AC, working voltage, 800 volts D C

C8, C9, C10, C11—Four Mershon electrolytic condensers in one copper case, with bracket (Q2-8, 2-18B)

C12, C13—Two 1 mfd. condensers, 200 volt DC working voltage

R—One Electrad 25,000-ohm wire wound potentiometer, with knob

R1—One .5 meg. Lynch metallized resistor

R2—One 1.0 meg. Lynch metallized resistor

R3—One .05 meg. (50,000 ohm) Lynch metallized resistor

R4—One 5.0 meg. Lynch metallized resistor

T1—One Polo 245 Power Supply, Cat. P245PS, with chokes built in (110V50-60 cycle primary; 2.5 volt at 3 amperes, 2.5 at 12 amperes; 5 volts at 2 amperes; and 724 volt (362-362) secondaries; with two 30 heavy chokes, all built into a steel container. All windings center-tapped except primary

2,500, 4,400, 774, 50, 8—One voltage divider of 7,732 ohms, apportioned as stated; 774-to-0 to carry 100 ma. at 50 v. (20 watt commercial rating); resistor has insulated mounting right angular feet.

PL—One pilot bracket with 2.5 volt AC bulb

OC, C6—One speaker filter choke with 2 mfd. 500 volt AC working voltage condenser, neither required if a dynamic speaker is to be worked

SP-, CP+—Two binding posts

Three National grid clips for caps of 224 tubes

F—One 1 ampere cartridge fuse with fuse holder

SW—One AC pendant switch with front and back openings; 250 watts

One aluminum subpanel, 14¼ x 9½ in., with five sockets affixed; drilled and insulated where necessary; hardware, including resistor mounting clips, two main brackets for condensers, and six subsidiary brackets

One HB Compact AC brown crackle finish steel cabinet, drilled; insulating washers for front

Two full-vision dials, with pointers

One AC pendant switch, 250 watts rating, front and rear openings

One 12 ft. length AC cable

Two rolls Corwico Braidite

Five Kelly tubes: three 224, one 245, one 280

Two flexible couplers or links

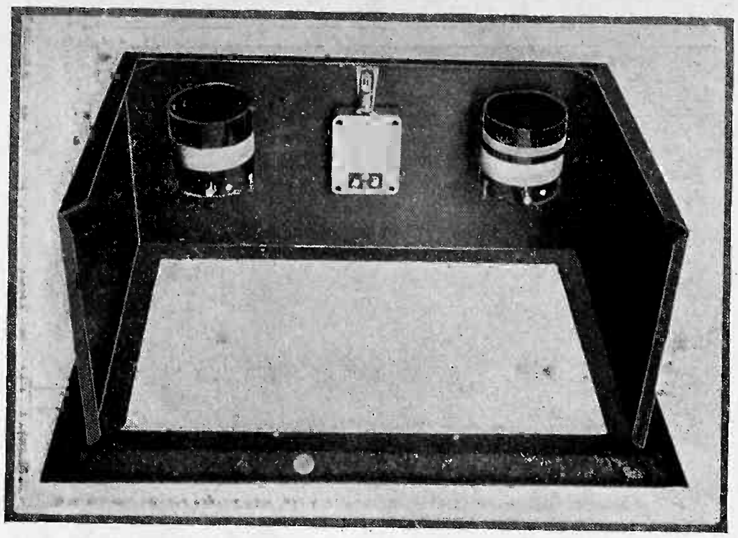

FIG. 6
THE TUNING COILS ARE MOUNTED "UPSIDE DOWN," THAT IS, WITH TICKLER AT BOTTOM, TO PROVIDE ROOM UNDERNEATH FOR OTHER PARTS. UNDER THE PILOT LIGHT IS THE VOLUME CONTROL.

use of tuned primary, with a set-up ratio to the detector input. Ordinarily tuned radio frequency amplification has a rising characteristic, being greater at the higher frequencies. The combination coupling method herein used circumvents that pronounced effect, because of tuning ingenuity, where otherwise an aperiodic coil with a fixed natural frequency would tend to defeat evenness of RF amplification.

And in the audio channel the scientific use of resistance coupling makes possible the exquisite preservation of tone values so jealously reproduced by the radio amplifier and detector.

Overloading of the detector is averted, too, by having the volume control govern the voltage input to the detector, instead of putting the control at some later point in a futile effort to correct damage already done.

Finger Near Coil Produces Signals

There is every incentive, from viewpoints of performance, economy, compactness and convenience, to build the AC model HB Compact, and besides it is far more than merely likely that you will not need any external antenna whatsoever, besides not requiring any ground.

The extreme sensitivity is attested by the fact that placing one's finger near, and not even on, the antenna coil will deliver enough voltage to permit tuning in the local stations at a volume level that requires use of the volume control. So a fixed condenser connected to one side of the AC line, the other side of the condenser to the small winding of the antenna coil, provides pickup from the lighting circuit.

Always this pickup is rather small, and in most receivers it will not produce enough signal strength to give loud enough reproduction, but with this circuit things are different. The sensitivity is of the order experienced with Super-Heterodynes, rather than TRF circuits.

Sometimes an AC line is shorted as to radio frequencies because of a by-pass effect, and in that instance no receiver can be operated from the line as an aerial pickup, but these instances are rare, and it is confidently expected that no one who builds the AC Compact will fail to get good results from the lamp socket aerial built into the receiver. If any one desires to use an indoor or outdoor aerial it should be connected to the point marked "A" (for antenna) in the circuit diagram, Fig. 5.

So you will have a receiver that, in lay parlance, is antennaless and, in a sense in no way derogatory, groundless as well, not to mention its being batteryless. With the fact the receiver requires tubes no one can seriously quarrel!

Follow the Official Layout

In building the receiver the layout of parts is of extreme importance, because if the prescribed plan is not followed not only will you fail to accommodate all the necessary parts, but even if you put some of them outside the cabinet (as an outlandish supposition), but you still would not obtain the best results from the receiver.

So the use of the aluminum subpanel, with sockets affixed, and holes provided for the prescribed parts, removes entirely the possibility of running into difficulty due to misplacement of parts.

Under the tuning coils, which are front panel-mounted, some parts are placed, at left paper dielectric condensers, and at right, if desired, an output filter. Such an output is needed only if a magnetic or inductor speaker is to be used. For dynamic speakers connect directly to plate of the last tube and the highest voltage, 250 volts, as dynamic speakers have built-in output transformers, and no additional device is needed for a single-sided output circuit such as this.

It might be assumed offhand that the radio frequency amplification is not even, but rises with increase in frequency in this tuning system as in others, because the antenna circuit has an aperiodic primary, L1, just as in other coils, and this is subject to the same vice of really having a tuning effect, being in a measure selective, but not varyingly so. And it might seem further that this argument is strengthened by the fact that the dynamic tuner system provides varying degrees of coupling, since the inductance of the tuned circuit changes, hence the relationship of the tuned secondary, L2L3, in the antenna circuit and the tuned primary, L4L5, in the plate circuit is altered progressively, in respect to the windings that feed or are fed.

Let us examine this phenomenon, since it is indeed a fact that the coefficient of coupling is not constant, and that at the lowest tunable frequency (highest receivable wavelength) the inductance in the tuned circuit is at maximum and the step-up ratio is affected. Is the whole claim of relatively constant coupling thus exploded, or is there some hidden virtue that saves the day?

An examination of the ramifications of the dynamic tuner is probably the most interesting topic concerning tuning inductances that has been raised in several years, and as the tuning system is brand-new, and not fully understood, if only for the reason its full scope never has been expounded, but mainly its simple application specified, the pertinent facts by which it achieves uniform amplification will be set forth.

The First Stage Analyzed

Let us analyze first the antenna stage. Here we have indeed an aperiodic primary L1. It picks up some frequencies better than others, due to its natural period or fundamental frequency. Somewhere around the middle of the broadcast band of frequencies, it so happens, such a coil has greatest pickup, with a decline at the lower frequencies which is slightly greater than the decline at the higher frequencies, in comparison with this mid-point of reference. So there is an unevenness to start with, even though the differences are not large.

Now, the secondary L2L3 of the antenna coil is tuned, and this embodies the Bernard Dynamic Tuner in full action, with the moving part of the secondary (L3) actuated by the same control that turns the tuning condenser C1. The secondary is in two series-connected parts. The condenser is across the extreme ends. The moving coil is so placed that at one position of parallelism with the fixed part of the secondary, when the condenser plates are enmeshed, the moving or dynamic coil aids the fixed coil to which it is connected. This is full aiding coupling, maximum inductance. Notice that it takes place when the highest receivable wavelength is tuned in, or lowest broadcast frequency. Hence the step-up ratio between the aperiodic antenna winding L1 and the full secondary L2L3 is *greatest* at the frequency of least sensitivity in ordinary receivers.

Moving Coil Starts to Buck

As the condenser is turned, and the moving coil automatically turning with it, less capacity is in use, less inductance, too, because the dynamic coil is being withdrawn from a position of full aiding coupling until at the middle of the dial the moving coil is at right angles with the fixed coil to which it is connected, and thus acts as if it, too, were a fixed inductance. Then as the condenser is turned to still lower capacity, the moving coil starts to buck the fixed coil. The effective inductance is declining all the while. In fact, that decline is the secret of why the Dynamic Tuner covers a much wider frequency range through the full-scale deflection of any condenser than does any other type of coil, no matter how tuned.

The step-up ratio is becoming less and less, at higher and higher frequencies, since the inductance of the secondary is diminishing. The dynamic part of the secondary becomes actually out of phase not only with its fixed component, the stator winding, but also with the aperiodic antenna winding. The step-up ratio is least therefore at the highest frequency. This is a goal sought in numerous tuning devices, because it keeps the amplification within bounds, and bestows stability upon a receiver.

If we were to stop here we would find that the amplification at the highest frequency was still far greater than at the lowest frequency, since the self-regenerative action, due to inter-electrode capacity coupling in the tube, and to stray inductive back-coupling, both more intense at the higher frequencies. So great would the difference still remain that there would be vicious squealing, were it not for the dynamic tuner's peculiar action in another direction.

Presentation of a New Viewpoint

The moment that the moving coil is turned past the central position where it acts as a fixed inductance, that moment does the moving coil start to buck its fixed counterpart, and a bucking coil is a regeneration squelcher, because opposing phase relationships introduce a radio frequency resistance, and in the present example this resistance, not enormous at all, works against the still overpowering negative resistance that arises from stray back-coupling. With the screen grid tube in use as a radio frequency amplifier this back-coupling is mostly inductive.

Hence the bucking effect of the moving coil tends to lower the degree of amplification for the higher frequencies, those past the 50-division of the dial, but the amplification is still an instability factor at the higher frequencies.

The situation has been partly turned about. Where we have been accusomed to uncontrollable oscillation, which was due to over-amplification under unfavorable circuit conditions, we are experiencing a preliminary but mild deterrent to inoperation. The longer wavelengths, or lower frequencies, still are getting far less than their required relative share, so that, inductively speaking, Mr. Amplification is still standing on his head. Is it conceivable that this awkward position will be righted?

We now come to the interstage coupler. This, too, is a dynamic tuner, but the windings are different. The same type of winding used for the secondary L2L3 of the antenna coil, for grid circuit connection, is now used instead as the primary L4L5 for plate circuit tuning.

Plate Tuning Helps

Positively there is no way of getting so much amplification out of a screen grid RF amplifying tube as by tuning the plate circuit, and here we tune it. The mere fact of tuning it tends to give the higher waves a better deal.

The chain of reversals is still being forged. As was pointed out, the plate circuit, as the previous grid circuit, uses maximum inductance concomitantly with maximum capacity, and minimum inductance with minimum capacity, the variometer effect of the moving coil working in the same direction as the capacity effect of the tuning condenser.

Coupled to the tuned primary coil is a large fixed secondary, so that a step-up ratio is established under any and all conditions to the detector tube from the plate circuit of the 224 RF amplifier. At the longest receivable wavelength, 545 meters, not quite all the capacity and inductance is used in either tuned circuit, but the amount used is so close to the total that we shall continue to suppose the total is in use.

We find now that the step-up ratio is less at the highest wavelength and most at the lowest, because the inductance (primary in plate circuit) feeding the pickup coil is least at the lowest wavelength and most at the highest wavelength. When the pickup coil L6 is fixed, as here, the larger the feeding coil's inductance, the lower the step-up, for the feeding coil could be made so large, in another instance, that there would be an actual step-down ratio to the pick-up coil. However, in the Bernard Tuner there is always a step-up ratio, even in the interstage coupler, the only point being that the step-up varies. We have seen how it increases with frequency in the first tuned circuit and now how it decreases with frequency in the second tuned circuit because the primaries and secondaries are turned about.

Two Cancel

As many must have assumed by this time, the counter effects of the two respective tuned circuits in regard to alteration of step-up ratio cancel each other, and the ratio is effectively always the same, due to the equal combination of equal differences. So we can forget completely the considerations of increasing and decreasing step-up.

But we can not forget that the bucking effect of the dynamic coil L5 in the tuned plate circuit, due to the resistance feature alone, and independent of step-up ratio effects already dismissed, is again important. It acts in the same direction in this circuit as in the first circuit, that is, it tends to lower the amplification at the higher frequencies, the higher the frequency, the greater the effect as compared with what would exist without the moving coil's presence. The greater the frequency, the greater the checking effect on over-amplification that spells disaster.

It is therefore true that the amplification is relatively even at radio frequencies, because opposite changes in ratio of step-up cancel, leaving the bucking effect to neutralize the over-amplification at the higher frequencies, which is the vice known as rising characteristic. There is now an even characteristic, due to the resistance effect when the moving coils enact their mighty drama of displacement of phase, and, having established an enormous amplification at the highest wavelength, we are happy to find the same great sensitivity at the other end, without vices.

We have not only explained why the radio frequency amplification is even, but we have analyzed the circuit as to the first tube, leaving unexpounded only two points: first, that the moving coil must be in a position of full aiding coupling in both circuits, when the condenser plates are fully enmeshed, otherwise a poor and disappointing receiver results; and, second, that the first circuit will not tune in step with the second circuit until the equalizing condenser CT is properly set. Once set it is left thus.

The tuning charts published in Radio University this week, page 15, will help you get the dynamic coil properly positioned. The stated dial readings will obtain only when the correct position exists. The wrong or opposite position will cause the higher wavelengths to come in at higher settings, but with ten or twelve of the uppermost waves beyond the tuning range, while the high broadcast frequencies will come in too high up, capacitatively, 200 meters being about 30 on the dial, instead of 9 or 10.

If the two circuits do not read alike, after the coils are properly placed, more capacity is required for CT. Usually

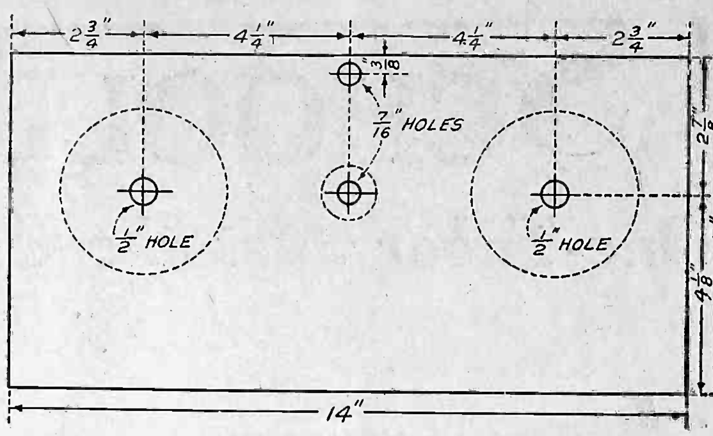

FIG. 7.
LAYOUT OF FRONT PANEL OF 7x14" BAKELITE OR HARD RUBBER IS USED WITH BASEBOARD. THE DOTTED CIRCLES SHOW WHERE THE EDGES OF 4-IN. DIALS AND 1-IN KNOB COME.

80 to 90 mmfd. maximum capacity is plenty, about 60 mmfd. being used, but if not, add more. Put two equalizers in parallel as a solution.

Now we come to the detector. This is a special type of detector, using the screen grid tube in space charge fashion, to accelerate the speed and quantity of electrons acting inside the tube. If you get the space charge detector working properly you will enjoy most amazing results in sensitivity, with volume beyond your greatest expectations, no matter if you are inclined to let your expectations soar.

As an example, during some of the preliminary laboratory work on this receiver it was found that with a negative bias of 0.48 volt, with 180 volts on the plate and 50 volts on the screen grid, detection was best. And the best was the loudest, most sensitive detection to come within the writer's experience. When the bias voltage was raised by 1 volt, detection became very poor, and when it was halved (0.24 volt) it was inferior to the optimum value to a considerable degree, although not nearly so bad as when it was raised 1 volt.

It was therefore obvious that space charge detection was critical, and foregone that some who would attempt it would not succeed. To make success as easy as possible for the greatest number, a voltage divider was designed, and finally specially produced for experimenters, so that the nearest practical voltage to .48 could be obtained without difficulty. This voltage is marked .5 on the diagram, but in reality, with about 80 milliamperes flowing through the 8-ohm section, it is .64 volt. This worked nicely, but an easy means exists to obtain even .48 volt if you desire to follow as closely as that. Simply connect a 30-ohm rheostat across the 8-ohm section, from the first intermediate tap, between B negative (C minus) and the adjoining tap. Connect the 1 mfd. bypass condenser C13, instead of from the 8-ohm tap to B negative, from the rheostat arm to B negative, and connect the detector cathode to the arm, instead of to the 8-ohm terminal. Now as you turn the rheostat, if it is 30 ohms total, your range is from 0.504 volts to zero, and you can obtain 0.48. You need not measure the voltage. Your ear will tell you abundantly.

Bias Voltage Certainly Critical

It is plain, therefore, that the bias voltage is critical, and although the less experienced radioists may escape best detection by the space charge method, I deemed it imperative to present this form of detection, and recommend it, because of the advantages bound to come to many.

As to those who will fail to get the stirring results which space charge detection makes possible, it is always an easy matter to adopt an orthodox power detector hookup. Simply reverse the connections to cap of the detector tube and G post of socket. Then the 50 volts will be applied to the G post, now used as the screen grid, while the cap picks up the detector input coil and is, in orthodox fashion, the control grid, or old familiar grid. No other change need be made, not even plate voltage, although it is pertinent to suggest that the cathode of the detector be moved up experimentally to the same lug on the voltage divider to which the cathodes of the two other 224 tubes are connected.

The audio channel remains unchanged no matter what type detector is used, even if you put a 2 meg. leak and a .00025 mfd. condenser with clips, in series with the connection to the cap of the detector, and return the detector to cathode, instead of to B negative. That would be leak-condenser detection, and it, too, gives good results in this circuit.

The amplification at audio frequencies is stupendous, but the quality is most excellent, even breath-taking, while the 245 power tube does its full share toward sustaining the quality performance. If a dynamic speaker is used, no output transformer or choke-condenser filter from the last tube should be used, but for a magnetic or inductor speaker, the filtered output must be included. For those who are to buy a speaker the inductor type, N12G, is highly recommended for this circuit.

(*Continued next week, September 28th issue*)

SCHOOLBOY'S SET

One-Tuber Just the Thing for Veriest Novice

By Jack Tully

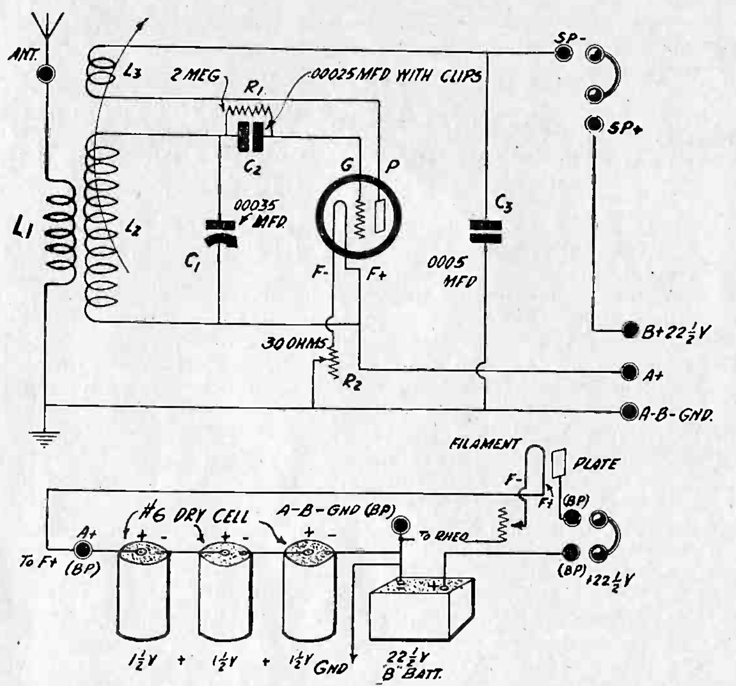

FIG. 1.

CIRCUIT IN SCHEMATIC DIAGRAM, WITH A PICTURE DIAGRAM OF THE BATTERY WIRING. FIVE OF THE BINDING POSTS ARE SHOWN IN THE PICTURE DIAGRAM AS BP. THE NINTH BINDING POST IS FOR AERIAL AND DOES NOT CONCERN THE BATTERY WIRING.

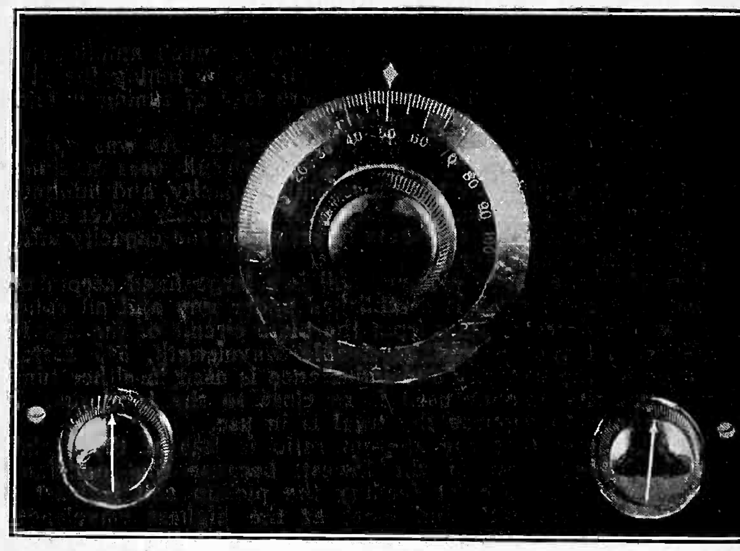

FIG. 2

THOUSANDS of schoolboys and scouts throughout the country like to build inexpensive receivers as a first step of initiation into the radio fraternity. What kind of set should they build at the first attempt? Obviously, the simplest set which gives promise of good reception.

At first the beginning was always a simple crystal set. It taught the boys the elements of tuning, the functioning of coils, condenser and elementary rectifiers. But crystal sets are no longer in good standing, because they are not sensitive enough to bring in stations at a distance, even when the increased power of broadcasting stations is considered. But their principal disadvantage is their lack of selectivity. It is practically impossible with a crystal set to separate any two stations operating simultaneously. If any of the well-known methods of increasing selectivity is employed, the remaining sensitivity is so low that nothing worth while can be brought in.

There is really no good reason why any one should build a crystal set these days, for a one-tube set is just about as easy to build, and it is not much more expensive. The difference in results is so much in favor of the tube set that any increase in cost or in difficulty of assembling is amply justified. And where is the boy who is afraid to tackle the more difficult job? Not among the schoolboys, certainly, and not among the scouts, surely.

A Challenge to the Boys

So here is a one-tube challenge to the boy who wishes to gain admittance to the radio fraternity in a practical way. If he accepts it he will have a neat little receiver with which he can expect to pull in stations, and to which he can subsequently add an amplifier to get loud speaker volume.

This receiver can be built around any battery tube, for example, a 99, a 200A, a 201A, or a 112A. In order to adjust the filament circuit to any one of these tubes he only has to vary the 30-ohm rheostat. The filament battery consists of three No. 6 dry cells, which give a voltage of 4.5 volts. This is too much for the 99, so the rheostat is used to adjust the current to normal for that tube. Since the tube is functioning as a detector, about 25 ohms is a suitable value, but the circuit will work very well if all the resistance in the rheostat is used. When a tube like the 201A is used, or any of the others mentioned above, the rheostat should be set at zero. This gives the tube 4.5 volts on the filament, at which value the tube is effective as a detector.

For plate voltage a single block of B battery is used, 22.5 volts. No more is necessary to make the tube regenerate well and to deliver a strong signal to the headphones. In Fig. 2, below the circuit diagram, is shown a simplified circuit of the connections of the filament and plate circuit.

All the essential connections are shown in the upper portion of Fig. 1. While it is not necessary to solder the joints provided they are all twisted together well, it is always desirable to do so. It gives the builder practice in the art of soldering, which every boy should know.

New Arrangement of Parts

The method of assembly is clearly indicated in Fig. 1 on the front cover. This is how one builder assembled the circuit, and is suggestive. No doubt any ingenious boy would prefer to use his own design, and he can do so with the assurance that the results will be good, provided he carefully follows the circuit diagram in Fig. 2. The required list of parts given herewith contains all that is needed to assemble the receiver.

[*Next week the exact dimensions of the brackets, panel holes, etc., will be given, together with a picture showing where each part is placed. Read more about this circuit in the September 28th issue, next week.—Editor.*]

(Other illustrations on front cover.)

LIST OF PARTS

L1, L2, L3—One three circuit tuner for .00035 mfd. tuning condenser
C1—One .00035 mfd. tuning condenser
C2—One .0025 mfd. fixed condenser with clips
C3—One .0005 mfd. fixed condenser
R1—One 2 meg. grid leak
R2—One 30 ohm rheostat
Ant., Sp–, Sp.+ (A–, B–, Gnd.), B+22½—Six binding post clips
Two knobs
One 7x10 in. front panel
One 3x6 in. subpanel with socket
Six supporting brackets
One dial
One dial pointer
One roll of insulated connecting wire

ACCESSORIES

Three No. 6 dry cells
One 22½ volt B battery
One pair of phones
Antenna and ground equipment
One tube

UP GOES VOLUME

When Proper SG Coupling is Used

By J. E. Anderson

Technical Editor

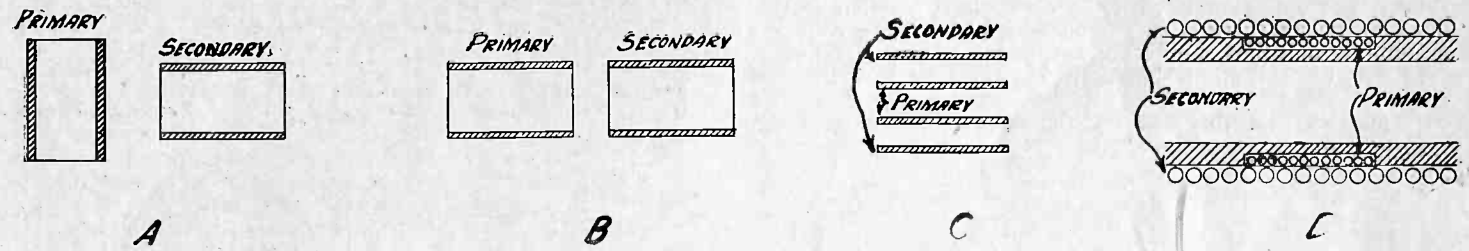

FIG. 1

A. TWO COILS PLACED AT RIGHT ANGLES HAVE ZERO COUPLING COEFFICIENT.
B. TWO COILS PLACED END-TO-END AND FAR APART HAVE A SMALL COEFFICIENT OF COUPLING.
C. IF ONE COIL IS PLACED INSIDE THE OTHER THE COEFFICIENT OF COUPLING IS LARGE.
D. THE COUPLING COEFFICIENT IS STILL LARGER IF ONE COIL IS WOUND IN A RECESS AND PLACED IN THE CENTER OF THE OTHER COIL.

WHEN dealing with screen grid tube circuits it is customary to emphasize the need of a high impedance load in order to force the tube to deliver as high output as possible. The load takes various forms, such as a choke coil of high impedance at the frequency of operation, a tuned circuit adjusted to resonance with the frequency being amplified, a resistance of high value or a transformer with high primary impedance. A high amplification can be obtained with any one of these methods provided the adjustments are made properly.

The tuned circuit, which must be of the parallel type, offers a very high impedance at the resonant frequency, and the impedance is a pure resistance. This resonant resistance, so to speak, is higher the lower the series resistance in the tuned circuit, that is, the lower the losses in the condenser and in the tuning coil.

The parallel tuned circuit has the advantage of being selective, but the impedance offered to the tube is not as high under practical conditions as the impedances that can be obtained with some of the other methods. For example, it is possible to get higher impedances with the non-selective couplers of the choke coil and pure resistance types. Let us give a few numerical values to illustrate this point.

Numerical Values

The effective resistance of a parallel tuned circuit is given by L/CR, in which L is the inductance of the tuning coil, C is the capacity of the tuning condenser, and R is the resistance in the tuning coil, the resistance in the condenser being assumed negligible in comparison with the resistance of the coil. This assumption is justified in all practical cases at radio frequencies. If the inductance has a value of 165 microhenries, the condenser a capacity of 500 mmfd., and the resistance a value of 5 ohms, the effective resistance of the tuned circuit at the resonant frequency is 66,000 ohms. Now 5 ohms is really a very low resistance. Actually, the resistance in the circuit would be higher, which would make the effective resonant resistance smaller than the value just calculated. Moreover, there will be shunt resistances in the circuit, which will further decrease the effective resistance of the tuned circuit. So it is reasonable to assume that the actual resistance of the tuned circuit to the resonant frequency is considerably lower than 66,000 ohms.

Non-Selective Impedances

If resistance coupling is used it is not difficult to get a value of 100,000 ohms, or even much higher. But what values can be expected out of a choke coil? The impedance of a choke coil can be taken the same as its reactance, and this is equal to the inductances in henries multiplied by 6.28 times the frequency of the current. Let the frequency be 550 kc and the inductance 100 millihenries. Then we have for the reactance 346,000 ohms. In order to get a reactance of 100,000 ohms we would need a choke coil of 29 millihenries. Choke coils ordinarily used for coupling have a much higher inductance. Therefore the impedance in choke coil coupling is higher than the resistance in tuned coupling, using customary values in both instances.

When transformer coupling is used at radio frequencies it is customary to specify that the primary impedance should be high in order to force the tube to deliver the maximum signal voltage. This is, indeed, correct, but it is not a sufficient condition. If it were it would only be necessary to connect a high inductance choke in the plate circuit of the tube and let it go at that. Or to retain the transformer, we might make the secondary a single turn on this choke coil.

Useful Coupling

Under these conditions the voltage across the load impedance would be great, indeed, but it would be of no use. The object of the high voltage across the load is to make use of it for input on the next tube. In some manner we must apply the high signal voltage developed across the load to the grid circuit of the next tube. In direct coupled circuits the entire voltage is impressed on the grid. The coupling coefficient is unity. In a transformer circuit the coupling coefficient may have any value between zero and unity. When the load impedance is not coupled at all to the grid the coefficient is zero. When only one turn is used around a high inductance choke coil, the coefficient does not differ much from zero. If many turns are used in the secondary, and if they are closely interwound with the turns of the primary, the coefficient is high, approaching unity.

It appears, therefore, that in order to get the greatest voltage from a screen grid tube to the grid of the succeeding tube, we must not only have a high impedance primary, but this must be coupled very closely to the secondary winding which is connected in the grid circuit of the next tube.

Coefficient of Coupling

And this brings us to a consideration of the coefficient of coupling. Upon what does it depend? If k be the coefficient of coupling, L1 the inductance of the primary, L2 the inductance of the secondary, and M the mutual inductance between the two windings, the coefficient of coupling is $k=M/(L1L2)^{1/2}$, or the coefficient of coupling is equal to the ratio of the mutual conductance to the square root of the product of the primary and secondary inductances.

From this it might be assumed that the coefficient of coupling could be increased by decreasing either or both of the inductances appearing in the denominator of the right hand member of the equation. But this is not so, for when either of the inductances is reduced, the mutual inductance between the two coils is reduced also. The coefficient of coupling, like the mutual inductance, is really a measure of the closeness with which the turns of the two windings are associated magnetically, which for radio frequency coils also means geometrically.

(Continued on page 13)

FIRST PRESENTATION
LINEAR R

Selectivity Retained,

By J. E. Anderson

The limitations on the grid bias discussed in these paragraphs apply only when it is desired to avoid overloading the power tube on strong signal voltages, particularly during tuning and volume adjustments. If momentary overloading of the power tube is not objectionable, or if the circuit is handled so that it does not occur, there is no reason why a high plate voltage and a suitably high bias should not be applied to the detector.

In this connection it should be remembered that the limitation of the detected output voltage is due to the flow of grid current, and that this reduces the selectivity. This reduction

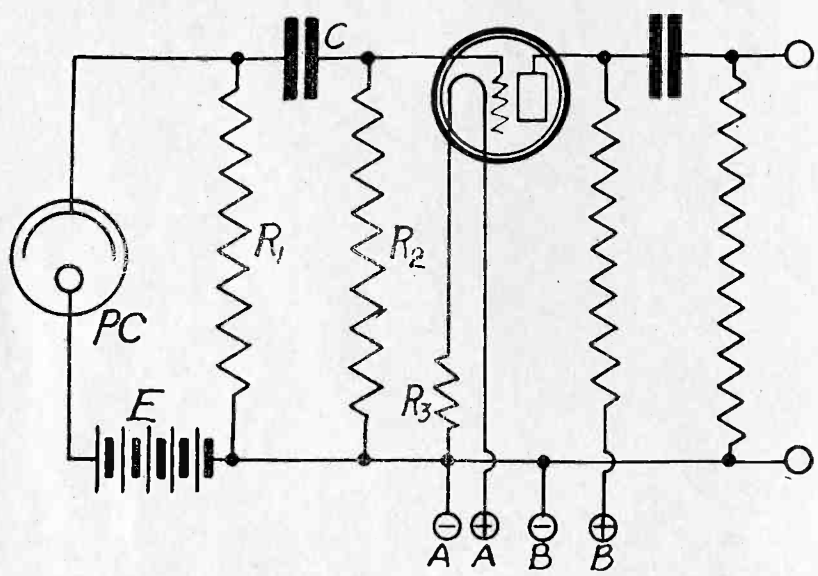

FIG. 88.
THIS ILLUSTRATES ONE CONNECTION OF A PHOTO-ELECTRIC CELL TO A RESISTANCE COUPLED AMPLIFIER.

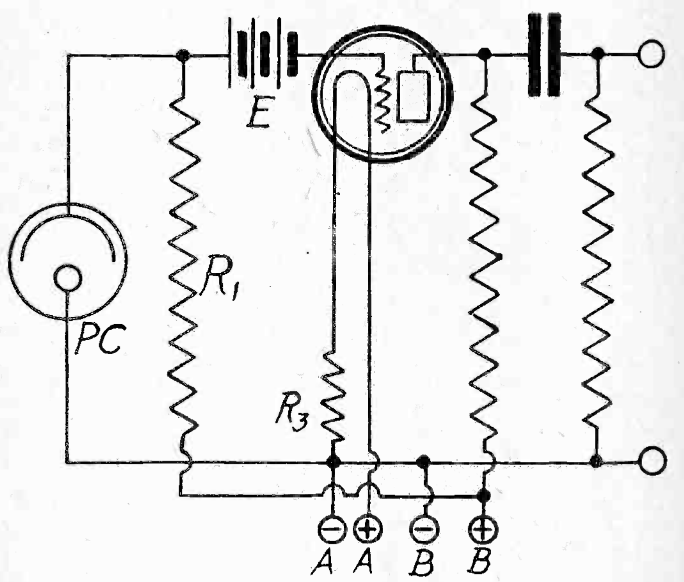

FIG. 89.
ANOTHER CONNECTION OF A PHOTO-ELECTRIC CELL TO A RESISTANCE COUPLED AMPLIFIER IN WHICH THE B BATTERY IS USED FOR POLARIZING THE CELL.

begins as soon as grid current flows, and is proportional to the reduced output voltage from the detector.

The first application of the thermionic tube to radio reception was the Fleming oscillation valve, a rectifier or detector using two electrodes, the filament and the plate. While this rectifier is not regarded as highly as detectors employing three-element tubes, it was a great improvement over earlier forms of detectors. But even now two electrode detectors are often used, and they probably would be employed more if they were more fully understood.

One of the disadvantages of the two-element rectifier is that it takes power from the tuned circuit and consequently reduces the selectivity. In this respect it functions like a grid bias detector when the grid is allowed to take considerable current. In the early applications of the diode, or two-element valve, the headphones were connected in series with the rectifier and the tuned circuit. In order to reduce the current and hence to increase the selectivity, the impedance of headphones had to be made very high. But even with the highest impedance headphones available at the time, the selectivity was not comparable with that obtainable when the grid bias method of detection is used under proper conditions. It would seem, therefore, that the diode rectifier has no justifiable place in a discussion of modern circuits. But that is not so, for recent innovations have directed interest to the diode once more. One of these innovations is the idea of linear detection.

In one sense the Fleming valve is used more at this time than it ever was before, not as a detector, but as a rectifier. The filament type rectifier used in most B supply units is only a modification and refinement of the old Fleming oscillation valve. The modification is mainly one of size. Not only is the Fleming valve used as rectifier in B supply units, but it is also used in laboratories for obtaining extremely high, steady voltages from alternating voltages. These special rectifier circuits do not use commercial frequencies, but radio frequencies. Such tubes are also used for obtaining high grid voltages, polarizing voltages for condenser speakers, and for automatic volume controls. Sometimes low commercial frequencies are used, sometimes audio frequencies, and sometimes radio frequencies.

In Fig. 40 two circuits were shown for obtaining grid bias by the use of a diode rectifier, and it was pointed out that these circuits took practically no power from the mains. If the line voltage remains constant the rectifier output also remains constant, and if the load resistance is high, this constant voltage is not much lower than the peak voltage of the alternating voltage impressed on the tube. If the line voltage fluctuates, on the other hand, the rectified output voltage fluctuates in the same manner, provided that the fluctuations are not so rapid as to be smoothed out by the filter in the circuit. Very slow changes in the input voltage appear as corresponding slow changes in the rectified output. Just how slow these changes must be in order to appear faithfully across the output resistance depends on the inductance of the choke coil, the capacity of the filter condensers, and on the current drawn from the device.

It is clear that the same type of circuit can be used for rectifying radio frequency currents. It is also clear that, if the values of the filter elements be chosen so that the highest audio frequency appears slow and so that the lowest radio frequency that may be impressed appears rapid, the circuit can also be used as a detector of radio signals modulated with audio frequencies. Moreover, if the resistance in the output be made very high, the rectified output voltage will be nearly equal to the peak of the radio frequency voltage impressed on the circuit. This rectified voltage will fluctuate according to the fluctuations of the modulated radio frequency signal.

Such a diode rectifier detector is shown in Fig. 95. The primary of the input transformer T is tuned with condenser C to the radio frequency signal to be rectified. For rectifier an ordinary three-element tube of the 227 type is used, but the plate and the grid are tied together so as to form a diode.

For broadcast frequencies the reverse current can be neglected because the capacity between the two electrodes is small. Hence the rectified current will consist of unidirectional pulses of

OF DETECTION BY

ECTIFIER

ndless Volume

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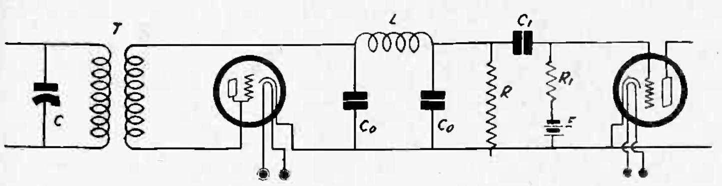


FIG. 95
A RECTIFYING DETECTOR OPERATING ON THE SAME PRINCIPLE AS THE RECTIFIER IN A B SUPPLY OR AS A C BATTERY ELIMINATOR.

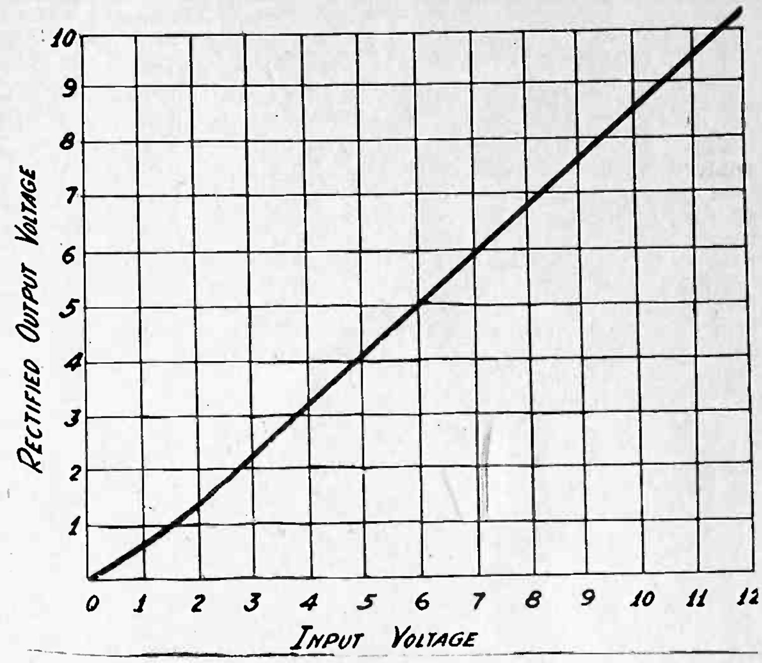


FIG. 96
GRAPH SHOWING THE RELATIONSHIP BETWEEN THE INPUT AND OUTPUT VOLTAGES IN THE CIRCUIT IN FIG. 95.

current having a frequency equal to the frequency of the signal. This follows from the fact that the circuit is a single wave rectifier.

The filter consisting of the inductance L and the two condensers Co is used to smooth out the ripples so that across the load resistance R there will be a steady voltage. That is, the voltage across R will be steady if the voltage across the secondary of T has a constant amplitude. If the signal is modulated the voltage across R will fluctuate according to the fluctuation in the amplitude of the signal voltage. The audio frequency fluctuations in the voltage across R can be impressed on the grid of an amplifier in the usual manner.

The question now arises as to whether the grid of the amplifier should be connected across R directly or as shown in Fig. 95. There will be a considerable DC component in the voltage across R, depending on the degree of modulation of the radio frequency signal. This DC component might be used as the bias on the amplifier tube, thus obviating the need for C1 and R1. However, the degree of modulation does not remain constant so that the bias on the amplifier would be continually changing. Furthermore, when the signal is cut off at any place ahead of the rectifier, for example, by cutting off the power at the transmitter or by detuning the receiver, the voltage across R falls to zero. This would make the bias on the amplifier zero, which in turn would make the plate current in that tube excessive. For these reasons it is advisable to use the arrangement shown in Fig. 95 and to adjust the bias E to suit the amplifier tube.

The resistance R1 imposes an additional load on the rectifier and thus reduces the voltage across R and R1. However, this can be offset by making both resistance higher. Suitable values for these resistors are one half megohm for R and one megohm for R1, although either or both may be larger.

It will be observed that the load network on this rectifier is the same as that frequently used after a three-element detector. The constants in the network can therefore be the same. For example, the value of each of the condensers Co can be .00025 mfd. and the inductance of the choke coil can be of the order of five millihenries. If R1 has a value of one megohm, C1 need not be larger than .02 mfd., and if R1 has a value of two megohms, C1 can have a value of .01 mfd. These combinations are consistent with equal amplification over the entire audio range.

Since the load on the rectifier tube is a very high resistance, of the same order of magnitude as the shunt grid leak in many grid circuit detectors, it is clear that the power taken from the tuned circuit is very small and that the reduction in volume and selectivity from this cause is very small.

Effect of Coupling on Amplification

(*Continued from page* 11)

If the primary and secondary windings are placed far apart, even if each one is large, the mutual inductance is small, as is the coefficient of coupling. The alternating magnetic field set up in the primary does not affect the secondary appreciably, that is, only a small voltage is induced in it. As the coils are brought closer together the coefficient of coupling increases, and so does the voltage induced in the secondary. If one coil is placed inside the other, (it makes no difference which is inside), the coupling is close. The more nearly equal the two diameters the closer is the coupling.

In order to increase the coupling coefficient still further, the primary turns can be bunched near the center of the other coil, and in order to as many of the primary turns as possible near the center, the turns of the primary may consist of fine wire. One way of getting very close coupling is to cut a groove in the form on which the secondary is wound just deep enough to admit the primary turns when wound in a single layer.

This applies to the case when the secondary is tuned. If the tuning condenser is put across the primary, the secondary should consist of the fine wire and placed in the groove in the center of the primary winding.

It is not possible to attain a unity coupling coefficient. There will always be some magnetic leakage, that is, magnetic lines from the primary which will not thread all of the secondary turns. This is true even in iron-core transformers, but in these the leakage can be made very small by proper design. In radio frequency coils the leakage will be comparatively large even at best. This, however, is not always a disadvantage, but rather an advantage. It is well known that the selectivity of a tuned circuit decreases as the coupling coefficient increases, and as a result the response is decreased rather than increased by increased coupling.

As a result of this, the coefficient of coupling between the primary and secondary windings is adjusted so that the voltage across the secondary is a maximum when the circuit is in tune rather than so that the coefficient has the greatest attainable value. The optimum coupling coefficient depends on the frequency, on the resistance in the secondary circuit, and on the resistance in the primary circuit. The secondary resistance is made as low as practicable and then the coupling is adjusted so that the voltage transfer is optimum for the particular tube with which the transformer is to work and at some frequency in the tuning range, usually somewhat below the geometric mean frequency of the range.

With proper design of the coupling transformer it is possible to get as effective voltage transfer with transformer coupling as with any other form of coupling, and still retain the advantage of high selectivity.

RADIO UNIVERSITY

Carrier Waves Are Steady

WHEN a station is broadcasting, does its wave stay steady, or does it change a little, so that retuning would be necessary? I should imagine it would be difficult to work a receiver if the carrier frequency changes from time to time so as to require turning the dial to compensate for each new difference.—J. H. E.

The wave is steadily at the same frequency, except in instances of violation of the Federal Radio Commission's order permitting no more than 500 cycles variation. This is too trivial a variation to affect the receiver tuning. Stations use wave monitors, in the form of wavemeters, and, a growing and greatly enhanced method, crystal control, to steady the carrier. The crystal is ground to the frequency of the carrier and passes only that frequency. The modulation is introduced into this accurate carrier. Reception surely would border on a nuisance if the stations wobbled as you suggest and the dials would have to be turned to keep pace with the variation.

* * *

Senility of Equipment

LATELY my reception has not been good. Unsteady signals are prevalent. Sometimes crackles arise, and although I shake the speaker cord I cannot get rid of them. My set is a five-tube battery model. While the set is four years old, I have had my present tubes and B batteries only a year and a half, and I get the A battery recharged three times a year.—D. B.

The remedy is to get new tubes and fresh B batteries and have your A battery recharged. You should get new tubes yearly, at least, and new large-size B batteries about every six months. The A battery should be charged once a month. While you are at it you might build yourself a new receiver, as yours certainly must be out of date in performance as well as in appearance.

* * *

Compactness Is Practical

IS it practical to build a good receiver compactly, or is it better to spread it out?—H. T.

It is entirely practical. The solution of the compactness problem is a matter of physical and electrical design. When the layout is properly arranged the compact can perform to the same high degree as the same circuit would on a subpanel of twice the width or depth. The compact receiver might not fare so well did it not gain considerably from shortness of leads, as compared with the other.

* * *

Effect of Load on Bias

WHAT effect has the load on the plate circuit of a tube in respect to the bias requirement?—F. S.

In general the load has no effect on the bias requirement, which is determined by the applied plate voltage, and not the voltage effective on the plate. The reason is that the total voltage is dropped in the plate-and-load circuit. You probably have in mind a resistor in the plate circuit which may halve the applied voltage to produce the effective plate voltage. But the applied voltage is still the determining factor in respect to the bias requirement, because it is the total circuit voltage. Much confusion has arisen concerning this point, possibly because tube data so often deal with no-load characteristics, and some persons incorrectly assume, therefore, that in an operating circuit the voltage drop in the load must be discounted to produce the effective voltage which was the basis of the data.

* * *

Comparison of Speaker Types

WHAT is the situation now in respect to loudspeakers? Has the magnetic speaker become outclassed? Is the dynamic speaker the best type made? What is the difference between the inductor dynamic and the inductor magnetic?—F. W. S.

The magnetic type speaker has declined in popularity, but it works just as well now as it did at any time, and since it has given much satisfaction to multitudes, one can scarcely say that it is altogether passe. That it has been outclassed by the better makes of dynamic speakers goes without saying. The magnetic type is somewhat deficient in low-note response, whereas the dynamic speaker is quite the opposite. The dynamic is at present the most popular. Of course it is considerably more expensive than the magnetic type. Between the two in point of cost is the inductor speaker, which consists of a magnetic mechanism so operated that the driving armature moves up and down in a generous gap, instead of from side to side in a gap 1/10,000 of an inch or so. This gives the inductor a far greater active area than the old-style magnetic. The pole pieces are not struck by the armature until the burden that the old magnetic could bear is greatly eclipsed. Besides, the inductor is an excellent reproducer. It is probably better than the regular dynamic in its frequency performance, that is, evenness of sensitivity to frequencies throughout the audible range. The low-note reproduction is most excellent, yet the high notes are not slighted, and the middle register, as with all speakers, receives good treatment. The inductor is sometimes called an "inductor dynamic," but it is really a magnetic unit. An "inductor dynamic" and an "inductor magnetic" are one and the very same thing. The inductor is not generally available as a cabinet-housed speaker, but is as a chassis, with the unit assembled on a spider, with suitable cone. A bracket is built in to make it possible for the chassis to stand on its own feet, or, rather, foot. At an extremely economical outlay it is probably hard, indeed, to excel the inductor, although it will not stand as much gaff as a dynamic. Another speaker on the horizon, but not generally available, is the condenser type. Some demonstrations have been given, and those who say they attended them report the volume poor, which coincides with technical theory that the condenser type of speaker is not inclined to be sensitive even though high voltage is used. However, the verdict on the condenser type will have to await the general distribution of the product among consumers.

* * *

Where the Filament Is

IN a vacuum tube, three elements, where is the filament located, in respect to the grid and plate?—F. E.

The plate is on the outside, the filament on the inside, and the grid is between the plate and filament. Hence the filament is next to the grid.

* * *

Which Comes First?

WHAT is the order of importance in the requirements of a receiver, e. g., selectivity, tone quality, volume and sensitivity? Is there any standard order?—H. S. D.

There is no standard order, but there is a standard of performance for each of these requirements that the Institute of Radio Engineers is trying to popularize, so that some agreed basis of comparison by manufacturers for their own use will be generally recognized. In individual instances of set users, however, an order of priority naturally will arise, determined by location requirements and personal preferences. Some persons would tolerate fair selectivity, in fact, would be so located that no greater selectivity was desired, but would insist on tremendous volume. With them volume would rank first. So the other requirements may be grouped in any order.

* * *

Capacity Feedback

I HAVE tried, without success, to get my circuit to regenerate. It is of the Universal type, that is, with feedback condenser of .00005 mfd. connected from plate of the detector tube to a midtap on the plate winding of the RF tube. What do you suggest?—J. U.

This type of feedback takes place only when the two voltages, the one in the RF tube plate and the one in the detector tube plate, are in phase. Therefore reverse the connections of the extreme ends of the plate winding used in the RF stage, or of the grid winding the feeds the detector. It makes no difference which one you reverse. The object of reversing is to cure the condition of opposing phases, in case that exists. If you do not get any better results one way than another, then look to the following: (1) insufficient maximum capacity of the feedback condenser; (2) poor condition of the detector tube; (3) too high a positive bias on the detector tube, so try the grid return to filament center, through a midtapped resistor of 30 ohms or more, or to negative filament; (4) incorrect detector plate voltage, either too high or too low, the too-high voltage killing regeneration sometimes, due to the paralysis effect; (5) remove any bypass condenser that may be connected from plate of the detector to ground or filament, as this is substantially a short circuit of the regeneration condenser; (6) put a radio frequency choke coil of 85 to 125 millihenries in series with the detector plate, between the joint of plate and regeneration condenser, and the connection to the audio coupler. You are bound to obtain regeneration if you get everything right. That is, the system is infallibly regenerative.

* * *

Gang Condenser Solution

HOW can a tuning condenser of the gang type be used where the respective tuned circuits do not return to the same voltage point, as where the grid circuit of one tube is tuned, the plate circuit of the next tube, etc.? Since the rotor is common, if the coils were connected without regard to this there would be a short circuit.—R. E. W.

The method used to avoid this difficulty is to connect the rotor to the grid return that would be taken by the first tube, which is at ground or a few volts negative, and avoid the short by connecting other tuned windings alone to their required desinations, B plus, etc., with a bypass condenser, 1 mfd. or more, from B plus to the rotor connection. This condenser should be in the receiver, close to the leads to which it connects. Thus the tuned circuit is completed through the bypass condenser, which is of such large capacity as not to affect the tuning characteristics of the variable condenser's sections. To illustrate: The antenna coil would be connected with aperiodic winding to aerial and ground, tuned secondary to stator of one section of the gang, rotor to grounded A minus. The next tuned circuit may be the plate of the first tube, with a high B potential, so connect the plate to one side of the tuned primary coil and to stator of another section of the gang. The return of the plate winding alone is made to B plus. The rotor of the condenser is already at A minus, so put the bypass condenser from B plus lead feeding the plate circuit to A minus. One bypass condenser will serve for multiple circuits provided the gap bridged is the same.

* * *

Conductive Antenna Coil

IS it well to use a conductively coupled antenna coil? How would it be connected? Give winding data.—H. G.

A conductively coupled antenna coil, consisting of a continuous winding, is effective. If aerial and ground are connected to the extreme ends of a single winding, and the usual tuning condenser placed across this winding, the whole band of broadcast wavelengths will not be tuned in, because of the direct introduction of the antenna-ground capacity, often as much as .00025 mfd., in parallel with the tuned circuit. Therefore an aperiodic antenna winding is used, consisting of 14 turns, while for .0005 mfd tuning 50 to 52 turns more are put on. Thus the coil has, say, 64 turns, tapped at the 14th. The diameter is 2½", the wire No. 24 insulated. The antenna is connected to the tap, the ground to the terminal 14 turns away from the antenna post, and the grid to the other terminal. If you are interested in commercial models of such coils, write to Screen Grid Coil Company, 143 West 45th Street, New York, N. Y., and mention RADIO WORLD.

* * *

HB Compact Tuning Curves

PLEASE give tuning pointers on the HB Compact, battery model, so I will know where the stations come in on dials reading 100 maximum and 0 minimum. The prescribed condensers are used, which I understand have a modified straight frequency line of capacity variation.—I. S.

Fig. 784 shows two curves, one for frequencies in kilocycles (kc) and the other for wavelengths in meters (m). The numbers are shown at bottom from 0-100 and from 100-0, so you will have the desired information no matter if your dials read higher numbers for higher frequencies (lower waves) or higher numbers for lower frequencies (higher waves). Note that the curves stop before reaching 0 and 100 in all instances. This shows that the Bernard Dynamic Tuners, with standard tuning condensers, tune above and below the broadcast frequency band, that is, the full band is covered, and more. Note that the midline type of tuning condenser, which you refer to, when used with the Bernard Tuner, produces a frequency line that is astonishingly close to straight, and which is a far better line in that respect than is produced by regulation straight frequency line condensers used with ordinary tuning coils. However, any type of condenser may be used, but the tuning points will not be the same as shown, though the band will be covered.

* * *

Value of R3 is 75,000 Ohms.

FOR the HB Compact, battery model, please state the resistance value of R3, which is in the plate circuit of the 222 screen grid tube used as first stage audio amplifier. I notice that on the diagram this is marked 75,000 ohms, but elsewhere I think I saw it mentioned as .75 meg., which is 750,000 ohms, or ten times as great as was printed on the diagram.—H. D.

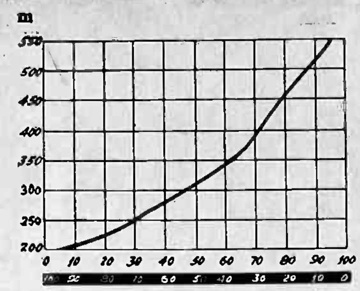
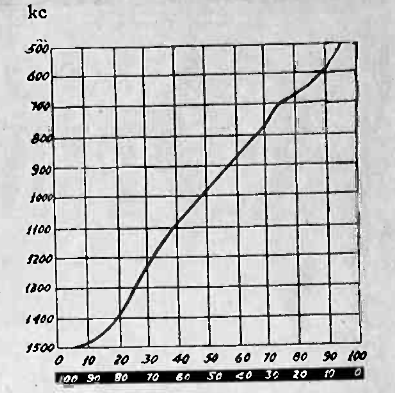


FIG. 784
TUNING CURVES TAKEN WITH BERNARD TUNERS



This resistor is 75,000 ohms (.075 meg.). If you saw this constant given as .75 ohms it certainly was a mistake.

* * *

Condensers on Front Panel

IS it all right to put the tuning condensers on the front panel of the HB Compact, battery model, with the tuning coils in the rear, or must the coils be on the front panel? Is a steel cabinet necessary? Can I not use a bakelite front panel and a wooden subpanel and get as good results?—G. S.

If you have tuning condensers with shafts extending also from the rear, then you may mount the condensers on the front panel, bracket the coils to the subpanel, and connect the front shaft of the coil to the rear shaft of the condenser with a link or flexible coupler. But that will make it harder to follow the pictorial diagram published full size in the August 31st issue. You will get just as good results using a bakelite front panel and a wooden subpanel; but you will have to accommodate the prescribed brackets to the slightly greater elevation of the wooden subpanel. The socketed aluminum subpanel and the steel cabinet are recommended also as being more economical.

* * *

Sensitive and Selective

IS the HB Compact, battery model, very sensitive? How is it in selectivity?—K. J.

It is probably the most sensitive four-tube battery-operated receiver ever designed, and it is adequately selective for all ordinary needs.

OHM'S AND KIRCHOFF

Complex Circuit Problems

By Bryant

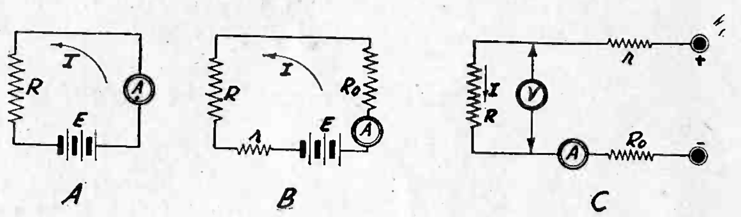


FIG. 1
CIRCUITS ILLUSTRATING THE APPLICATION OF OHM'S LAW

If a battery, a resistance and an ammeter be connected in series, as in Fig. 1A, and the circuit closed, there is a certain deflection of the pointer of that meter. If the emf (voltage) of the battery be doubled, the resistance remaining at its original value, the deflection of the pointer of the ammeter will also be doubled. If the emf be trebled, the deflection will also be multiplied by three. This experiment shows that the current flowing in a circuit of constant resistance is directly proportional to the emf in the circuit. Expressed in symbols the proportion takes the form I = kE, in which I is the current indicated by the meter, E is the emf of the battery and k is a constant the value of which depends on the units in which E and I are measured.

If the resistance in the circuit be doubled, the deflection on the ammeter will be just one-half as it was for the same value of emf as it was previously; and if the resistance be trebled, the deflection will be one-third as great as it was for the same voltage before the resistance was changed. In general, if the resistance be multiplied by a factor n, the deflection will be divided by the same factor, provided the emf in the circuit remains constant. This shows that the current is inversely proportional to the resistance, the voltage remaining constant. Expressed in symbols, the proportion takes the form I = K/R, in which I is the current, R the resistance and K some constant of proportionality depending on the units selected for measuring the resistance and the current.

Holding Current Constant

It is also possible to vary the resistance and the emf in the circuit in such a manner that the deflection on the ammeter remains constant. When this is done it is found that when the emf in the circuit is doubled the resistance must also be doubled to keep the current or deflection constant. In general, if the emf be multiplied by a factor n the resistance must be multiplied by the same factor in order to keep the current constant. In symbols this experimental fact becomes E/R = C, in which E is the emf, R the resistance and C a constant.

These three experiments point to a single relationship among the three elements entering into the problem, namely, E = kIR, in which E is the emf, k some constant depending on the units chosen, I the current, and R the resistance. Now if the emf is measured in volts, the current in amperes, and the resistance in ohms, the constant k is unity by definition of the three units. Then the equation connecting the three quantities becomes E = IR. This is Ohm's law, named for the German physicist, Georg Ohm, who first formulated the law. From this law it is possible to find any one of the three quantities when the two others are known.

While Ohm's law is experimental the most refined tests have failed to reveal any deviations from it, and it has been tested to an accuracy better than one part in 100,000. It holds not only for direct and steady currents but also for alternating and varying currents. However, when varying currents are involved, the impedance must be used in place of the resistance. The impedance used must be that corresponding with the frequency of variation of the emf.

Variation of the the Law

In the case just discussed the emf acting in the circuit and the total resistance were considered. But the law applies to portions of a circuit as well. However, when only a portion of the resistance is taken the potential difference between the terminals of this portion must be used in place of the emf. The potential difference is commonly spoken of as the voltage drop. In Fig. 1B is a circuit in which the acting emf E is that of the battery. There are three different resistances connected in series, R, r and Ro. If Ohm's law is applied to the entire circuit it takes the form E = (R + r + Ro) I, where I is the current forced through the three series resistances by the emf of the battery. This equation can also be written E = RI + rI + RoI, which can be interpreted as follows: The emf in a circuit is equal to the sum of all the voltage drops in the circuit. The truth of this is axiomatic.

In Fig. 1C the circuit has been drawn slightly different manner. Somewhere to the right of the two open terminals there is a source of emf, such as a battery or a B battery eliminator, and there may be many resistors in series not shown. A current I flows through the circuit and this will be indicated by the ammeter A. A potential meter, that is, a voltmeter which draws no current, is connected across the main resistance R. This meter shows the potential difference between the ends of R, or the voltage drop in R. When Ohm's law is applied this portion of the circuit it is V = IR, where V is the voltage drop in volts. If the potential meter is connected across r it may show a potential difference of v volts. Then we have v = rI. Similarly for Ro we have Vo = RoI.

Applications of Ohm's Law

Ohm's law is the basis of the quantitative solution of all circuit problems and it is applied constantly. A few examples will help to show its use. We know that the filament terminal voltage of a certain tube is 5 volts and that the current is .25 ampere. What is the resistance of the filament under operating conditions? In this case E, or V, is equal to 5, and I is equal to .25. Therefore by Ohm's law we have 5 = .25R, or the resistance is 20 ohms. Again, suppose that we have a resistance of 1,000 ohms and we connect a battery of 45 volts across it. What current will flow in the circuit? Would it be safe to connect a 0-10 milliammeter in series with the battery and the resistance? In this case the emf E is 45 volts and the resistance R is 1,000 ohms. By Ohm's law we have 45 = 1,000I. Therefore I is equal to .045 ampere, or 45 milliamperes. It would not be safe to connect a 0-10 milliammeter in the circuit.

Just how much resistance would be required in series with the battery to make it safe to connect a 0-10 milliammeter in this circuit? In this problem we know the emf E and the current I. The current is the maximum reading of the milliammeter. Hence by Ohm's law we have 45=.01R, whence the value of the resistance is 4,500 ohms.

Suppose we have a battery-operated screen-grid tube in which the filament current is .132 ampere and we wish to put a resistor in the negative leg to obtain a bias of 1.5 volts. Here we have the value of V equals 1.5 volts and the value of I equals .132 ampere. Then by Ohm's law we have 1.5=.132R, whence R is 11.36 ohms. Again suppose that we have a push-pull amplifier stage composed of two 245 tubes requiring a bias of 50 volts. The plate current under normal conditions of these tubes is .064 ampere. Hence we have 50=.064R. Therefore R should be 781 ohms.

One useful application of Ohm's law is to voltmeters. Suppose we have a 0-1 milliammeter and desire to use this as the indicator in a voltmeter. The instrument will be one of 1,000 ohms per volt, which is determined by the range of the milliammeter. The maximum current that this meter can take is one milliampere and we take that as the value of I. Let the desired range of the voltmeter be 750 ohms. What value of resistance should be connected in series with the milliammeter? We have the equation 750=.001R, whence R must be 750,000 ohms. Other ranges can be obtained by using other values of resistors. Since the instrument has a sensitivity of 1,000 ohms per volt, there must be 1,000 ohms for every volt on the scale.

Kirchhoff's Laws

Although there are innumerable applications of Ohm's law, there are many circuit problems which cannot be solved by means of it. If the circuit is not simple but consists of a com-

's Laws Expounded

lved Easily by Their Use

Iolworthy

plex network of different resistances, Ohm's law cannot be applied unless the current in each resistance is measured as well as the potential difference between the terminals of each resistance. This is not practical and sometimes it is not even possible. In such complex cases we have recourse to Kirchhoff's laws, which are two in number.

The first of these laws states that the sum of the voltage drops in any mesh in the network is equal to the sum of the emfs in that mesh. In applying this law, the signs of both the currents and the emfs must be taken into account, so that if there is no emf in the mesh the sum of the voltage drops is zero.

The meaning of the first law of Kirchhoff is illustrated in Fig. 2A. This circuit is a type of current attenuator consisting of eight different resistances and a single source of emf, or battery. Generally, no two resistors carry the same current, and no two resistors have the same potential difference between their terminals, except R5 and R7.

There are many meshes in the network, but not all the possible ones are independent. The first mesh contains the emf E and the resistances Ro and R1. Another mesh contains the resistances R1, R2 and R3, but no emf. Still another contains R2, R4 and R6, but no emf.

The currents in the various resistances have been indicated by I, with a subscript corresponding with the subscript of the resistance. The directions of the currents have also been indicated. These directions are those which one would expect from the polarity of the battery. In solving this particular network for the currents they would all come out positive. However, it is not at all necessary to assume that they flow in the directions indicated. The directions may be assumed arbitrarily just so the first Io is assumed correctly. If in the solution any current turns out to be negative, the current flows in the direction opposite to that assumed.

Direction of Summation

In summing up the voltage drops in any mesh one should proceed progressively around it, preferably in the direction of the majority of the currents. The product of any R and I in the direction of summation is positive and the product of any R and I against the current is negative. This is true whether or not the directions have been assumed correctly. The algebraic sum of the voltage drops is, by Kirchhoff's first law, equal to the algebraic sum of the emfs.

Take for example the first mesh in the network. The emf is equal to E, and it is positive. Going around the mesh in the clockwise direction, we first come to Ro, from which we get RoIo, a positive voltage drop. Then we encounter R1, from which we get R1I1, which is also positive. There is no other resistance in the mesh. Hence E=RoIo+R1I1.

In the next mesh current I2 and I3 flow in the clockwise direction and therefore the summation will be taken in this direction. There are three resistors in the mesh and the three voltage drops are R2I2, R3I3 and —R1I1. The third is negative because in going around the mesh in the clockwise direction we go against I1. Since there is no emf in this mesh, we have by Kirchhoff's first law R2I2+R3I3—R1I1=0.

The voltage drop summation in the other meshes is done exactly the same way. It is clear that Kirchhoff's first law is really an extension of Ohm's law.

Kirchhoff's Second Law

The second law of Kirchhoff states the algebraic sum of all the currents that flow to the junction of two or more conductors is equal to zero. This is simply a mathematical statement that current cannot pile up at a point. The law may also be stated that the sum of all the currents that flow to the point is equal to the sum of all the currents that flow away from the same point. There is no discrepancy between the two statements because a current that flows away from the point in question is negative when considered algebraically as flowing to that point.

Consider the point P in Fig. 2A, at which four conductors meet. Four currents flow to that point, but three of them are negative, for they actually flow away from it. By Kirchhoff's second law we have I0—I1—I2—I6=0, or I0=I1+I2+I6. Another point where four currents "converge" is S. Here we have I6+I4—I5—I7=0, or I6+I4=I5+I7.

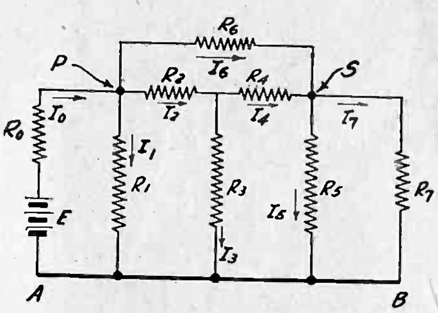


FIG. 2A

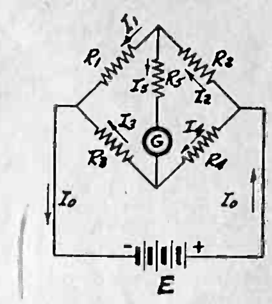


FIG. 1B

CIRCUITS ILLUSTRATING KIRCHHOFF'S LAWS.

If the line AB is a heavy conductor so that the voltage drop in it is negligible, the entire line can be considered as a point, which is the junction of five conductors. Four of the currents flow toward this point and one flows away. Hence we have I0=I1+I3+I5+I7.

If the emf E and all the resistors in the network of Fig. 2A are known, all the currents can be determined by Kirchhoff's two laws. As there are eight currents in this particular circuit, there must be eight independent conditions, or equations, for solving the problem. Five of these conditions are obtained by summing up the voltage drops in the five independent meshes in the network clearly shown in the circuit. The remaining three conditions are obtained by summing up the currents that flow to three of the junction points. These three equations are those given in the preceding paragraph.

These eight simultaneous equations can be solved by any one of several well-known methods in algebra. In any network there will be as many equations as there are currents to be found.

The Wheatstone Bridge

Kirchhoff's laws are used for solving the circuit network known as a Wheatstone bridge, which is shown in Fig. 2B. This circuit is used for measuring unknown resistances in terms of a known resistance and of a known ratio of two resistances. The bridge consists of four resistors connected electrically in the form of a square, with a battery E connected diagonally between two opposite corners and a galvanometer G between the other two corners.

When the battery circuit is closed, there will in general be a current in every branch of the network, and all the currents will be different, except under certain conditions. Suppose the current I5 through the galvanometer is zero. Then it is clear that I1 equals I2, and that I3 equals I4. Also, if I5 is zero, it is clear that the potential difference between the upper and lower corners of the bridge is zero. Therefore we have the following relations: R1I1=R3I3 and R2I2=R4I4. Divide the first of these equations by the second, member for member, remembering that I1 equals I2 and I3 equals I4. Then we have R1/R2=R3/R4, a relation which must exist among the four resistances in order that no current shall flow through the galvanometer or bridge circuit. If R1 is unknown and if the ratio of R3 to R4 is known, then R2 can be adjusted until no current flows in the galvanometer, when R1=R2 (R3/R4) gives the value of R1.

The same equation can be obtained by making use of Kirchhoff's laws explicitly. The first law can be applied to the two triangular meshes and the mesh involving R1, R2 and the battery E. The second law can be applied to the upper and lower vertices of the square. The resulting five equations are solved for I5, which is then equated to zero. This yields directly R1R4—R2R3=0, which is the same as the equation expressed in the ratio form above.

RADIO WORLD

The First and Only National Radio Weekly

Eighth Year

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The Big Show

THE Sixth Annual Radio World's Fair is big business, bigger business than any of its five predecessors.

When the first Show was held, in 1924, the teeming crowds in attendance gave many their first intimation that radio had won public approval, and was on the way to becoming one of the necessary luxuries. Since then it has become a luxurious necessity.

Now one does not stare at the many thousands that daily attend the Radio Show, as the public calls it, during the entire week of its brilliant life at Madison Square Garden.

The object of the Show is exhibition, not selling. The manufacturers quietly take some orders, to be sure, but not so discreetly do they exhibit and extol their wares, and the lay public tries to absorb as much of the information as possible, despite the double handicap that the lay public does not understand fully the language that is spoken, any more than do the salesmen who for the most part do the speaking. Every salesman at the Show has the right to seek technical redress from the manufacturers' technical experts, if he has the detective ability to locate them.

Now the Show has become mostly a matter of sets, whereas in 1924 mostly parts manufacturers engaged the booths. There is still a large parts business left, some $40,000,000 a year, with fewer parts manufacturers to divide this business among them, and with a younger generation showing an intense interest in radio technique and promising to provide a still more substantial parts market in years to come, while not trivially contributing to it even now.

This juvenile interest not only deserves stimulation but requires it. Largely from the ranks of these radio-minded juveniles of to-day will come the radio engineers of to-morrow. It is surprising how well informed some of these youngsters are. They learn something about radio at public school, more at high school, and attend outside courses, and it is no uncommon thing to hear a thirteen-year-old boy talk familiarly about the phase angle difference in an inductive-capacitive circuit and the plate load reactance, and even doubt the efficacy of some circuit design offered by a reputable engineer in a learned periodical. More power to the young doubter, for he will be the adult doer soon enough!

Television has captured the imagination of the juveniles even while defeating their ambition of succeeding at it presently, a defeat shared sufficiently by their elders! Some adults have said that television is just around the corner. Well, the youngsters always did like the corners!

The Fascination of Experimenting

THERE is every incentive to experiment with radio hookups. Besides constituting a joyous hobby, it appeals constantly to one's imagination. One is forever pursuing an idea. It is never reached, but that is true of every ideal. One may say that anything ideal is divine, for certainly its attainment would require perfection, and there are signs all along the path of life constantly reminding man of his imperfections. George Bernard Shaw probably never saw one of those signs, but mortal eyes can never avert them.

It has been characteristic of most circuits offered to individual constructors in recent years that they do not appeal much to the experimental side of one's nature. Persons sometimes are impelled to shun anything offered as experimental, perhaps because circuits and sets touted as the last word in radio have not always been so incinerative, hence admission of the existence of an experimental feature may be thought of as condemning the whole works.

Circuits and sets the world over are becoming more and more machine-like, less and less individual. In fact, sameness attends many of them. With circuits, as with books, paintings, houses, or tailoring, peculiarly meritorious attainment is possible, but not without somebody's hard work. If nothing experimental is offered in a circuit, no particular harm is done. A certain standard of performance is achieved as a steady average, and like all averages, a penalty attaches. This penalty is a lowered standard of performance and it is paid to gain freedom from disappointment in performance. Selling something and making it stay sold merge into the same problem.

Nevertheless, individual builders of receivers certainly must welcome suggestions for achieving extraordinary performance in sensitivity, volume and tone realism. It is entirely wholesome to present a circuit of this nature, with the frank statement of the experimental feature, provided a standardized solution is offered as ever available to those stumped in trying to make the extraordinary experiment work. One may fall back upon the standard at no loss whatever, just as the plucky swimmer is none the worse off for having failed to swim the English Channel. He can still go by boat from Dover to Calais.

Somebody has to think and work, so that experimental circuits may still attract the vital interest of those who yearn to outdo the conventional and undo the commonplace. A certain iconoclastic spirit does not necessarily mean contempt for the acknowledged easy ways, nor a penchant for sheer destruction. It may denote, and often does denote, a healthy impatience with the average results. Extraordinary feats, especially wherein one is a participant, even if as a mountain-climber following a guide to scale some new peaks, is ever an irresistible challenge to the adventurous spirit of mankind.

The circuit experiment must not be futile. It may be not altogether easy of successful performance, but it must have a technological substantiality. Others must have emerged to new vistas of attainment by the proposed path, even though the concomitant warning to followers is that the going may prove rough. And, again, the bus will take you to some destination not ridiculously remote, and over the concrete State road, for a nickel!

The technical radio press has lacked something of the experimental excitement that was prevalent three years ago and longer ago. It can not be denied that interest in that very press has declined in the same period. The constant requirement for producing something not only new but superior has been exacting, and for some fatally exacting. Those periodicals that have passed out or changed their garb may be suspected of having expired of circuitous anæmia or of having moved into a new field for lack of strength to cultivate the old and hard one. Certain it is that the enthusiasm to experiment is with us from childhood to second childhood, and that substantial, even though alluring promises will continue rightfully to inspire us to new efforts. Extinction of the hope of attaining something extraordinary is a ruthless trampling upon the progressive spirit.

It's Play

IS IT "play" to listen in? Not quite, in the opinion of Stuart Chase, who contributes the chapter on "Play" to the panorama of modern civilization entitled, "Whither Mankind," a thought-provoking volume by specialists that stirs up more than one pot of intellectual porridge.

Citing that of an evening 30,000,000 persons in the United States may be listening in, Mr. Chase immediately proceeds to divest the young giant of radio of his play raiment:

"Once a singer sang a song," he writes. "Conceivably he enjoyed it, and so his singing was play. That song was heard by an audience, who watched the singer, watched his lips, watched his movements, caught something of his spirit, and also conceivably enjoyed it—but at one remove; the audience did not itself sing. The song meanwhile, with the utmost scientific ingenuity, was inscribed upon a plate of composition material, and by running a sharp instrument over that material it could be reproduced, and still enjoyed—at two removes from reality. The plate and the sharp instrument are finally set down in front of a radio broadcaster. Not 30,000,000 people, but a solid fraction of them, are, as they turn the knobs, listening to a song which one machine has caught from another machine, which was caught, lidless and blind, by the first machine from a more or less bored singer vocalizing into its dead, impersonal face. And those of us who hear this song, while we are indeed 'playing' the radio, are not playing as the Rock Veddahs, and the Athenians, define the term. We are not playing ourselves; we are being played to—and at three removes from the original."

It would be easy for all to agree that listening in is play or is not play, if all could agree on a definition of play. There is a debate, as Mr. Chase points out, as to whether play is an instinct, but he says there is a concensus that play is a vital principle to the growth of children, and, as to adults, is a major necessity not far below hunger and mating. Play is certainly an exceptional activity, and derives its distinction from work in the fact of differentiation from required activity. In only certain minor instances compulsory activity is play because of coincidence of keen desire with the requirement to perform the activity that appeases that impulse.

Since radio provides mostly song, instrumental music, plays and continuities, although informatory and educational programs are growing, one can not well deny that listening in is play, nor is it fair to attempt to bolster up a denial with the insinuation that radio consists largely of broadcasting phonograph records. When the author says that 30,000,000 persons listen in of a night, he says, although he seems not to realize it, that listening in is play. You could not get 30,000,000 persons to listen in one night a year, much less nightly, if listening in were work!

Alphabetical List of Stations by Call Letters; Location and Frequency

[FROM FEDERAL RADIO COMMISSION LIST REVISED UP TO NOON, SEPTEMBER 11th]

Station Location Frequency
WAAF—Chicago, Ill., 920
WAAM—Newark, N. J., 1250
WAAT—Jersey City, N.J., 1070
WAAW—Omaha, Nebr., 660
WABC-WBOQ—N.Y. City, 860
WABI—Bangor, Me., 1200
WABZ—New Orleans, La., 1200
WADC—Akron, O., 1320
WAGM—Royal Oak, Mich., 1310
WAIU—Columbus, O., 640
WAPI—Birmingham, Ala., 1140
WASH—Gd. Rapids, Mich., 1270
WBAK—Harrisburg, Pa., 1430
WBAL—Baltimore, Md., 1060
WBAP—Fort Worth, Tex., 800
WBAW—Nashville, Tenn., 1490
WBAX—Wilkes-Barre, Pa., 1210
WBBC—Brooklyn, N. Y., 1400
WBBL—Richmond, Va., 1370
WBBM-WJBT—Chicago, Ill., 770
WBBR—Rossville, N. Y., 1300
WBBY—Charleston, S. C., 1200
WBBZ—Ponca City, Okla., 1200
WBCM—Bay City, Mich., 1410
WBIS—See WNAC
WBMS—Fort Lee, N. J., 1450
WBNY—New York, N. Y., 1350
WBOQ—See WABC
WBOW—Terre Haute, Ind., 1310
WBRC—Birmingham, Ala., 930
WBRE—Wilkes-Barre, Pa., 1310
WBRL—Tilton, N. H., 1430
WBSO—Wellesley H., Mass., 780
WBT—Charlotte, N. C., 1080
WBZ—Springfield, Mass., 990
WBZA—Boston, Mass., 990
WCAC—Storrs, Conn., 600
WCAD—Canton, N. Y., 1220
WCAE—Pittsburgh, Pa., 1220
WCAH—Columbus, Ohio, 1430
WCAJ—Lincoln, Nebr., 590
WCAL—Northfield, Minn., 1250
WCAM—Camden, N. J., 1280
WCAO—Baltimore, Md., 600
WCAP—Asbury Pk., N. J., 1280
WCAT—Rapid City, N.D., 1200
WCAU—Philadelphia, Pa., 1170
WCAZ—Carthage, Ill., 1070
WCBA—Allentown, Pa., 1440
WCBD—Zion, Ill., 1080
WCBM—Baltimore, Md., 1370
WCBS—Springfield, Ill., 1210
WCCO—Minneapolis, Minn., 810
WCDA—Cliffside, Pk., N.J., 1350
WCFL—Chicago, Ill., 970
WCGU—Coney Island, N.Y.,1400
WCKY—Covington, Ky., 1480
WCLB—Lg. Beach, N.Y., 1500
WCLO—Kenosha, Wis., 1200
WCLS—Joliet, Ill., 1310
WCMA—Culver, Ind., 1400
WCOA—Pensacola, Fla., 1120
WCOC—Columbus, Miss., 880
WCOH—Yonkers, N.Y., 1210
WCRW—Chicago, Ill., 1210
WCSH—Portland, Maine, 940
WCSO—Springfield, O., 1380
WDAE—Tampa, Fla., 620
WDAF—Kansas City, Mo., 610
WDAG—Amarillo, Tex., 1410
WDAH—El Paso, Tex., 1310
WDAY—W. Fargo, N. D., 1280
WDBJ—Roanoke, Va., 930
WDBO—Orlando, Fla., 620
WDEL—Wilmington, Ind., 1120
WDGY—Minneapolis, Minn., 1180
WDOD—Chattanooga, Tenn., 1280
WDRC—New Haven, Conn.,1330
WDSU—New Orleans, La., 1270
WDWF-WLSI—Cr'nst'n,R.I.1210
WDZ—Tuscola, Ill., 1070
WEAF—New York, N.Y., 660
WEAI—Ithaca, N. Y., 1270
WEAN—Providence, R.I., 780
WEAO—Columbus, O., 550
WEAR—Cleveland, O., 1070
WEBC—Duluth, Minn., 1280
WEBE—Cambridge, O., 1210
WEBQ—Harrisburg, Ill., 1210
WEBR—Buffalo, N. Y., 1310
WEBW—Beloit, Wis., 600
WEDC—Chicago, Ill., 1210
WEDH—Erie, Pa., 1420
WEEI—Weymouth, Mass., 590
WEHS—Evanston, Ill., 1310
WELK—Phila, Pa., 1370
WEMC—Berrien Spgs., Mch. 590
WENR-WBCN—Chicago, Ill., 870
WEPS—Gloucester, Mass., 1200
WEVD—New York, N. Y., 1300
WEW—St. Louis, Mo., 760
WFAA—Dallas, Texas, 1040
WFAN—Philadelphia, Pa., 610
WFBC—Knoxville, Tenn., 1200
WFBG—Altoona, Pa., 1310
WFBJ—Collegeville, Minn., 1370
WFBL—Syracuse, N. Y., 900
WFBM—Indianapolis, Ind., 1230
WFBR—Baltimore, Md., 1270
WFDF—Flint, Mich., 1310
WFI—Philadelphia, Pa., 560
WFIW—Hopkinsville, Ky., 940
WFJC—Akron, O., 1450
WFKD—Philadelphia, Pa., 1310
WFLA-WSUN—Clrw'tr Fla, 900
WGAL—Lancaster, Pa., 1310
WGBB—Freeport, N. Y., 1210
WGBC—Memphis, Tenn., 1430
WGBF—Evansville, Ind., 630
WGBI—Scranton, Pa., 880
WGBS—New York City, 1180
WGCM—Gulfport, Miss., 1210
WGCP—Newark, N. J., 1250

Station Location Frequency
WGES—Chicago, Ill., 1360
WGH—Newport News, Va., 1310
WGHP—Detroit, Mich., 1240
WGL—Ft. Wayne, Ind., 1370
WGMS—See WLB-WGMS
WGN-WLIB—Elgin, Ill., 720
WGR—Buffalo, N. Y., 550
WGST—Atlanta, Ga., 890
WGY—Schenectady, N. Y., 790
WHA—Madison, Wis., 940
WHAD—Milwaukee, Wis., 1120
WHAM—Rochester, N. Y., 1150
WHAP—N. Y. City, 1300
WHAS—Louisville, Ky., 820
WHAZ—Troy, N. Y., 1300
WHB—Kansas City, Mo., 950
WHBC—Canton, Ohio, 1200
WHBD—Bellefontaine, O., 1370
WHBF—Rock Island, Ill., 1210
WHBL—Sheboygan, Wis., 1410
WHBP—Johnstown, Pa., 1310
WHBQ—Memphis, Tenn., 1370
WHBU—Anderson, Ind., 1210
WHBW—Philadelphia, Pa., 1500
WHBY—W. De Pere, Wis., 1200
WHDF—Calumet, Mich., 1370
WHDH—Gloucester, Mass., 830
WHDI—Minneapolis, Minn. 1180
WHDL—Tupper Lake, N.Y.,1420
WHEC-WABO-Roch'st'r,NY.1440
WHFC—Cicero, Ill., 1310
WHIS—Bluefield, W. Va., 1420
WHK—Cleveland, Ohio, 1390
WHN—New York, N.Y., 1010
WHO—Des Moines, Ia., 1000
WHP—Harrisburg, Pa., 1430
WIAS—Ottumwa, Iowa, 1420
WIBA—Madison, Wis., 1210
WIBG—Elkins, Park, Pa., 930
WIBM—Jackson, Mich., 1370
WIBO—Chicago, Ill., 570
WIBR—Steubenville, O., 1420
WIBS—Elizabeth, N. J., 1450
WIBU—Poynette, Wis., 1310
WIBW—Topeka, Kan., 1300
WIBX—Utica, N. Y., 1200
WICC—Bridgeport, Conn., 1190
WIL—St. Louis, Mo., 1200
WILL—Urbana, Ill., 890
WILM—Wilmington, Del., 1420
WINR—Bay Shore, N. Y., 1210
WIOD—Miami Beach, Fla., 560
WIP—Philadelphia, Pa., 610
WISN—Milwaukee, Wis., 1120
WJAD—Waco, Texas, 1240
WJAG—Norfolk, Nebr., 1060
WJAK—Kokomo, Ind., 1310
WJAR—Providence, R.I., 890
WJAS—Pittsburgh, Pa., 1290
WJAX—Jacksonville, Fla., 1260
WJAY—Cleveland, Ohio, 620
WJAZ—Chicago, Ill., 1480
WJBC—La Salle, Ill., 1200
WJBI—Red Bank, N. J., 1210
WJBK—Ypsilanti, Mich., 1370
WJBL—Decatur, Ill., 1200
WJBO—New Orleans, La., 1370
WJBU—Lewisburg, Pa., 1210
WJBW—New Orleans, La., 1200
WJBY—Gadsden, Ala., 1210
WJDW—Emory, Va., 1370
WJDX—Jackson, Miss., 1270
WJDZ—W. Salem, N. C., 1310
WJJD—Mooseheart, Ill., 1130
WJKS—Gary, Ind., 1360
WJR—Detroit, Mich., 750
WJSV—Mt.Vernon Hills,Va., 1460
WJW—Mansfield, O., 1210
WJZ—New York, N. Y., 760
WKAQ—San Juan, P. R., 890
WKAR—E. Lansing, Mich., 1040
WKAV—Laconia, N. H., 1310
WKBB—Joliet, Ill., 1310
WKBC—Birmingham, Ala., 1310
WKBF—Indianapolis, Ind., 1400
WKBH—La Crosse, Wis., 1380
WKBI—Chicago, Ill., 1310
WKBN—Youngstown, O., 570
WKBO—Jersey City, N.J., 1450
WKBP—Battle Creek, Mch.,1420
WKBQ—New York, N. Y., 1350
WKBS—Galesburg, Ill., 1310
WKBV—Brookville, Ind., 1500
WKBW—Buffalo, N. Y., 1470
WKBZ—Ludington, Mich., 1500
WKEN—Buffalo, N. Y., 1040
WKJC—Lancaster, Pa., 1200
WKRC—Cincinnati, O., 550
WKY—Okla. City, Okla., 900
WLAC—Nashville, Tenn., 1490
WLAP—Louisville, Ky., 1200
WLB-WGMS—Minneapolis, 1250
WLBC—Muncie, Ind., 1310
WLBF—Kansas City, Mo., 1420
WLBG—Ettrick, Va., 1200
WLBL—Stevens Pt., Wis., 900
WLBW—Oil City, Pa., 1260
WLBX—L. I. City, N.Y., 1500
WLBZ—Bangor, Maine, 620
WLCI—Ithaca, N. Y., 1210
WLEX—Lexington, Mass., 1360
WLEY—Lexington, Mass., 1420
WLIB-WGN—See WGN-WLIB
WLIT—Philadelphia, Pa., 560
WLOE—Chelsea, Mass., 1500
WLS—Chicago, Ill., 870
WLSI-WDWF—See WDWF
WLTH—Brooklyn, N. Y., 1400
WLW—Mason, Ohio, 700
WLWL—New York, N. Y., 1100
WMAC—Cazenovia, N. Y., 570
WMAF—Dartmouth, Mass. 1360
WMAK—Buffalo, N. Y., 900

Station Location Frequency
WMAL—Washington, D.C., 630
WMAN—Columbus, Ohio, 1210
WMAQ—Chicago, Ill., 670
WMAZ—Macon, Ga., 890
WMBA—Newport, R. I., 1500
WMBC—Detroit, Mich, 1420
WMBD—Peoria Hts., Ill., 1440
WMBG—Richmond, Va., 1210
WMBH—Joplin, Mo., 1420
WMBI—Addison, Ill., 1080
WMBJ—Pittsburgh, Pa., 1500
WMBL—Lakeland, Fla., 1310
WMBO—Auburn, N. Y., 1370
WMBQ—Brooklyn, N. Y., 1500
WMBR—Tampa, Fla., 1210
WMC—Memphis, Tenn., 570
WMCA—New York, N.Y., 570
WMES—Boston, Mass., 1500
WMMN—Fairmont, W. Va., 890
WMPC—Lapeer, Mich., 1500
WMRJ—Jamaica, N. Y., 1420
WMSG—New York, N. Y., 1350
WMT—Waterloo, Iowa, 1200
WNAC-WBIS—Boston, 1230
WNAD—Norman, Okla., 1010
WNAT—Philadelphia, Pa., 1310
WNAX—Yankton, S. D., 570
WNBF—Binghamton, N.Y., 1500
WNBH—N'w Bedf'rd, Mass.,1310
WNBJ—Knoxville, Tenn., 1310
WNBO—Washington, Pa., 1200
WNBR—Memphis, Tenn., 1430
WNBW—Carbondale, Pa., 1200
WNBX—Springfield, Vt., 1200
WNBZ—Saranac Lk., N.Y. 1290
WNJ—Newark, N. J., 1450
WNOX—Knoxville, Tenn., 560
WNRC—Greensboro, N.C., 1440
WNYC—New York, N.Y., 570
WOAI—San Antonio, Tex., 1190
WOAN—Lawrenceburg, Tenn. 600
WOAX—Trenton, N. J., 1280
WOBT—Union City, Tenn., 1310
WOBU—Charlestown, W.Va., 580
WOC—Davenport, Ia., 1000
WOCL—Jamestown, N. Y., 1210
WODA—Paterson, N. J., 1250
WOI—Ames, Iowa, 560
WOK-WMBB—See WMBB
WOKO—Poughkeepsie, NY., 1440
WOL—Washington, D.C., 1310
WOMT—Manitowoc, Wis., 1210
WOOD—Gd. Rapids, Mich., 1270
WOQ—Kansas City, Mo., 610
WOR—Newark, N. J., 710
WORC—Auburn, Mass., 1200
WORD—Chicago, Ill., 1480
WOS—Jefferson City, Mo., 630
WOV—New York, N.Y., 1130
WOW—Omaha, Nebr., 590
WOWO—Ft. Wayne, Ind., 1160
WPAP-WQAO—See WQAO
WPAW—Pawtucket, R.I., 1210
WPCC—Chicago, Ill., 570
WPCH—New York, N.Y., 810
WPEN—Philadelphia, 1500
WPG—Atlantic City, N.J.,1100
WPOE—Patchogue, N. Y., 1420
WPOR-WTAR—See WTAR
WPRC—Harrisburg, Pa., 1200
WPSC—State College, Pa., 1230
WPTF—Raleigh, N. C., 680
WQAM—Miami, Fla., 1240
WQAN—Scranton, Pa., 880
WQAO-WPAP—N.Y.C., 1010
WQBC—Utica, Miss., 1360
WQBZ—Weirton, W.V., 1420
WRAF—LaPorte, Ind., 1200
WRAK—Erie, Pa., 1370
WRAW—Reading, Pa., 1310
WRAX—Philadelphia, Pa., 1020
WRBC—Valparaiso, Ind., 1240
WRBI—Tifton, Ga., 1310
WRBJ—Hattiesburg, Miss., 1500
WRBL—Columbus, Ga., 1200
WRBQ—Greenville, Miss., 1210
WRBT—Wilmington, N. C., 1370
WRBU—Gastonia, N.C., 1210
WRC—Washington, D. C., 950
WREC—Memphis, Tenn., 600
WREN—Lawrence, Kans., 1220
WRHM—Friedley, Minn., 1250
WRJN—Racine, Wis. 1370
WRK—Hamilton, Ohio, 1310
WRNY—New York, N.Y., 1010
WRR—Dallas, Tex., 1280
WRUF—Gainesville, Fla., 1470
WRVA—Richmond, Va., 1110
WSAI—Cincinnati, O., 1330
WSAJ—Grove City, Pa., 1310
WSAN—Allentown, Pa., 1440
WSAR—Fall River, Mass., 1450
WSAZ—Huntington, W.V., 580
WSB—Atlanta, Ga., 740
WSBC—Chicago, 1210
WSBT—South Bend, Ind., 1230
WSDA-WSGH—See WSGH
WSGH-WSDA—Bklyn.,NY. 1400
WSGP—Savannah, Ga., 1410
WSIX—Springfield, Tenn., 1210
WSM—Nashville, Tenn., 650
WSMB—New Orleans, La., 1320
WSMK—Dayton, Ohio, 570
WSOA—Deerfield, Ill., 1480
WSPD—Toledo, Ohio, 1340
WSSH—Boston, Mass., 1420
WSUI—Iowa City, Ia., 580
WSUN-WFLA—See WFLA
WSVS—Buffalo, N. Y., 1370
WSYR—Syracuse, N. Y., 570
WTAD—Quincy, Ill., 1440
WTAG—Worcester, Mass., 580
WTAM—Cleveland, O., 1070

Station Location Frequency
WTAQ—Eau Claire, Wis., 1330
WTAR-WPOR—Norf'lk, Va., 780
WTAW—College Station, 1120
WTAX—Streator, Ill., 1210
WTBO—Cumberland, Md., 1420
WTFI—Toccoa, Ga., 1450
WTIC—Avon, Ct., 600, 1060
WTMJ—Milwaukee, Wis., 620
WWAE—Hammond, Ind., 1200
WWJ—Detroit, Mich., 920
WWL—New Orleans, La., 850
WWNC—Asheville, N. C., 570
WWRL—Woodside, N.Y., 1500
WWVA—Wheeling, W.Va., 1160
KCRC—Enid, Okla., 1370
KDB—Santa Barbara, Cal.,1500
KDKA—Pittsburgh, Pa., 980
KDLR—Devils Lake, N.D., 1210
KDYL—Salt Lake, Utah, 1290
KEJK—Beverly Hills, Calif., 1170
KELW—Burbank, Calif., 780
KEX—Portland, Ore., 1180
KFAB—Lincoln, Nebr., 770
KFAD—Phoenix, Ariz., 620
KFBB—Great Falls, Mont., 1360
KFBK—Sacramento, Calif., 1310
KFBL—Everett, Wash., 1370
KFDM—Beaumont, Tex., 560
KFDY—Brookings, S.Dak., 550
KFEL—Denver, Colo., 940
KFEQ—St. Joseph, Mo., 560
KFGQ—Boone, Iowa, 1310
KFH—Wichita, Kans., 1300
KFHA—Gunnison, Colo., 1200
KFI—Los Angeles, Calif., 640
KFIF—Portland, Ore., 1420
KFIO—Spokane, Wash., 1230
KFIZ—Fond du Lac, Wis., 1420
KFJB—Marshalltown, Ia., 1200
KFJF—Okla. City, Okla., 1470
KFJI—Astoria, Ore., 1370
KFJM—Gd. Forks., N.D., 1370
KFJR—Portland, Ore., 1300
KFJY—Fort Dodge, Iowa, 1310
KFJZ—Fort Worth, Tex., 1370
KFKA—Greeley, Colo., 880
KFKB—Milford, Kans., 1050
KFKU—Lawrence, Kans., 1220
KFKX-KYW—See KYW
KFKZ—Kirksville, Mo., 1200
KFLV—Rockford, Ill., 1410
KFLX—Galveston, Tex., 1370
KFMX—Northfield, Minn., 1250
KFNF—Shenandoah, Iowa, 890
KFOR—Lincoln, Nebr., 1210
KFOX—Long Beach, Calif, 1250
KFPL—Dublin, Tex., 1310
KFPM—Greenville, Tex., 1310
KFPW—Siloam Spgs., Ark.,1340
KFPY—Spokane, Wash., 1390
KFQA-KMOX—See KMOX
KFQD—Anchorage, Alaska, 1230
KFQU—Holy City, Calif., 1420
KFQW—Seattle, Wash., 1420
KFQZ—Hollywood, Calif., 860
KFRC—San Francisco, Cal., 610
KFRU—Columbia, Mo., 630
KFSD—San Diego, Calif., 600
KFSG—Los Angeles, Calif., 1120
KFUL—Galveston, Tex., 1290
KFUM—Colo. Springs, Col.,1270
KFUO—Clayton, Mo., 550
KFUP—Denver, Colo., 1310
KFVD—Culver City, Calif., 710
KFVS—Cape Girardeau, Mo.1210
KFWB—Hollywood, Calif., 950
KFWC—S. Pomona, Calif., 1200
KFWF—St. Louis, Mo., 1200
KFWI—San Francisco, Cal., 930
KFWM—Oakland, Calif., 930
KFXD—Jerome, Idaho, 1420
KFXF—Denver, Colo., 940
KFXJ—Edgewater, Colo., 1310
KFXR—Okla. City, Okla., 1310
KFXY—Flagstaff, Ariz., 1420
KFYO—Abilene, Tex., 1420
KFYR—Bismarck, N.D., 550
KGA—Spokane, Wash., 1470
KGAR—Tuscon, Ariz., 1370
KGB—San Diego, Calif., 1360
KGBU—Ketchikan, Alaska, 900
KGBX—St. Joseph, Mo., 1370
KGBZ—York, Nebr., 930
KGCA—Decorah, Iowa, 1270
KGCI—San Antonio, Tex., 1370
KGCR—Watertown, S.D., 1210
KGCU—Mandan, N. D., 1200
KGCX—Vida, Mont., 1420
KGDA—Dell Rapids, S.D., 1370
KGDE—Fergus Falls, Minn,1200
KGDM—Stockton, Calif., 1100
KGDR—San Antonio, Tex., 1500
KGDY—Oldham, S. D., 1200
KGEF—Los Angeles, Calif., 1300
KGEK—Yuma, Colo., 1200
KGER—Lg. Beach, Calif., 1370
KGEW—Ft. Morgan, Colo., 1200
KGEZ—Kalispell, Mont., 1310
KGFF—Alva., Okla., 1420
KGFG—Okla. City, Okla., 1370
KGFI—Corpus Christi, Tex.,1500
KGFJ—Los Angeles, Calif., 1420
KGFK—Hallock, Minn., 1200
KGFL—Raton, N. Mex., 1370
KGFW—Ravenna, Nebr., 1420
KGFX—Pierre, S. D., 580
KGGC—San Francisco, Cal.,1420
KGGF—Picher, Okla., 1010
KGGM—Albuquerque, N.M., 1370
KGHF—Pueblo, Colo., 1320
KGHG—McGehee, Ark., 1310
KGHI—Little Rock, Ark., 1500
KGHL—Billings, Mont., 950

Station Location Frequency
KGHX—Richmond, Tex., 1500
KGIQ—Twin Falls, Idaho, 1320
KGIR—Butte, Mont., 1360
KGIW—Trinidad, Colo., 1420
KGIX—Las Vegas, Nev., 1420
KGJF—Little Rock, Ark., 890
KGKB—Brownwood, Tex., 1500
KGKL—San Angelo, Tex., 1370
KGKO—Wichita, Falls, Tex 570
KGKX—San Point, Idaho, 1420
KGO—Oakland, Calif., 790
KGRC—San Antonio, Tex., 1370
KGRS—Amarillo, Tex., 1410
KGU—Honolulu, Hawaii, 940
KGW—Portland, Ore., 620
KGY—Lacey, Wash., 1200
KHJ—Los Angeles, Calif., 900
KHQ—Spokane, Wash., 590
KICK—Red Oak, Iowa, 1420
KID—Idaho Falls, Idaho, 1320
KIDO—Boise, Idaho, 1250
KIT—Yakima, Wash., 1370
KJBS—San Francisco, Cal., 1070
KJR—Seattle, Wash, 970
KLCN—Blytheville, Ark., 1290
KLO—Ogden, Utah, 1370
KLPM—Minot, N.D., 1420
KLRA—Little Rock, Ark., 1390
KLS—Oakland, Calif., 1440
KLX—Oakland, Calif., 880
KLZ—Dupont, Colo., 560
KMA—Shenandoah, Iowa, 930
KMBC—Independence, Mo., 950
KMED—Medford, Ore., 1310
KMIC—Inglewood, Calif., 1120
KMJ—Fresno, Calif., 1200
KMMJ—Clay Center, Nebr., 740
KMO—Tacoma, Wash., 1340
KMOX-KFQA—St. Louis, 1090
KMTR—Hollywood, Calif., 570
KNX—Hollywood, Calif., 1050
KOA—Denver, Colo., 830
KOAC—Corvallis, Ore., 560
KOB—State College, N.M., 1180
KOCW—Chickasha, Okla., 1400
KOH—Reno, Nev., 1370
KOIL—Council Bluffs, Ia., 1260
KOIN—Portland, Ore., 940
KOL—Seattle, Wash., 1270
KOMO—Seattle, Wash, 920
KOOS—Marshfield, Ore., 1370
KORE—Eugene, Ore., 1420
KOY—Phoenix, Ariz., 1390
KPCB—Seattle, Wash., 1210
KPJM—Prescott, Ariz., 1500
KPLA—Los Angeles, Calif., 1000
KPO—San Francisco, Cal, 680
KPOF—Denver, Colo., 880
KPPC—Pasadena, Calif., 1200
KPQ—Seattle, Wash., 1210
KPRC—Houston, Tex., 920
KPSN—Pasedena, Calif., 950
KPWF—Westminster, Calif.1490
KQV—Pittsburgh, Pa., 1380
KQW—San Jose, Calif., 1010
KRE—Berkeley, Calif., 1370
KRGV—Harlingen, Tex., 1260
KRLD—Dallas, Tex., 1040
KRMD—Shreveport, La., 1310
KRSC—Seattle, Wash., 1120
KSAC—Manhattan, Kans., 580
KSCJ—Sioux City, Ia., 1330
KSD—St. Louis, Mo., 550
KSEI—Pocatello, Idaho, 900
KSL—Salt Lake City, U., 1130
KSMR—Santa Maria, Calif, 1200
KSO—Clarinda, Iowa, 1380
KSOO—Sioux Falls, S. D., 1110
KSTP—St. Paul, Minn., 1460
KTAB—Oakland, Calif., 550
KTAP—San Antonio, Tex., 1420
KTAT—Ft. Worth, Tex., 1240
KTBI—Los Angeles, Calif., 1300
KTBR—Portland, Ore., 1300
KTBS—Shreveport, La., 1450
KTHS—Hot Springs, Ark., 800
KTM—Los Angeles, Calif.,780
KTNT—Muscatine, Iowa, 1170
KTSA—San Antonio, Tex., 1290
KTSL—Shreveport. La., 1310
KTSM—El Paso, Tex., 1310
KTUE—Houston, Tex., 1420
KTW—Seattle, Wash., 1270
KUJ—Longview, Wash., 1500
KUOA—Fayetteville, Ark., 1390
KUOM—Missoula, Mont., 570
KUSD—Vermillion, S.D., 890
KUT—Austin. Tex., 1120
KVEP—Portland, Ore., 1500
KVI—Tacoma, Wash., 760
KVL—Seattle, Wash., 1370
KVOA—Tucson, Ariz., 1260
KVOO—Tulsa, Okla., 1140
KVOS—Bellingham, Wash., 1200
KWCR—Cedar Rapids, Ia., 1310
KWEA—Shreveport, La., 1210
KWG—Stockton, Calif., 1200
KWJJ—Portland, Ore., 1060
KWK—St. Louis, Mo., 1350
KWKC—Kansas City, Mo., 1370
KWKH—Kennonwood, La., 850
KWLC—Decorah, Iowa, 1270
KWSC—Pullman, Wash., 1390
KWTC—Santa Ana, Calif., 1500
KWWG—Brownsville, Tex., 1260
KWYO—Laramie, Wyo., 600
KXA—Seattle, Wash., 570
KXL—Portland, Ore., 1250
KXO—El Centre, Calif., 1200
KXRO—Aberdeen, Wash., 1420
KYA—San Francisco, Cal.,1230
KYW-KFKX—Chicago, Ill., 1020
KYWA—Chicago, Ill., 1020
KZM—Hayward, Calif., 1370

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

[FROM FEDERAL RADIO COMMISSION LIST REVISED UP TO NOON, SEPTEMBER 11th]

* Canadian shared
** Canadian exclusive
S-Studio

550 KC, 545.1 METERS
WGR-Buffalo, N. Y.
WEAO-Columbus, O.
WKRC-Cincinnati, O.
KFUO-Clayton, Mo.
S-St. Louis, Mo.
KSD-St. Louis, Mo.
KFDY-Brookings, S. D.
KFYR-Mismark, N. D.
KTAB-Oakland, Calif.

560 KC, 535.4 METERS
WHDI-Minneapolis, Minn.
WIOD-Miami, Fla.
WLIT-Philadelphia
WFI-Philadelphia
KFDM-Beaumont, Tex.
WNOX-Knoxville, Tenn.
WOI-Ames, Iowa
KFEQ-St. Joseph, Mo.
KOAC-Corvallis, Ore.
KLZ-Dupont, Colo.

570 KC, 526 METERS
WNYC-New York, N. Y.
WMCA-Hoboken, N. J.
S-New York, N. Y.
WSYR-Syracuse, N. Y.
WMAC-Cazenovia, N. Y.
WSMK-Dayton, O.
WKBN-Youngstown, O.
WWNC-Asheville, N. C.
KGKO-Wichita Falls, Tex.
WNAX-Yankton, S. D.
WPCC-Chicago, Ill.
WIBO-Desplaines, Ill.
S-Chicago, Ill.
KUOM-Missoula, Mont.
KXA-Seattle, Wash.
KMTR-Hollywood, Cal.

***580 KC, 516.9 METERS**
WTAG-Worcester, Mass.
WOBU-Charleston, W. Va.
WSAZ-Huntington, W. Va.
KGFX-Pierre, S. D.
KSAC-Manhattan, Kans.
WSUI-Iowa City, Iowa

590 KC, 508.2 METERS
WEEI-N. Weymouth, Mass.
WEMC-Berrien Spgs., Mich.
WCAJ-Lincoln, Nebr.
WOW-Omaha, Nebr.
KHQ-Spokane, Wash.

***600 KC, 499.7 METERS**
WTIC-Hartford, Conn.
WCAC-Storrs, Conn.
WCAO-Baltimore, Md.
WREC-Whitehaven, Tenn.
WOAN-Lawrenceburg, Tenn
WEBW-Beloit, Wis.
KFSD-San Diego, Calif.
KWYO-Laramie, Wyo.

610 KC, 491.5 METERS
WFAN-Philadelphia
WIP-Philadelphia
WDAF-Kansas City, Mo.
WOQ-Kansas City, Mo.
KFRC-San Francisco

620 KC, 483.6 METERS
WLBZ-Bangor, Maine
WDBO-Orlando, Fla.
WDAE-Tampa, Fla.
WJAY-Cleveland, O.
WTMJ-Brookfield, Wis.
KGW-Portland, Ore.
KFAD-Phoenix, Ariz.

***630 KC, 475.9 METERS**
WMAL-Washington, D. C.
WOS-Jefferson City, Mo.
KFRU-Columbia, Mo.
WGBF-Evansville, Ind.

640 KC, 468.5 METERS
WAIU-Columbus, O.
KFI-Los Angeles, Calif.

650 KC, 461.3 METERS
WSM-Nashville, Tenn.

660 KC, 454.3 METERS
WEAF-Bellmore, N. Y.
S-New York City
WAAW-Omaha, Nebr.

670 KC, 447.5 METERS
WMAQ-Addison, Ill.
S-Chicago, Ill.

680 KC, 440.9 METERS
WPTF-Raleigh, N. C.
KPO-San Francisco

****690 KC, 434.5 METERS**

700 KC, 428.3 METERS
WLW-Mason, Ohio

710 KC, 422.3 METERS
WOR-Kearny, N. J.
S-Newark, N. J.
KFVD-Culver City, Calif.

720 KC, 413 METERS
WGN-WLIB-Elgin, Ill.
S-Chicago, Ill.

****730 KC, 413 METERS**

740 KC, 405.2 METERS
WSB-Atlanta, Ga.
KMMJ-Clay Center, Nebr.

750 KC, 399.8 METERS
WJR-Silver Lake, Mich.
S-Detroit, Mich.

760 KC, 394.5 METERS
WJZ-Boundbrook, N. J.
S-New York, N. Y.
WEW-St. Louis, Mo.
KVI-Des Moines, Wash.
S-Tacoma

770 KC, 389.4 METERS
KFAB-Lincoln, Nebr.
WBBM-WJBT-Glenview,
S-Chicago, Ill.

***780 KC, 384.4 METERS**
WBSO-Wellesley, Mass.
WTAR-WPOR-Norfolk, Va.
WEAN—Providence, R.I.
WMC-Memphis, Tenn.
KELW-Burbank, Calif.
KTM-Santa Monica, Cal.
S-Los Angeles, Calif.

790 KC, 379.5 METERS
WGY-Schenectady, N. Y.
KGO-Oakland, Calif.

800 KC, 374.8 METERS
WBAP-Ft. Forth, Tex.
KTHS-Hot Springs Nat'l Park, Ark.

810 KC, 370.2 METERS
WPCH-Hoboken, N. J.
S-New York, N. Y.
WCCO—Anoka, Minn.
S-Minneapolis.

820 KC, 365.6 METERS
WHAS-Jeffersontown, Ky.
S-Louisville, Ky.

830 KC, 361.2 METERS
WHDH-Gloucester, Mass.
KOA-Denver, Colo.

****840 KC, 356.9 METERS**

850 KC, 352.7 METERS
KWKH-Kennonwood, La.
WWL-New Orleans, La.

860 KC, 348.6 METERS
WABC-WBOQ-N. Y. City
KFQZ-Hollywood, Calif.

870 KC, 344.6 METERS
WLS-Crete, Ill.
S-Chicago, Ill.
WENR-WBCN-Chicago

***880 KC, 340.7 METERS**
WQAN-Scranton, Pa.
WGBI-Scranton, Pa.
WCOC-Columbus, Miss.
KLX-Oakland, Calif.
KPOF-Denver, Colo.
KFKA-Greeley, Colo.

***890 KC, 336.9 METERS**
WJAR-Providence, R. I.
WKAQ-San Juan, P. R.
WMMN-Fairmont, W. Va.
WMAZ-Macon, Ga.
WGST-Atlanta, Ga.
KGJF-Little Rock, Ark
WILL-Urbana, Ill.
KUSD-Vermillion, S. D.
KFNF-Shenandoah, Iowa

900 KC, 331.1 METERS
WFBL-Syracuse, N. Y.
WMAK-Martinsville, N. Y.
S-Buffalo, N. Y.
WKY-Okla. City, Okla.
WFLA-WSUN-
Clearwater, Fla.
WLBL-Stevens Point, Wis.
KHJ-Los Angeles, Calif.
KSEI-Pocatello, Idaho
KGBU-Ketchikan, Alaska

****910 KC, 329.5 METERS**

920 KC, 325.9 METERS
WWJ-Detroit, Mich.
KPRC-Houston, Tex.
WAAF-Chicago, Ill.
KOMO-Seattle, Wash.

***930 KC, 322.4 METERS**
WIBG-Elkins Park, Pa.
WDBJ-Roanoke, Va.
WBRC-Birmingham, Ala.
KGBZ-York, Nebr.
KMA-Shenandoth, Iowa
KFWM-Oakland, Calif.
KFWI-San Francisco

940 KC, 319.0 METERS
WCSH-Portland, Maine
WFIW-Hopkinsville, Ky.
WHA-Madison, Wis.
KOIN-Sylvan, Ore.
S-Portland, Ore.
KGU-Honolulu, T. H.
KFEL-Denver, Colo.
KFXF-Denver, Colo.

950 KC, 315.6 METERS
WRC-Washington, D. C.
KMBC-Independence, Mo.
WHB-Kansas City, Mo.
KFWB-Hollywood, Calif.
KPSN-Pasadena, Calif.
KGHL-Billings, Mont.

****960 KC, 312.3 METERS**

970 KC, 309.1 METERS
WCFL-Chicago, Ill.
KJR-Seattle, Wash.

980 KC, 305.9 METERS
KDKA-Wilkins Township.
S-Pittsburgh, Pa.

990 KC, 302.8 METERS
WBZ-E. Springfield, Mass.
S-Boston, Mass.
WBZA-Boston, Mass.

1000 KC, 299.8 METERS
WHO-Des Moines, Iowa
WOC-Davenport, Iowa
KPLA-Los Angeles, Calif.

***1010 KC, 296.9 METERS**
WQAO-WPAP-
Cliffside, N. J.
S-New York, N. Y.
WHN-New York, N. Y.
WRNY-Coytesville, N. J.
S-New York, N. Y.
KGGF-Picher, Okla.
WNAD-Norman, Okla.
KQW-San Jose, Calif.

1020 KC, 293.9 METERS
WRAX-Philadelphia.
KYW-KFKX-Chicago.
KYWA-Chicago.

****1030 KC, 291.2 METERS**

1040 KC, 288.3 METERS
WKEN-Grand Island, N.Y.
S-Buffalo, N. Y.
WKAR-E. Lansing, Mich.
WFAA-Dallas, Tex.
KRLD-Dallas, Tex.

1050 KC, 285.5 METERS
KFKB-Milford, Kans.
KNX-Los Angeles, Calif.
S-Hollywood, Calif.

1060 KC, 282.8 METERS
WBAL-Glen Morris, Md.
S-Baltimore, Md.
WTIC-Avon, Conn.
WJAG-Norfolk, Nebr.
KWJJ-Portland, Ore.

1070 KC, 280.2 METERS
WAAT-Jersey City, N. J.
WTAM-Cleveland, Ohio
WEAR-Cleveland, Ohio
WCAZ-Carthage, Ill.
WDZ-Tnscola, Ill.
KJBS-San Francisco

1080 KC, 277.6 METERS
WBT-Charlotte, N. C.
WCBD-Zion, Ill.
WMBI-Chicago, Ill.

1090 KC, 257.1 METERS
KMOX-KFOA-Kirkwood
S-St. Louis, Mo.

1100 KC, 272.6 METERS
WPG-Atlantic City, N. J.
WLWL-Kearny, N. J.
S-New York, N. Y.
KGDM-Stockton, Calif.

1110 KC, 270.1 METERS
WRVA-Richmond, Va.
KSOO-Sioux Falls, S. D.

***1120 KC, 267.7 METERS**
WDEL-Wilmington, Del.
WCOA-Pensacola, Fla.
WTAW-College Sta., Tex.
KUT-Austin, Tex.
WISN-Milwaukee, Wis.
WHAD-Milwaukee, Wis.
KFSG-Los Angeles, Calif.
KRSC-Seattle, Wash.

1130 KC, 265.3 METERS
WJJD-Mooseheart, Ill.
WOV-Secaucus, N. J.
S-New York, N. Y.
KSL-Salt Lake City, Utah.

1140 KC, 263 METERS
WAPI-Birmingham, Ala.
KVOO-Tulsa, Okla.

1150 KC, 260.7 METERS
WHAM-Victor Township
S-Rochester, N. Y.

1160 KC, 258.5 METERS
WWVA-Wheeling, W. Va.
WOWO-Ft. Wayne, Ind.

1170 KC, 256.3 METERS
WCAU-Byberry, Pa.
S-Philadelphia, Pa.
KTNT-Muscatine, Iowa
KEJK-Beverly Hills, Calif.

1180 KC, 254.1 METERS
WDGY-Minneapolis, Minn.
WHDI-Minneapolis, Minn.
WGBS-Astoria, L. I.
S-New York City.
KEX-Portland, Ore.
KOB-State College, N. M.

1190 KC, 252 METERS
WICC-Easton, Conn.
S-Bridgeport, Conn.
WOAI-San Antonio, Tex.

***1200 KC, 249.9 METERS**
WABI-Bangor, Maine.
WNBX-Springfield, Vt.
WEPS-Gloucester, Mass.
WORC-Auburn, Mass.
WIBX-Utica, N. Y.
KGW-Stockton, Calif.
WHBC-Canton, Ohio.
WLAP-Louisville, Ky.
WLBG-Ettrick, Va.
WNBO-Washington, Pa.
WPRC-Harrisburg, Pa.
WKJC-Lancaster, Pa.
WNBW-Carbondale, Pa.
WABZ-New Orleans, La.
WJBW-New Orleans, La.
WBBY-Charleston, S. C.
WBBZ-Ponca City, Okla.
WFBC-Knoxville, Tenn.
WRBL-Columbus, Ga.
KGCU-Mandan, N. D.
WJBC-LaSalle, Ill.
WJBL-Decatur, Ill.
WWAE-Hammond, Ind.
WRAF-Laporte, Ind.
WMT-Waterloo, Iowa
KFJB-Marshalltown, Iowa
WCAT-Rapid City, S. D.
KGDY-Oldham, S. D.
WIL-St. Louis, Mo.
KFWF-St. Louis, Mo.
KFKZ-Kirksville, Mo.
KGDE-Fergus Falls, Minn.
KGFK-Hallock, Minn.
WCLO-Kenosha, Wis.
WHBY-West DePere, Wis.
KFWC-Ontario, Calif.
S-Pomona, Calif.
KPPC-Pasadena, Calif.
KXO-El Centro, Calif.
KMJ-Fresno, Calif.
KSMR-Santa Maria, Calif.
KGEK-Yuma, Colo.
KGEW-Ft. Morgan, Colo.
KFHA-Gunnison, Colo.
KVOS-Bellingham, Wash.
KGY-Lacey, Wash.

***1210 KC, 247.8 METERS**
WJBI-Red Bank, N. J.
WGBB-Freeport, N. Y.
WINR-Bayshore, N. Y.
WCOH-Greenville, N. Y.
S-Yonkers, N. Y.
WOCL-Jamestown, N. Y.
WLCI-Ithaca, N. Y.
WPAW-Pawtucket, R. I.
WDWF-WLSI-
Cranston, R. I.
WMAN-Columbus, Ohio
WJW-Mansfield, Ohio
WEBE-Cambridge, Ohio
WBAX-Wilkes-Barre, Pa.
WJBU-Lewisburg, Pa.
WTAZ-Richmond, Va.
WMBG-Richmond, Va.
WSIX-Springfield, Tenn.
WRBU-Gastonia, N. C.
WJBY-Gadsden, Ala.
WMBR-Tampa, Fla.
WRBQ-Greenville, Miss.
WGCM-Gulfport, Miss.
KWEA-Shreveport, La.
KDLR-Devils Lake, N. D.
KGCR-Watertown, S. D.
KFOR-Lincoln, Neb.
WHBU-Anderson, Ind.
KFVS-Cape Girardeau, Mo.
WEBQ-Harrisburg, Ill.
WSBC-Chicago, Ill.
WCRW-Chicago, Ill.
WEDC-Chicago, Ill.
WCBS-Springfield, Ill.
WTAX-Streator, Ill.
WHBF-Rock Island, Ill.
WIBA-Madison, Wis.
WOMT-Manitowoc, Wis.
KPQ-Seattle, Wash.
KPCB-Seattle, Wash.

1220 KC, 245.8 METERS
WCAD-Canton, N. Y.
WCAE-Pittsburgh, Pa.
WREN-Lawrence, Kan.
KFKU-Lawrence, Kan.

1230 KC, 243.8 METERS
WNAC-Boston
WBIS-Boston
WPSC-State College, Pa.
WSBT-South Bend, Ind.
WFBM-Indianapolis, Ind.
KYA-San Francisco, Calif.
KFIO-Spokane, Wash.
KFQD-Anchorage, Alaska

1240 KC, 241.8 METERS
WGHP-Fraser, Mich.
S-Detroit, Mich.
KTAT-Ft. Worth, Tex.
WJAD-Waco, Tex.
WQAM-Miami, Fla.
WRBC-Valparaiso, Ind.

1250 KC, 239.9 METERS
WGCP-Newark, N. J.
WODA-Paterson, N. J.
WAAM-Newark, N. J.
WLB-WGMS-Minneapolis
WRHM-Fridley, Minn.
KFMX-Northfield, Minn.
WCAL-Northfield, Minn.
KFOX-Long Beach, Calif.
KXL-Portland, Ore.
KILO-Boise, Idaho

1260 KC, 238 METERS
WLBW-Oil City, Pa.
WJAX-Jacksonville, Fla.
KVOA-Tucson, Ariz.
KWWG-Brownsville, Tex.
KRGV-Harlingen, Tex.
KOIL-Council Bluffs, Ia.

1270 KC, 236.1 METERS
WJDX-Jackson, Miss.
WEAI-Ithaca, N. Y.
WFBR-Baltimore, Md.
WASH-Grand Rapids, Mich.
WOOD-Furnwood, Mich.
S-Grand Rapids, Mich.
WDSU-New Orleans, La.
KWLC-Decorah, Iowa
KGCA-Decorah, Iowa
KTW-Seattle, Wash.
KOL-Seattle, Wash.
KFUM-Colo. Springs, Col.

1280 KC, 234.2 METERS
WCAM-Camden, N. J.
WCAP-Asbury Park, N.J.
WOAX-Trenton, N. J.
WDOD-Chattanooga, Tenn.
WRR-Dallas, Tex.
WDAY-Fargo, N. D.
WEBC-Superior, Wis.
S-Duluth, Minn.

1290 KC, 232.4 METERS
WNBZ-Saranac Lake, N. Y.
WJAS-Pittsburgh, Pa.
KTSA-San Antonio, Tex.
KFUL-Galveston, Tex.
KLCN-Blytheville, Ark.
KDYL-Salt Lake City

1300 KC, 230.6 METERS
WBBR-Rossville, N. Y.
WHAP-Carlstadt, N. J.
S-New York, N. Y.
WEVD-Woodhaven, N. Y.
S-New York, N. Y.
WHAZ-Troy, N. Y.
KFH-Wichita, Kan.
WIBW-Topeka, Kan.
KGEF-Los Angeles
KTBI-Los Angeles
KFJR-Portland, Ore.
KTBR-Portland, Ore.

1310 KC, 228.3 METERS
WKAV-Laconia, N. H.
WEBR-Buffalo, N. Y.
WNBH-New Bedford, Mass.
WOL-Washington, D. C.
WGH-Newport News, Va.
WRK-Hamilton, Ohio
WAGM-Royal Oak, Mich.
WFDF-Flint, Mich.
WNAT-Philadelphia, Pa.
WFKD-Frankford, Pa.
S-Philadelphia.
WHBP-Johnstown, Pa.
WFBG-Altoona, Pa.
WRAW-Reading, Pa.
WGAL-Lancaster, Pa.
WRBI-Tifton, Ga.
WSAJ-Grove City, Pa.
WBRE-Wilkes-Barre, Pa.
WMBL-Lakeland, Fla.
WKBC-Birmingham, Ala.
KGHG-McGehee, Ark.
WOBT-Union City, Tenn.
WNBJ-Knoxville, Tenn.
KRMD-Shreveport, La.
KTSL-Cedar Grove, La.
S-Shreveport, La.
KFPM-Greenville, Tex.
WDAH-El Paso, Tex.
KTSM—El Paso, Tex.
KGFI-Corpus Christi, Tex.
KFPL-Dublin, Tex.
KFXR-Okla. City, Okla.
WKBS-Galesburg, Ill.
WEHS-Evanston, Ill.
WCLS-Joliet, Ill.
WKBB-Joliet, Ill.
WKBI-Chicago, Ill.
WHFC-Cicero, Ill.
KWCR-Cedar Rapids, Ia.
KFJY-Ft. Dodge, Ia.
KFGQ-Boone, Ia.
WBOW-Terre Haute, Ind.
WJAK-Marion, Ind.
WLBC-Muncie, Ind.
WIBU-Poynette, Wis.
KFBK-Sacramento, Calif.
KGEZ-Kalispell, Mont.
KFUP-Denver, Colo.
KFXJ-Edgewater, Colo.
KMED-Medford, Ore.
WJDZ-Winston Salem, N. C.

1320 KC, 227.1 METERS
WADC-Akron, Ohio
WSMB-New Orleans, La.
KGIO-Idaho Falls, Idaho
KGIQ-Twin Falls, Idaho
KGHF-Pueblo, Colo.
KID-Idaho Falls, Idaho

1330 KC, 225.4 METERS
WDRC-New Haven, Conn.
WSAI-Harrison, Ohio
S-Cincinnati
WTAQ-Washington, Wis.
S-Eau Claire, Wis.
KSCJ-Sioux City, Iowa

1340 KC, 223.7 METERS
WSPD-Toledo, Ohio
KFPW-Siloam Springs, Ark.
KMO-Tacoma, Wash.

1350 KC, 221.1 METERS
WBNY-New York, N. Y.
WMSG-New York, N. Y.
WCDA-New York, N. Y.
WKBQ-New York, N. Y.
KWK-St. Louis, Mo.

1360 KC, 220.4 METERS
WLEX-Lexington, Mass.
WMAF-South Dartmouth, Mass.
WQBC-Utica, Miss.
WJKS-Gary, Ind.
WGES-Chicago, Ill.
KFBB-Great Falls, Mont.
KGIR-Butte, Mont.
KGB-San Diego, Calif.

1370 KC, 218.8 METERS
WMBO-Auburn, N. Y.
WSVS-Buffalo, N. Y.
WCBM-Baltimore, Md.
WBBL-Richmond, Va.
WHBD-Bellefontaine, O.
WHDF-Calumet, Mich.
WJBK-Ypsilanti, Mich.
WJDW-Emory, Va.
WIBM-Jackson, Mich.
WRAK-Erie, Pa.
WELK-Philadelphia.
WJBO-New Orleans, La.
WHBQ-Memphis, Tenn.
WRBT-Wilmington, N. C.
KGFG-Okla. City, Okla.
KCRC-Enid, Okla.
KGCI-San Antonio, Tex.
KGRC-San Antonio, Tex.
KFJZ-Ft. Worth, Tex.
KGKL-San Angelo, Tex.
KFLX-Galveston, Tex.
WFBJ-Collegeville, Minn.
WGL-Ft. Wayne, Ind.
KGDA-Dell Rapids, S. D.
KFJM-Grand Forks, N. D.
WKWC-Kansas City, Mo.
KGBX-St. Joseph, Mo.
WRJN-Racine, Wis.
KGAR-Tucson, Ariz.
KIT-Yakima, Wash.
KOH-Reno, Nev.
KZM-Hayward, Calif.
KRE-Berkeley, Calif.
KGER-Long Beach, Calif.
KLO-Ogden, Utah
KOOS-Marshfield, Ore.
KFBL-Everett, Wash.
KVL-Seattle, Wash.
KFJI-Astoria, Ore.
KGFL-Raton, N. M.
KGGM-Albuquerque, N.M.

1380 KC, 217.3 METERS
WCSO-Springfield, Ohio.
KQV-Pittsburgh, Pa.
KSO-Clarinda, Ia.
KWBH-LaCrosse, Wis.

1390 KC, 215.7 METERS
WHK-Cleveland, O.
KLRA-Little Rock, Ark.
KOY-Phoenix, Ariz.
KUOA-Fayetteville, Ark.
KOW-Denver, Colo.
KWSC-Pullman, Wash.
KFPY-Spokane, Wash.

1400 KC, 214.2 METERS
WCGU-Coney Isl., N. Y.
WSGH-WSDA-Bklyn, N Y
WLTH-Brooklyn, N. Y.
WBBC-Brooklyn, N. Y.
KOCW-Chickasha, Okla.
WCMA-Culver, Ind.
WKBF-Indianapolis, Ind.

1410 KC, 212.6 METERS
WBCM-Hampton, Mich.
S-Bay City, Mich.
KGRS-Amarillo, Tex.
WDAG-Amarillo, Tex.
KFLV-Rockford, Ill.
WHBL-Sheboygan, Wis.
WSGP-Savannah, Ga.

1420 KC, 211.1 METERS
WHDL-Tupper Lake, N.Y.
WHIS-Bluefield, W. Va.
WLBH-Patchogue, N. Y.
WMRJ-Jamaica, N. Y.
WLEY-Lexington, Mass.
WTBO-Cumberland, Md.
WSSH-Boston, Mass.
WPOE-Patchogue, N. Y.
WIBR-Steubenville, O.
WILM-Wilmington, Del.
WEDH-Erie, Pa.
WMBC-Detroit, Mich.
WKBP-Battle Creek, Mich.
WQBZ-Weirton, W. Va.
KGFF-Alva, Okla.
KTAP-San Antonio, Tex.
KTUE-Houston, Tex.
KFYO-Abilene, Tex.
KICK-Red Oak, Iowa
WIAS-Ottumwa, Iowa
WLBF-Kansas City, Kan
WMBH-Joplin, Mo.
KLMP—Minot, N.D.
KGFW-Ravenna, Neb.
KFIZ-Fond du Lac, Wis.
KFXY-Flagstaff, Ariz.
KGFJ-Los Angeles, Calif.
KFQU-Holy City, Calif.
KGGC-San Francisco.
KFXD-Jerome, Idaho
KGIW-Trinidad, Colo.
KGCX-Vida, Mont.
KFIF-Portland, Ore.
KORE-Eugene, Ore.
KFQW-Seattle, Wash.
KXRO-Aberdeen, Wash.

1430 KC, 209.7 METERS
WBRL-Manchester, N. H.
WHP-Harrisburg, Pa.
WBAK-Harrisburg, Pa.
WCAH-Columbus, Ohio
WGBC-Memphis, Tenn.
WNBR-Memphis, Tenn.

1440 KC, 208.2 METERS
WHEC-WABO-
Rochester, N. Y.
WOKO-Mt. Beacon, N. Y.
S-Poughkeepsie, N.Y.
WCBA-Allentown, Pa.
WSAN-Allentown, Pa.
WNRC-Greensboro, N. C.
WTAD-Quincy, Ill.
WMBD-Peoria Hts., Ill.
KLS-Oakland, Calif.

1450 KC, 206.8 METERS
WBMS-Fort Lee, N. J.
WNJ-Newark, N. J.
WIBS-Elizabeth, N. J.
WKBO-Jersey City, N. J.
WSAR-Fall River, Mass.
WFJC-Akron, Ohio
KTBS-Shreveport, La.
WTFI-Toccoa, Ga.

1460 KC, 205.4 METERS
WJSV-Mt. Vernon, Va.
KSTP-Westcott, Minn.
S-St. Paul, Minn.

1470 KC, 204 METERS
WKBW-Amherst, N. Y.
S-Buffalo, N. Y.
KFJF-Okla. City, Okla.
WRUF-Gainesville, Fla.
KGA-Spokane, Wash.

1480 KC, 202.6 METERS
WJAZ-Mt. Prospect, Ill.
S-Chicago, Ill.
WSOA-Deerfield, Ill.
S-Chicago, Ill.
WORD-Batavia, Ill.
S-Chicago, Ill.
WCKY-Villa Madonna, Ky.
S-Covington, Ky.

1490 KC, 201.2 METERS
WBAW-Nashville, Tenn.
WLAC-Nashville, Tenn.
KPWF-Westminster, Calif

1500 KC, 199.9 METERS
WMBA-Newport, R. I.
WLOE-Chelsea, Mass.
WMES-Boston, Mass.
WNBF-Binghamton, N. Y.
WMBQ-Brooklyn, N. Y.
WLBX-L. I. City, N. Y. C.
WCLB-Long Beach, N. Y.
WWRL-Woodside, N. Y.
WKBZ-Ludington, Mich.
WMPC-Lapeer, Mich.
WMBJ-Wilkinsburg, Pa.
S-Pittsburgh, Pa.
WOPI-Bristol, Tenn.
WPEN-Philadelphia, Pa.
KGHI-Little Rock, Ark.
WRBJ-Hattiesburg, Miss.
KGKB-Brownwood, Tex.
KGDR-San Antonio, Tex.
KGHX-Richmond, Tex.
WKBV-Brookville, Ind.
KPJM-Prescott, Ariz.
KVEP, Portland, Ore.
KWTC-Santa Ana, Calif.
KDB-Santa Barbara, Calif.
KUJ-Long View, Wash.

[TO CONVERT ABOVE FREQUENCIES TO WAVELENGTHS SEE PRECEDING PAGE]

U.S.A. Short Wave Broadcasting Stations

Station	LOCATION	KC.	METERS
KDKA (W8XK)	East Pittsburgh, Pa.	4,791	62.50
(W8XS)			
(W8XP)	Portable	7,012 11,878	42.75 25.24
KEJK (W6XAN)	Los Angeles, Cal.	2,830	105.9
KEWE	Bolinas, Cal.	21,263	14.10
KFPY (W7XAB)	Spokane, Wash.	2,830	105.90
KFQU (W6XBH)	Holy City, Cal.	9,671	31
KFQZ (W6XAL)	Hollywood, Cal.	2,770	108.20
KFVD (W6XBX)	Culver City, Cal.	2,855	105
KFWB (W6XBR)	Los Angeles, Calif.	2,855 7,491	105 40
KFWO (W6XAD)	Avalon, Calif.	5,650	53.07
KGER (W6XBV)	Long Beach, Calif.	6,142	48.86
KGB	San Diego, Calif.	4,600	65.18
KGDE	Barrett, Minn.	7,941	40
KHJ (W6XAU)	Los Angeles, Calif.	2,880	104.1
KJBS (W6XAR)	San Francisco, Calif.	4,914	61
KJR (W7XC, W7XO)	Seattle, Wash.	2,850	105.20
KMOX	St. Louis, Mo.	6,118	49
KMTR	Los Angeles, Calif.	2,770	108.2
KNRC (W6XAF)	Santa Monica, Calif.	2,770	108.2
KNX (W6XA)	Los Angeles, Calif.	2,800	107.1
KOIL (W9XU)	Council Bluffs, Ia.	4,910	61.06
KWE-KEWE	Bolinas, Calif.	21,263	14.1
KWJJ (W7XAO)	Portland, Ore.	5,600	53.54
WAAM (WX2BA)	Newark, N. J.	4,600	65.18
WABC (W2XE)	Richmond Hill, N. Y.	5,124	58.5
WBRL (W1XY)	Tilton, N. H.	2,750	109
WBZ	Springfield, Mass.	4,283	70
WCFL	Chicago, Ill.	8,050	37.24
WCGU (WTXBH)	Brooklyn, N. Y.	5,552	54
WCSH (W1XAB)	Portland, Me.	4,700	63.79
WCX	Pontiac, Mich.	9,370	32
WEAO (W8XJ)	Columbus, Ohio	5,550	54.02
WGY (W2XAF) (W2XAD)	Schenectady, N. Y.	5,521 15,328 59,964	31.48 19.56 52
WHK (W8XF)	Cleveland, Ohio	4,540	66.04
WJR-WCX (W8XAO)	Pontiac, Mich.	9,370	32
WJZ (W3XAL)	New York, N. Y.	6,096 to 21,420	49.18 to 13.95
WLW (W8XAL)	Cincinnati, Ohio	5,764	52.02
WNAL (W9XAB)	Omaha, Nebr.	2,855	105
WOR (W2XAQ)	Kearny, N. J.	4,581	65.4
WOWO	Ft. Wayne, Ind.	13,150	22.8
WRNY (W2XAL)	New York, N. Y.	9,700	30.91
WSM (4XD)	Nashville, Tenn.	9,540	31.43
WTFF	Mt. Vernon, Va.	5,352	56
KGO (W6XAX, W6XAN)	San Francisco, Calif.	29,982 to 7,491	10 to 40

Foreign Short Wave Stations

Hours on the Air

Station	Location	Kc.	M.	EST.*	CST.*	MST.*	PST.*
AFK	Doberitz, Germany	7,980 3,978	37.56 75.36	Monday, Wednesday and Friday 6-7 AM. 2-3 AM.	 7-8 AM. 3-4 AM.	 8-9 AM. 4-5 AM.	 9-10 AM 5-6 AM
EATH	Vienna, Austria	8,108	37	Monday and Thursday 5:30-7PM	 6:30-8PM	 7:30-9PM	 8:30-10AM
YR	Lyons, France	7,463	40.2	Every day except Sunday 11:30-12:30 P.M.	 12:30-1:30 P.M.	 1:30-2:30 P.M.	 2:30-3.30 P.M.
FL	Eiffel Tower, Paris	9,231	32.5	Time signals every day 2:56 AM. & 2:56 PM.	 3:56 AM. & 3:56. PM.	 4:56 AM. & 4:56 PM.	 5:56 AM. & 5:56 PM.
EH9OC	Berne, Switzerland	9,370	32.	Monday, Tuesday and Saturday 3-4 PM.	 4-5 PM.	 5-6 PM.	 6-7 PM.
PCL	Kootwijk, Holland	16,300	18.4	6-10 PM.	7-11 PM.	8-12 PM.	9 AM-1.PM.
		7,895	38.8	10 AM.-8 PM.	11 AM.-9 PM.	12 M.-10 PM.	1 PM.-11 PM.
POHI	Huizen, Holland	17,779	16.88	10 AM.-12 M.	11 AM.-1 PM.	12 M.-2.PM.	1 PM.-3 PM.
PCJ	Eindhoven, Holland	9,590	31.88	Thursday 2-4 PM. 7-8 PM. Friday 8-11 AM. 2-4PM. Saturday 8 PM.-2 AM.	Thursday 3-5 PM. 8-9 PM. Friday 9 AM.-1 PM. 3-5 PM. Saturday 9 PM.-3 AM.	Thursday 4-6 PM. 9-10PM. Friday 10 AM.-2 PM. 4-6 PM. Saturday 10 PM.-4 AM.	Thursday 5-7 PM. 10-11PM. Friday 11 AM.-3 PM. 5-7 PM. Saturday 11 PM.-5 AM.
5 SW	Chelmsford, England	11,751	25.53	Every day except Saturday and Sunday 7:30-8:30 AM. 2-7 PM.	 8:30-9:30 AM. 3-8 PM.	 9:30-10:30 AM. 4-9 PM.	 10:30-11:30 AM. 5-10 PM.
RFN	Moscow, Russia	6,000	50	Tuesday, Thursday and Friday 8-9 AM.	 9-10 AM	 10-11 AM.	 11-12 AM.
7LO	Nairobi, Kenya Colony, Africa	9,677	31	11 AM.-3 PM.	12 AM.-4 PM.	1 PM.-5 PM.	2 PM.-6 PM.

* Add one hour for daylight saving time
EST—Eastern Standard Time
CST—Central Standard Time
MST—Mountain Standard Time
PST—Pacific Standard Time

CBS CHAIN

Station	Location	Kc.	Meters
WABC-WBOQ	New York City, N. Y.	860	348.6
WADC	Akron, Ohio	1320	227.1
WAIU	Columbus, O.	640	468.5
WBBM	Chicago, Ill.	770	389.4
WCAO	Baltimore, Md.	600	499.7
WCAU	Philadelphia, Pa.	1170	256.3
WDOD	Chattanooga, Tenn.	1280	234.2
WDSU	New Orleans, La.	1270	236.1
WEAN	Providence, R. I.	550	545.1
WFAN	Philadelphia, Pa.	610	491.5
WFBL	Syracuse, N. Y.	900	333.1
WFBM	Indianapolis, Ind.	1230	243.8
WCCO	Minneapolis, Minn.	810	370.2
WBRC	Birmingham, Ala.	930	322.4
WGHP	Detroit, Mich.	1240	241.8
WMAQ	Chicago, Ill.	670	447.5
WNAC	Boston, Mass.	1230	243.8
WOWO	Ft. Wayne, Ind.	1160	258.5
WREC	Memphis, Tenn.	600	499.7
WRHM	Friedley, Minn.	1250	239.9
WSPD	Toledo, O.	1340	223.7
WTAR	Norfolk, Va.	780	384.4
WWNC	Asheville, N. C.	570	526
KDYL	Salt Lake City, Utah	1290	232.4
KFH	Wichita, Kans.	1300	230.6
WMAK	Buffalo, N. Y.	900	333.1
WKBW	Buffalo, N. Y.	1470	204
WKRC	Cincinnati, O.	550	545.1
WHK	Cleveland, O.	1390	215.7
WLBW	Oil City, Pa.	1260	238
WJAS	Pittsburgh, Pa.	1290	232.4
WMAL	Washington, D. C.	630	475.9
WHEC	Rochester, N. Y.	1440	208.2
WIBW	Topeka, Kans.	1300	230.6
KFJF	Oklahoma City, Okla.	1470	204
KFPY	Spokane, Wash.	1390	215.7
KFRC	San Francisco, Calif.	610	491.9
KHJ	Los Angeles, Calif.	900	333.1
KLRA	Little Rock, Ark.	1390	215.7
KLZ	Denver, Colo.	560	535.4
KMBC	Independence, Mo.	950	315.6
KMOX	St. Louis, Mo.	1090	275.1
KOIL	Council Bluffs, Iowa	1260	238
KOIN	Portland, Ore.	940	319
KRLD	Dallas, Tex.	1040	288.3
KTSA	San Antonio, Tex.	1290	232.4
KVI	Seattle, Tacoma, Wash.	760	394.5
WDBJ	Roanoke, Va.	930	322.4
WISN	Milwaukee, Wis.	1120	267.7
CFRB		960	312.5
CKGW	Toronto, Canada	960	312.5
CKAC	Montreal, Canada	730	411
CJGC	London, Ont., Canada	910	329.7
WKBN	Youngstown, O.	570	526
WLAC	Nashville, O.	1490	201.6

NBC CHAIN

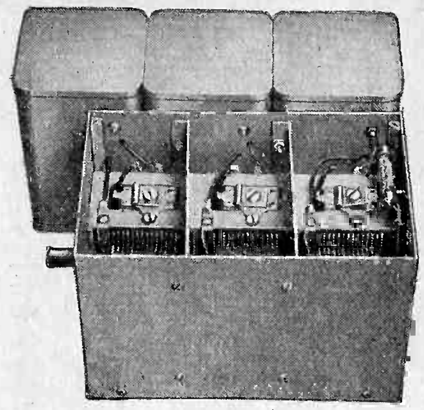
Station	Location	Kc.	Meters
WAPI	Birmingham, Ala.	1140	263
WBAL	Baltimore, Md.	1060	282.8
WBAP	Fort Worth, Tex.	800	374.8
WBT	Charlotte, N. C.	1080	277.6
WBZ	Springfield, Mass.	990	302.8
WBZA	Boston, Mass.	990	302.8
WCAE	Pittsburgh, Pa.	1220	245.8
WCFL	Chicago, Ill.	970	309.1
WCSH	Portland, Me.	940	319
WDAF	Kansas City, Mo.	610	491.5
WEAF	New York, N. Y.	660	454.3
WEAR	Cleveland, O.	1070	280.2
WEBC	Duluth, Minn.	1280	234.2
WEEI	Weymouth, Mass.	590	508.2
WENR-WBCN	Chicago, Ill.	870	344.6
WFAA	Dallas, Tex.	1040	288.3
WFI	Philadelphia, Pa.	560	535.4
WFJC	Akron, O.	1450	206.8
WGN-WLIB	Elgin, Ill.	720	416.4
WGR	Buffalo, N. Y.	550	545.1
WGY	Schenectady, N. Y.	790	379.5
WHAM	Rochester, N. Y.	1150	260.7
WHAS	Louisville, Ky.	820	365.6
WHO	Des Moines, Iowa	1000	299.8
WIOD	Miami Beach, Fla.	560	535.4
WJAR	Providence, R. I.	890	336.9
WJAX	Jacksonville, Fla.	1260	238
WJR	Detroit, Mich.	750	399.8
WJZ	New York, N. Y.	760	394.5
WKY	Oklahoma City, Okla.	900	333.1
WLIT	Philadelphia, Pa.	560	535.4
WLS	Chicago, Ill.	870	344.6
WLW	Mason, O.	700	428.3
WMC	Memphis, Tenn.	570	526
WOAI	San Antonio, Tex.	1190	252
WOC	Davenport, Iowa	1000	299.8
WOW	Omaha, Nebr.	590	508.2
WPTF	Raleigh, N. C.	680	440.9
WRC	Washington, D. C.	950	315.6
WREN	Lawrence, Kans.	1220	245.8
WRVA	Richmond, Va.	1110	270.1
WSAI	Cincinnati, O.	1330	225.4
WSB	Atlanta, Ga.	740	405.2
WSM	Nashville, Tenn.	650	461.3
WSMB	New Orleans, La.	1320	227.1
WTAG	Worcester, Mass.	580	516.9
WTAM	Cleveland, O.	1070	280.2
WTIC	Avon, Conn.	600 1060	499.7 282.8
WTMJ	Milwaukee, Wis.	620	483.6
WWJ	Detroit, Mich.	920	325.9
KDKA	Pittsburgh, Pa.	980	303.9
KFI	Los Angeles, Calif.	640	468.5
KGO	Oakland, Calif.	790	379.5
KGW	Portland, Ore.	620	483.6
KHQ	Spokane, Wash.	590	508.2
KOA	Denver, Colo.	830	361.2
KOMO	Seattle, Wash.	920	325.9
KPO	San Francisco, Calif.	680	440.9
KPRC	Houston, Tex.	920	325.9
KSD	St. Louis, Mo.	550	545.1
KSL	Salt Lake City, Utah	1130	265.3
KSTP	St. Paul, Minn.	1460	205.4
KTHS	Hot Springs, Ark.	800	374.8
KVOO	Tulsa, Okla.	1140	263
KWK	St. Louis, Mo.	1350	222.1
KYW-KFKX	Chicago, Ill.	1020	293.9

CANADIAN BROADCASTING SCHEDULE

CITY	Call	Kc.	Meters	TIME	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
Moncton, N. B.	CNRA	630	475.9	AS		1:45 - 3:30 PM 4:00 - 4:10 PM	1:45 - 3:30 PM 4:00 - 4:10 PM 9:00 -11:00 PM	1:45 - 3:30 PM 4:00 - 4:10 PM	1:45 - 3:30 PM 4:00 - 4:10 PM 8:30 -12:00 PM	1:45 - 3:30 PM 4:00 - 4:10 PM	1:45 - 3:30 PM
Quebec, P. Q.	CNRQ	880	340.9	ED			9:00 -11:00 PM		9:30 -12:00 PM		
Montreal, P. Q.	CNRM	730	411	ED			12:00*-12:30 PM 9:00 -11:00 PM		12:00*-12:30 PM 9:30 -12:00 PM		
Ottawa, Ont.	CNRO	690	434.8	ED		11:30*-12:30 PM 3:00 - 5:30 PM	11:30*-12:30 PM 3:00 - 5:30 PM 8:45 -11:00 PM	11:30*-12:30 PM 3:00 - 5:30 PM	11:30*-12:30 PM 3:00 - 5:30 PM 9:30 -12:00 PM	11:30*-12:30 PM 3:00 - 5:30 PM	11:30*-12:30 PM 3:00 - 5:30 PM
Toronto, Ont.	CNRT	840	357.1	ED			10:00 -11:00 PM		9:30 -12:00 PM		
London, Ont.	CNRL	910	329.7	ED			10:00 -11:00 PM		9:30 -12:00 PM		
Winnipeg, Man.	CNRW	780	384.6	CS	9:00-10:00 PM	9:00 -10:00 PM	11:00 -12:00 PM	6:30 - 7:30 PM	9:00 -10:00 PM	6:30 - 7:30 PM	
Regina, Sask.	CNRR	960	312.5	MS					8:30 -10:30 PM		
Saskatoon, Sask.	CNRS	910	329.7	MS	2:30- 3:30 PM	2:30 - 3:30 PM	2:30 - 3:30 PM 10:00 -11:00 PM	2:30 - 3:30 PM	2:30 - 3:30 PM	2:30 - 3:30 PM	2:30 - 3:30 PM
Edmonton, Alta.	CNRE	580	517.2	MS			10:00 -11:00 PM				
Calgary, Alta.	CNRC	690	434.8	MS		9:30 -10:30 PM			9:30 -10:30 PM		
Vancouver, B. C.	CNRV	1030	291.3	PS		10:30*-11:30* 10:00 -11:00 PM	10:30*-11:30* 9:00 -11:30 PM	10:30*-11:30* 10:00 -11:00 PM	10:30*-11:00* 10:30 -11:00 PM	10:30*-11:30* 8:30 -11:30 PM	

NEW PARTS

Hammarlund Mfg. Co.

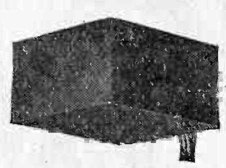


Three-stage screen grid radio frequency unit, wired and pre-tested.

Audio Transformer with high impedance primary.

Shielded RF choke with polarized outlets.

Power Block



Condenser Block, affording seven capacities at different working voltages, 600, 500, 400 and 300 volts.

Complete units for the audio and radio channels, separate audio units as well as many special RF components for screen grid receivers, have just been brought out by the Hammarlund Manufacturing Company, Inc., 424 West 33rd Street, New York City. The apparatus specially constructed to enable the design of these parts cost $10,000, while the tools made to permit their manufacture cost $55,000.

The new parts include a three-stage radio frequency band filter designed to work into a screen grid radio frequency amplifier; a three-stage screen grid radio frequency unit; a shielded polarized radio frequency choke, SPC at $1.50; a group of audio amplifying apparatus which includes single-sided and push pull transformers, and a power supply for the receiver as well as for one or two 245 tubes, this containing a specially designed power transformer, voltage divider, condenser block and choke unit.

The three-stage wired band filter unit, BS-3, is a completely wired and assembled three-stage band filter pre-selector tuning unit, containing a matched .0005 mfd. three gang Battleship Midline condenser housed in an aluminum shield, and a set of three special radio frequency filter coils, each enclosed in a copper can. This unit permits absolute flat top tuning, producing a pure radio frequency signal for entrance into the RF and AF amplifying channels. List price, $27.

The companion unit to the BS-3 is the three-stage screen grid RF amplifier, RF-3, also completely wired and assembled. This also contains a matched .0005 mfd. three gang Battleship Midline condenser, enclosed in an aluminum can with partitions shielding each condenser, and three matched RF coils in separate copper cans, each can also containing the shielded RF choke. The RF unit which feeds into the detector also contains a metallized grid leak and mica condenser. List price, $35.

To further prevent feedback and permit greater amplification, there is the aluminum screen grid tube shield, TS, list price, 60 cents.

The first stage audio frequency transformer, AF-2, has a ratio of 1½ to 1, while the ratio of the push-pull input transformer, AF-4, is 2 to 1, on each side. List Price, each, $8.

The primaries of both transformers are very large. This coupled with the use of treated laminations grouped in a special way into unusually large cores permits *uniform* amplification from as low as 46 cycles to as high as 4800 cycles.

One of the output transformers, AF-M, is an impedance matching unit designed to match 245 tubes to magnetic speakers, while the other AF-D, works directly into the moving coil of a dynamic speaker. List price, each, $8.

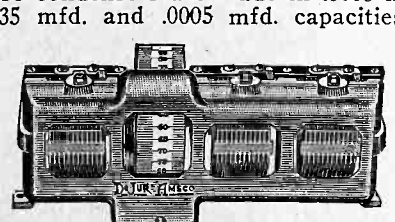
The power supply unit, PS-45, consists of a high voltage transformer, with a 110 volt primary, tapped at 80 volts for use with a voltage regulator. The high voltage secondary has an output of 750, is rated at 100 mils, and is center tapped. There is also a 5 volt, 2 ampere center-tapped winding for supplying filament voltage to a 280 tube; a 2½ volt, 3 ampere center-tapped winding for the filaments of a pair of 245 tubes, and a 2½ volt, 9 ampere winding for the filaments of five 224 or 227 tubes and two 30-henry chokes. List price, $24.

The voltage divider, RHQ-30, consists of a 9525 ohm wire wound resistor conservatively rated at 30 watts, tapped at 850, 3000, 2160 and 2375 ohms. List price, $2.50.

The filter condenser block, CHQ-30, has seven condenser sections consisting of a 2 mfd. condenser rated at 600 volts, a 4 mfd. condenser rated at 500 volts, a 2 mfd. condenser rated at 400 volts, a 1 mfd. condenser rated at 300 volts, a 1 mfd. condenser rated at 400 volts and a pair of 1 mfd. condensers, each rated at 200 volts. Pig-tail leads are provided for sub-base connections. List price, $16.50.

Dejur-Amsco Corporation

The newest addition to the DeJur-Amsco line is a series of multiple condensers of the bathtub type, with dial assembly completely matched and balanced. These condensers are made in .0003 mfd., .00035 mfd. and .0005 mfd. capacities in



Gang Condenser with Dial Assembly

single double and quadruple units. Two .00035 mfd. types may be had, in standard and short lengths. Dial assembly may be included. The De-Jur Amsco Corporation's address is Broome & Lafayette Streets, New York City.

KELLY TUBE CO.

An exclusive tube, the 228- high mu AC, otherwise like the 227, is made by Kelly Tube Co., 143 West 45th Street, New York City.

Radiall Company

The Radiall Company, makers of Amperites, announces a new self-adjusting line voltage control for AC sets, to eliminate all line voltage troubles. Different from any other appliance of this kind, it is made in glass bulb form, resembling in appearance the standard radio tube, the glass being opalescent. The bulb contains the resistance unit which is surrounded with an inert gas, which gives the line Amperite its precise regulating properties over a fluctuation of from 95 to 125 volts, the resultant voltage remain-

Automatic Line Voltage Regulator

ing steady at a predetermined value. The device is provided with the UX type base. This device can be used in any part of the country, being designed to work against the widest line fluctuations which run as high as 30 volts in many sections. Many of the leading makes of standard receivers now coming on the market will be equipped with this precise regulator. Continuous life tests in the Radiall laboratories show a life of 3,000 hours and over, and it is guaranteed by the Radiall Company for a life of 2,000 hours at maximum voltage.

Cornish Wire Company

In addition to their line of Corwico Braidite Wire for every radio use, the Cornish Wire Company, 32 Church Street, New York City, announces the new Corwico Vulcan Lightning Arrestor. This arrestor carries insurance up to $100 for lightning damage to any set on which

Lightning Arrestor in attractive case

it is installed. It is durably made to stand up under hard use and adverse conditions and functions to guard the set against electrical discharges also aiding in detouring static charges, making reproduction less noisy. It comes handsomely boxed, each box containing the insurance guarantee. The list price is $1.00.

Duovac Radio Tube Corp.

The Douvac Radio Tube Corporation, 360 Furman Street, Brooklyn, N. Y., announces a complete line of radio tubes for 1929-30. Duovac uses a method of rigid element suspension to prevent heat expansion from altering spacing of tube elements.

Clarostat Mfg. Co.

Among the new parts brought out by the Clarostat Manufacturing Co., 291 North Sixth Street, Brooklyn, N. Y., is the Super-Power Clarostat, the giant member of the Clarostat family. It is a type of the heaviest duty adjustable resistor. The Super-Power Clarostat is furnished in three ranges, filament range, ¼ to 10 ohms; low range, 25 to 500 ohms; universal range, 100 to 100,000 ohms. It withstands high temperature when dissipating up to its maximum capacity of 250 watts. Finished in nickel, with mica and asbestos insulation. List price, $6.

This device dissipates up to 250 watts.

Pacent Electric Co.

The Pacent Electric Company, 91 Seventh Avenue, New York City, announces several new Phonovox models, series 106; a new Electric motor and Phonotrol as among their leading items. These models are especially designed to meet the requirements of power amplifiers and power speakers. They are claimed to cover a frequency range of from 40 to 8,000 cycles with a practically flat curve. Needle scratch has been practically eliminated by lessening the natural period of resonance of the armature end of the pick-up unit as a whole. The three distinctive models are all finished in a modernistic note. The Super De Luxe Model 106A lists at $12.50. The Super De Luxe Model 106B lists at $15. The Ultra Phonovox 106 is equipped with counterbalanced tone arm and automatic on-off switch built in base of stand, and lists at $35.

A new model Phonomotor, Model 140, for 50-60 cycles, also is ready. This is of the squirrel cage induction type. The list price is $25, complete, with 12" turntable.

The Phonotrol for use with any radio set-phonograph combination gives access to either type of entertainment at the throw of a switch. A volume control is built in. The Phonotrol box measures only a trifle over 4" all around.

Polymet Mfg. Corp.

The Polymet Manufacturing Corporation, 829-839 East 134th Street, New York City, announces a line of small molded condensers, with insulated mounting hole, condenser size, ¼x21/32"x1½", in all capacities up to .006 mfd. This concern also announces two unusual volume controls, one a metal shell type with a resistance element made of a special compound. Outside diameter is 1½". It can be made up in any required taper and is recommended for use when any resistance of more than 5,000 ohms is required. The second new type of Polymet volume control is a wire wound type cased in a bakelite shell. It is recommended for use when resistances of less than 5,000 ohms are required.

A THOUGHT FOR THE WEEK

THERE will be two dramas based on radio on the boards this season. Page the managers who said they'd never book a play based on radio, their arch enemy.

Insuline Corporation

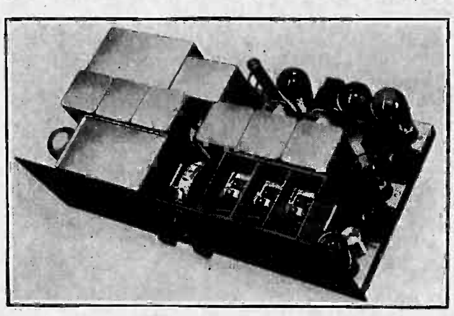
Among the new apparatus of the Insuline Corporation of America, 78-80 Cortlandt Street, New York City, are a lightning arrestor (list, $1.00), an Antennavolt, $2.25, and a Filtervolt. The new Antennavolt is an air-cooled device, designed to act as a line voltage control, line noise eliminator with fuse action, lightning protection and antenna elimination.

New Antennavolt

The new Filtervolt is made in two models, Senior and Junior, and is designed to filter out the man-made static. The Senior model lists at $15. The Filtervolt, Jr., for light duty, lists at $3.

Hammarlund-Roberts

The appearance of the 1930 model Hammarlund-Robers H.-Q is shown in the accompanying illustration. The eye appeal is of a high order. The circuit developed is said to be most remarkable, but the sponsors of this kit-circuit are not desirous of revealing the circuit diagram and other electrical information just yet, as they were annoyed by copyists of their fine creations in the past. But preparations are being made for an early presentation of all the intimate details of the circuit in Radio World.



View of the Hi-Q 30

Polo Engineering Labs

This season Polo Engineering Laboratories, 57 Dey Street, New York City, is featuring a line of power apparatus, including as leading features a 245 Power Supply that compactly contains the filament, high voltage and primary windings (110 v AC, 50-60 cycles, 40 cycles or 25 cycles), as well as two 30-henry chokes, also contained in the same steel casing, which is cadmium plated. The Laboratories have adopted a policy of selling direct to the consumer, and have priced their products at an equivalent of 50 per cent. off what otherwise would be the list price.

SPECIAL NOTICE

Several columns of announcements of other new parts, made by such leading manufacturers as Electrad, Inc., Silver-Marshall, Ferranti, Inc., Silver-Marshall, had to be omitted from the present issue of Radio World due to lack of space, but will be published next week, in the September 28th issue. All constructors will want to obtain the first-hand information on new parts, so should be sure to obtain the September 28th issue.

Literature Wanted

H. D. Barbour, 866 Warsaw Ave., Winnipeg, Man., Can.
Thomas Lewis, 271 E. Market St., Wilkes-Barre, Pa.
Frank Clifford, 581 Bethune Ave., E., Detroit, Mich.

Aerovox Wireless Corp.

The Aerovox Wireless Corporation 70-72 Washington Street, Brooklyn, N.Y., announces a new line of filter and by-pass condenser blocks, designed to work under heavy drain. These may be had also in block combinations in two sections: a filter section and a by-pass section. The universal units come in eight types, priced from $6.75 to $25, while the by-pass units come in four types, from $2.40 to $9. A new line of Universal Pyrohm resistors is announced. Any resistance value may be obtained simply by connecting units in series. In a wide variety of types, covering all uses, they list for from $1.25 to $2.50. The Aerovox Corporation also offers a line of non-inductive condensers, socket power condensers, resistors and line noise interference eliminators. All these are shown in a handsome new catalog.

Filter-By-Pass Condenser in one case.

Pyrohm Resistor

Bodine Electric Company

The Bodine Electric Co., Chicago, Ill., announces the new Type RC-10 Electric turntable unit, single phase, operating without commutator or brushes. It lists at $35 for 110-115 volt, 50-60 cycles, for 25-30 cycles, $38. The Eastern representatives are Stoner & Heath, Inc., 122 Greenwich Street, New York City.

The Audak Company

The Audak Company, 565 Fifth Avenue, New York City, announces a new phonograph pick-up. It may be had for use with AC or battery receivers. Model number 1, de luxe, is priced at $30, and model number 2 at $16.75.

Cornell Electric Mfg. Co.

The Cornell "Cub" Condenser is the latest development of the Cornell Electric Mfg. Co., Long Island City, New York. It may be used with the standard grid leak or with any pigtail leak as it can be wrapped around the grid leak wires and both units soldered with one operation. It is available in capacities from .0001 to .02.

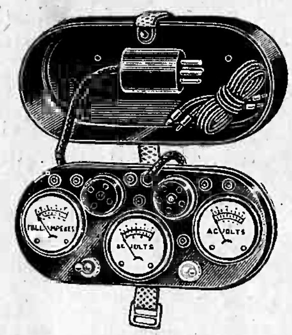
New Corporations

Mariners Radio Service—Attys. Vogel & Whynam, 389 Broadway.
National Union Radio Corp., Jackson Heights, N. Y.—Corporation Trust Co. of America, Dover, Del.
Pilgrim Radio Distributing Corp., supplies—Atty. F. S. Rauser, 38 Park Row, New York, N. Y.
Jewish Broadcasting Corp.—Atty. N. Zvirin, 26 Court St., Brooklyn, N. Y.
Transport Radio Equipment Corp., Farmingdale.—Atty. F. C. Dowd, Farmingdale, New York.
Pathe Sound Pictures, Inc., Dover, Del.—United States Corp. Co., Dover, Del.
Kimbel Radio Corp.—Atty. L. J. Peltin, 501 East 161st St., New York.
National Union Radio Corp. of New York—Attys. Chadbourne, Stanchfield & Levy, New York, N. Y.
Paramount Radio and Electric Co., Northfield, N. J.—Atty. Clarence E. Knauer, Atlantic City, N. J.
S. Shearn, radio supplies—Attys. Rothstein & Rothstein, 225 Broadway, New York, N. Y.
Radio Products Corp., Jersey City—Corporation Trust, Jersey City, N. J.

The New Readrite TUBE and SET TESTER

Model 245

Tests Screen Grid



Model 245, Tube and Set Tester, with braid strap and leather handle.

What a comforting assurance it is to have a tube-and-set-testing outfit in shooting trouble in a receiver! You want one that is compact, and reliable and that tests the new tubes as well as the old. These advantages are provided by the new Readrite Model 245, over-all dimensions, 4 x 8½ x 3¼". This tester is especially designed for the new sets with screen grid and 245 power tubes. The case cover is a unique feature, providing space to carry all cords, cable and adapter. The three double-reading meters are: milliammeter 0-20, 0-100; D.C. voltmeter 0-60, 0-300; A.C. voltmeter 0-10, 0-140. The plug attached to the cable is connected into the set socket for testing the set and the tubes. The cable leads are connected to the tip jacks, as required, depending on the reading range required of the two voltmeters. Extra cords permit the use of each meter individually. You can test not only AC and DC tubes, including screen grid, for filament and plate voltage and plate current, but also line voltage, whether AC or DC. Complete, compact, beautiful to behold, the Model 245 is built in a metal case, with metal slip-on cover, both finished in attractive enamel with Oriental finish. Eye appeal and technical appeal are combined in the Model 245, which is a boon to every service man and experimenter.

We manufacture a complete line of meters, AC and DC, as well as other types of tube and set-testing devices. Send for our catalogue. Mention "Radio World."

Readrite Meter Works
[ESTABLISHED 1904]

12 College Avenue Bluffton, Ohio

LYNCH

Manufacturers of LYNCH RESISTORS, EQUALIZORS, SUPPRESSORS, MOUNTINGS, RESISTANCE-COUPLED KITS, ETC.

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Blueprint FREE!

Get a free blueprint of either circuit listed on the coupon below, by sending $1.00 for eight weeks' subscription for RADIO WORLD, or send $1.50 for 13 weeks' (quarter of a year) and get both blueprints free!

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Enclosed please find:

☐ $1 for which send RADIO WORLD for 8 weeks and send free blueprint of the battery model 4-tube Screen Grid Diamond of the Air.

☐ $1 for which send RADIO WORLD for 8 weeks and send free blueprint of the 4-tube AC Scren Grid Diamond of the Air.

☐ $1.50 for which send RADIO WORLD for 13 weeks and send both blueprints free.

(If renewing a subscription put cross here)

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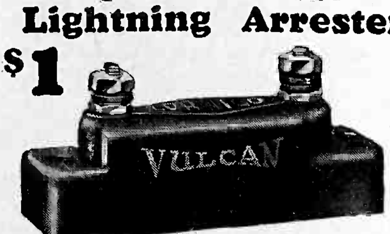
CORWICO VULCAN Lightning Arrester

$1



$100 Guarantee Against Lightning Damage Enclosed in Each Box
Also dissipates accumulated static charges, thus improving reception
At Your Dealer or Direct Upon Receipt of Price.

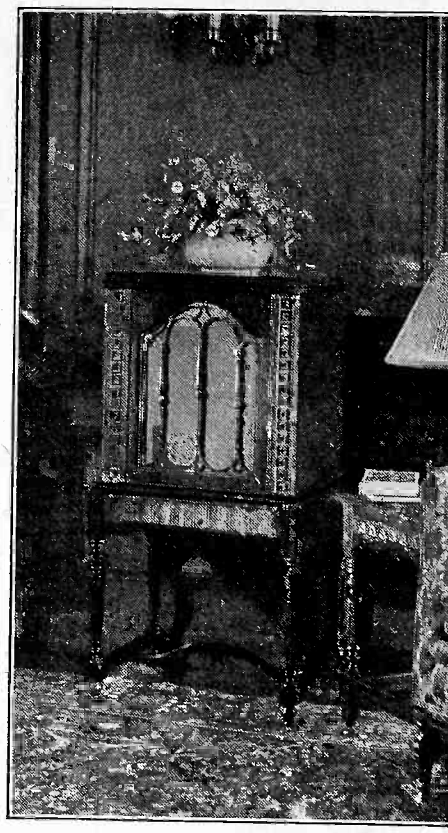
CORNISH WIRE COMPANY
32 Church Street, New York City
Makers of Corwico BRAIDITE Hook-up Wire

PEERLESS

12" AC Super Dynamic Speaker in SONORA Highboy Cabinet

At Only $37.50

LIST PRICE, $155.00



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

Amazing Buy!

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

Money-Back Guarantee!

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

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

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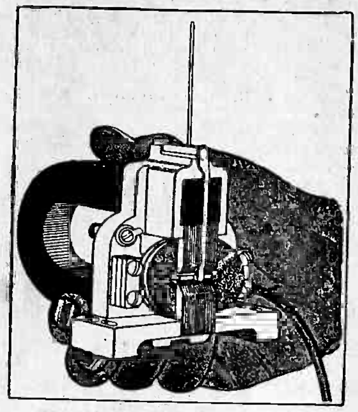

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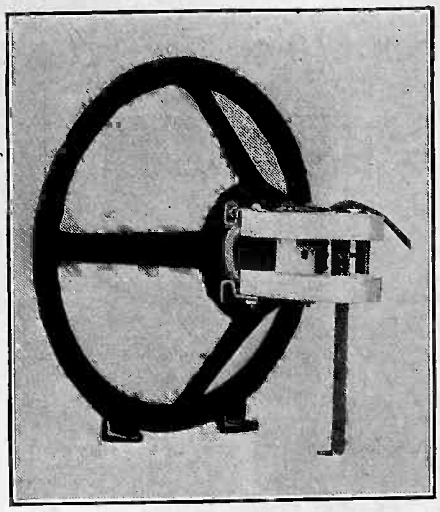

Absolutely the best tone quality, with amazing sensitivity, is assured when you use the Inductor Speaker on a fine audio amplifier. The chassis is sold completely erected with a supporting brace. The unit, cone spider and ring, are sturdily put together. Use a baffle board or box of your own choice. Baffle instruction sheet in each carton.

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For single 112, 112A or 210 output tube, 9" diameter, order Cat. N9R. For 171, 171A, 245 or 250 single output, or ANY push-pull output where you have an output transformer or midtapped impedance order Cat. N9G @ $11.95 net.

Same as above, only 12" outside diameter, N12R for tubes in previous "R" Model, and N12G for tubes to previous "G" Model @ $12.95 net.

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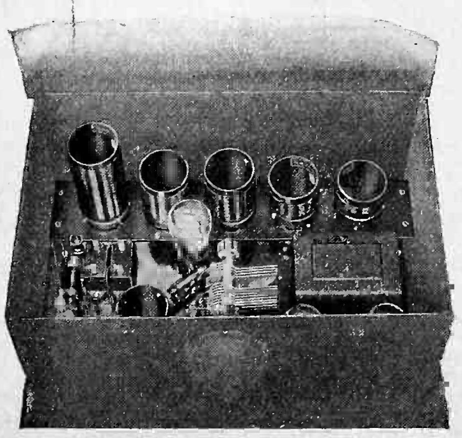

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4 TUBE THRILL BOX SW-4

All parts, all six coils, cabinet @ more than 40% off list...$33.00 net
Velvet B, 3580; 280 tube free..$16.13 net

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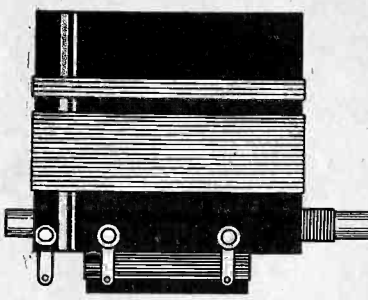
A NEW IDEA IN COILS!

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

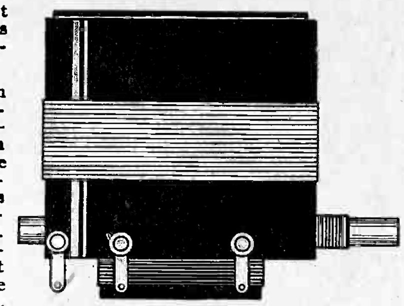


Cat. No. BT5A—$2.50
FOR .0005 MFD. CONDENSERS
Bernard Tuner for antenna coupling, the primary being fixed and the secondary tuned. This coil is used as input to the first screen grid radio frequency tube. The double-action tuning method invented by Herman Bernard is employed. Adjust an equalizing condenser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

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

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

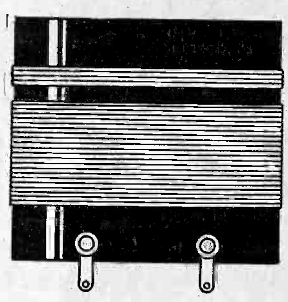
The Bernard Tuner is a two-winding coil for interstage coupling, working out of a screen grid tube, 222 or 224, and into any type tube. The tuned primary has coupled to it a still larger inductance, on separate inside form, for step-up, thus greatly increasing an already enormous amplification. This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



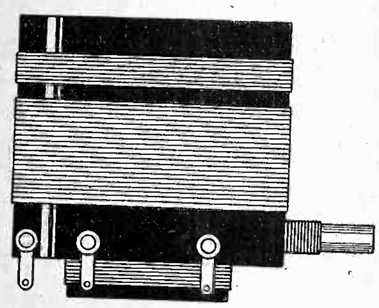
Cat. No. BT5B—$2.50
FOR .0005 MFD. CONDENSERS
Bernard Tuner for working out of a screen grid tube, consists of a rotary coil in series with a fixed coil, the two constituting a tuned primary, for tuning the combined rotary and fixed windings to exceed the broadcast band of wavelengths. The condenser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

The Diamond Pair

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



Cat. No. RF5—$0.75
FOR .0005 MFD. CONDENSER
Antenna coil for any standard circuit, and one of the two coils constituting the Diamond Pair. The secondary is carefully wound to match the inductance of the companion coil's secondary, so equality of tuning prevails.
Cat. No. RF3 for .00035...$0.80



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

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

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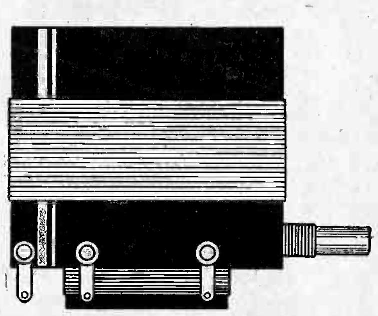
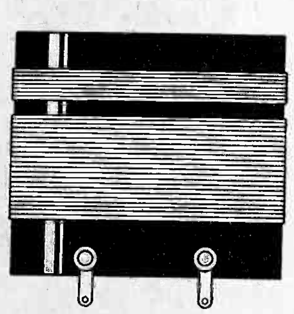


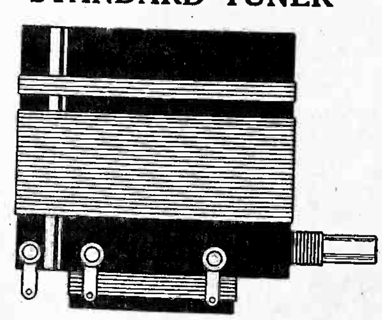
Cat. No. VA5—$1.10
FOR .0005 MFD. CONDENSER
Moving primary and fixed secondary, for antenna coupling, adjustable from a knob at the front panel, thus providing volume control.
Cat. No. VA3 for .00035 mfd..........$1.15

SG TRANSFORMER



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

STANDARD TUNER



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

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

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

Quantity Cat. No. Price	Quantity Cat. No. Price	Quantity Cat. No. Price	Quantity Cat. No. Price
☐ BT5A@$2.50	☐ RF5@$0.75	☐ VA5@$1.10	☐ SGSF@$0.75
☐ BT3A@$2.55	☐ RF3@$0.80	☐ VA3@$1.15	☐ SGS3@$0.80
☐ BT5B@$2.50	☐ SGT5@$1.25	☐ T5@$1.25	☐ FL4@$0.35
☐ BT3B@$2.55	☐ SGT3@$1.30	☐ T3@$1.30	☐ EQ80@$0.35

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Insulated Link

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

FL4..$0.35

Data on Construction

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

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

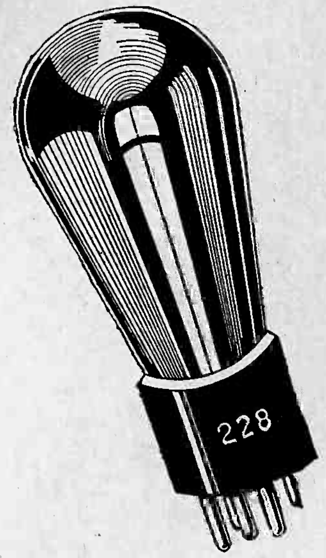
Only the Bernard Tuners have a shaft extending from rear. This feature is necessary so that physical coupling to tuning condenser shaft may be accomplished by the insulated link.

[Note: Those desiring the 90 mmfd. equalizing condenser for use with the antenna model Bernard Tuner, BT5A or BT3A, should order EQ80 at $0.35.]

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

New High Mu AC Tube

228 Provides Higher Amplification and is an Excellent Power Detector



228 AC High Mu Tube, with an amplification factor of 45 is an exclusive contribution to tube science by Kelly laboratories.

WHEN signals are weak in an up-to-date AC receiver using 227 tube as detector or audio amplifier, replace the 227 with the new 228 high mu AC tube and be amazed at the difference in volume.

The up-to-date receivers have high impedance primary in the first audio transformer, or have a resistor in the plate circuit, so the high mu tube is a boon indeed.

As a detector the 228 can be used with leak and condenser, with grid returned to cathode, or as a negative bias (power) detector. See table, lower left corner.

Since the 228 has the same base, same prongs and same heater voltage as the 227, it can be used for replacement and improvement, and without requiring any wiring changes or any other changes. Simply insert the 228 in the socket from which the 227 is removed.

228
$2.50

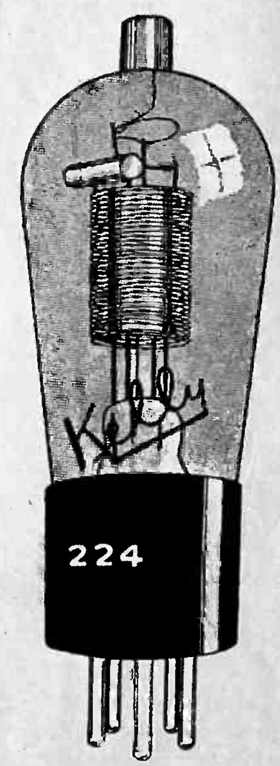
CHARACTERISTICS OF THE 228

Heater voltage 2.5 volts AC.
Heater current 1.75 amperes.
Amplification factor 45.
Mutual conductance 1,000.
Plate voltage 180 volts.
Grid bias, detector —6 volts.
Grid bias, amplifier —2.5 volts.
Load resistance, 0.1 to 0.5 meg.
Internal plate resistance 45,000 ohms.

The plate current under normal operation is less than one milliampere. Hence the 228 tube imposes minimum load on the B supply.

The 228 is not suitable as a radio frequency amplier.

224 at $3.00—245 at $2.25—227 at $1.50—226 at 95c



The screen grid tubes have proved not only their capability but their dependability, and in AC circuits the 224 AC screen grid tube is popularly used as amplifier and detector, with the 245 as output, singly or in push-pull. Safe and satisfactory, Kelly 224 tubes are made with the same expertness and precision that characterizes the entire line of Kelly tubes. Our products are used by laboratories, technicians, experimenters and general consumers because of proven merit.

The Kelly 224 screen grid tube is not only excellent as a radio frequency amplifier but as a detector, especially applicable as a space charge detector.

A suitable high impedance load should always be in the plate circuit of any screen gride tube. For RF a large untuned primary, or a tuned primary, for detection and AF a resistor of 50,000 ohms or higher, usually considerably higher, or a high impedance inductance. You will find Kelly 224 fully meets your most exacting requirements.

The 224 and 227 are 5-prong (UY) tubes, the 245 and 226 4-prong (UX) tubes.

Battery Type Screen Grid 222 at $3.50

The battery operation the 222 screen grid tube is an important contribution, because enabling such high amplification that battery circuits are put on a par with AC circuits in performance. The 222 is the most popular battery-operated tube for up-to-date circuits and the Kelly model is made to produce clear reception and have exceptionally long life.

5-Day Money Back Guarantee!

You run no risk whatever when you purchase Kelly tubes. Not only are they expertly made but they are sold on a 5-day money-back guarantee. This exclusive form of protection enables you to be the ultimate judge in your own laboratory or your own home, with no appeal from your decision on our part. If you are not delighted with the performance of Kelly tubes, we are not even satisfied, and will promptly refund your money on the foregoing 5-day basis.

If at any time after the five days expire, after receipt of tubes by you, there should develop any adverse condition for which you deem the tube at fault, you may communicate directly with us, and we will give the matter prompt attention. Our aim is to render a real service and through such efforts have we built up our volume of business.

Types of Tubes and Their Voltages

		Amplifier		Detector		Remarks
Tube	Fil. Volt	Plate Volts	Neg. Bias	Plate Volts	Neg. Bias	
228	2.5 AC	180	2.5	180	6	Heater type, 5 prongs.
224	2.5 AC	180	1.5	180	6	Heater type; SG volts, 75
245	2.5 AC	250	50.0	—	—	——
226	1.5 AC	135	9.0	—	—	——
227	2.5 AC	180	9.5	180	18-25	Heater type
171A	5ACorDC	180	40.5	—	—	——
210	7.5 AC	350	27.0	—	—	——
250	7.5 AC	450	84.0	—	—	——
280	5.0 AC	350AC	—	—	—	Full-wave rectifier
281	7.5 AC	700AC	—	—	—	Half-wave rectifier
222	3.3 DC	135	1.5	135-180	4-7	SG volts, 45
240	5.0 DC	135-180	3-4.5	135	1.5-3	——
112A	5.0 DC	135	9.0	135	Leak-cond.	——
UX199	3.3 DC	90	4.0	90	Leak-cond.	——

Kelly Tube Company, 143 West 45th St., N. Y. City

Enclosed please find $.......... for which ship at once tubes marked below:

☐ 228 AC high mu, @.........$2.50	☐ 222 battery screen grid........$3.50
☐ 224 AC screen grid @........$3.00	☐ 240 battery high mu...........$1.25
☐ 245 AC power tube @........$2.25	☐ 112A battery power tube.......$0.95
☐ 226 AC amplifier @.........$0.95	☐ 171A battery power tube.......$0.95
☐ 227 AC det.-amp. @.........$1.50	☐ 201A battery tube.............$0.65
☐ 171A AC power tube @.....$0.95	☐ UX199 battery tube..........$1.25
☐ 210 AC power tube @.........$4.50	☐ Matched pair of 245s for push-pull (for both)..............$4.50
☐ 250 AC power tube @.........$6.00	☐ Matched pair 171As for AC Push-Pull (for both).........$1.90
☐ 280 AC rectifier @...........$1.75	
☐ 281 AC rectifier @...........$3.50	

ALL PRICES QUOTED ARE SELLING PRICES AND ARE NET

Name ....

Address ....

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

☐ Put cross here if C.O.D. shipment is desired.

An Outstanding Achievement

4 SCREEN GRID TUBES • POWER DETECTION • BAND SELECTOR TUNING • RAINBOW PROJECTOR DIAL

WESTERN UNION

Chicago, Ill. September 1929.

NATIONAL CO INC
MALDEN Mass

ON LABORATORY ASSEMBLY AND [illegible] TEST OF MB-29 [illegible] ELECTRICALLY [illegible] SHOULD BE RECOGNIZED TO RADIO [illegible] EFFICIENCY AND ECONOMY [illegible]

[illegible] Hall Managing [illegible] Citizens Radio [illegible]

Sangerville, Maine
September 3, 1929

National Co., Inc.
61 Sherman St.
Malden, Mass.

Gentlemen:

Received your [illegible] Kit last Monday morning and Monday night it was completely wired and is connected to my last year's National Power Amplifier and tuned with Chicago on a three-foot antenna.

I was so pleased with the simplicity of wiring a set with as many tuned stages as this one that I take this opportunity to express my satisfaction to you, the manufacturer.

Yours truly

David Barker

SCIENCE & INVENTION
SCREEN BOOK
AMAZING STORIES
RADIO NEWS
COMPLETE DETECTIVE NOVEL

MACKINNON-FLY PUBLICATIONS, INC.
EXPERIMENTER PUBLICATIONS, INC.
NOVEL MAGAZINE CORPORATION
381 Fourth Ave., New York

National Co. Inc
61 Sherman St.
Malden, Mass.

September 10, 1929.

Gentlemen:

We were particularly interested in the MB-29 receiver which we have just received.

The character of the design is in line with the most advanced developments in radio receivers and design of the same character will undoubtedly be found in some of the more expensive receivers offered for sale during the coming season.

The care with which the work has been carried out and the completeness with which it has been followed through, must in the final analysis, be extremely helpful to the entire radio business.

With best wishes for the success of your enterprise in selling this splendid receiver, and in the sincere belief that you will be successful in doing so, I am

Cordially yours,

Arthur H. Lynch

Arthur H. Lynch,
Editorial Director.

6559 N. Ashland [illegible]
Chicago, Ill.
Sept. 4, 1929

National Company, Inc.,
Malden, Mass.
Gentlemen:

While visiting Mr. William J. Halligan at the above address, I had the pleasure of listening to his MB 29 set which your Company manufactures.

Its truly wonderful tone quality together with the total absence of objectionable noises so impressed me that my particular [illegible] to learn if I can obtain a similar outfit will be greatly appreciated.

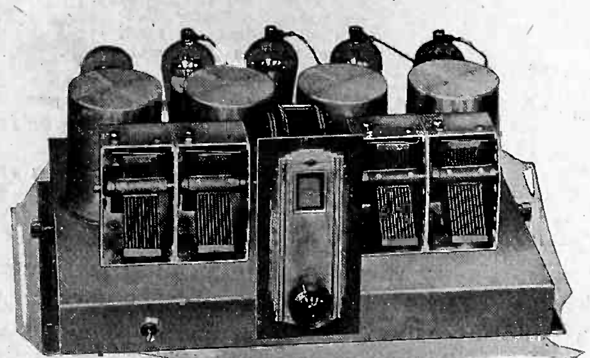
If I can obtain the excellent musical reproduction that I heard on Mr. Halligan's set, you can rest assured that you have won another radio enthusiast.

Hoping that I may receive your literature and prices at an early date, I am

Very truly yours,

[illegible] Allen

P.S. Please mail to me at the above address, for forwarding



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RADIO WORLD
The First and Only National Radio Weekly—Eighth Year
[illegible] Street, New York, N. Y.
Telephones: Bryant 0558, 0559

Sept. 7, 1929

National Company, Inc.,
Malden, Mass.

Gentlemen:

When I first saw your MB-29 circuit I was much impressed by its skillful electrical and mechanical design. It tempted my desire to possess as very few receivers have done. Since that time I have studied it very carefully from every point of view, and in no particular have I found it to be wanting. It would be difficult, indeed, to improve it.

The circuit has a sensitivity more than sufficient to satisfy all reasonable demands; a selectivity that commends it to places where interference is exceptionally severe; an appearance that pleases the eye; and an ease of operation which enables the most inexpert to bring out all its capabilities.

You are to be congratulated on the design and production of such a circuit.

Yours sincerely,

J. E. Anderson

J. E. Anderson
Technical Editor

SUBSCRIPTION RATES: $6.00 YEARLY (52 ISSUES); $3.00 SIX [illegible] 15¢ A COPY

WGS

Manomet, Mass.
July 20, 1929

National Co. Inc
Malden
Mass.

Gentlemen:

I have just tried my Velvatone MB-29 and the performance is most gratifying [illegible] pretensions to [illegible] to hear programs [illegible] fidelity, particularly as [illegible] no [illegible] in range or selectivity [illegible]

I am more than pleased with the set in every way.

Cordially yours,

William [illegible]

HENRY [illegible]

September 2, 29

National Company Inc.
Malden, Mass.
Gentlemen:

The [illegible] for the M.B. 29 have arrived and I want to express my appreciation of your remarkably complete kit. Never before have I ever bought any radio equipment, so beautifully constructed and so complete in all necessary wire, resistors, condensers, etc. You are entitled to be complimented on your excellent achievement.

I find it will be best to provide a separate power supply for the M.B. 29. I am assuming that the "Velvet" [illegible] will take care satisfactorily of the power needs of the unit and am therefore ordering one from you direct;

I will be very glad to report to you my success with the M.B. 29 when completed. Yours very truly,

Henry [illegible]

National Co Inc
Malden Mass

I have just assembled a National MB 29 tuner. Altho I have not as yet had the time to properly test this receiver I have already received over forty stations with it. The set is very selective and I have received [illegible] easily, as many [illegible] times very [illegible] the best one I have operated to date.

Very truly yours
J. F. McColgan
20 [illegible] Ave
Jamaica Plain Mass

Parts Used: Aluminum base, sockets, binding posts, NATIONAL Screen Grid Transformers, individual aluminum coil shields, 5 cord cable, A. C. switch, Volume Control, resistors and choke coils, all necessary by-pass condensers, NATIONAL Rainbow Dial, NATIONAL Weld-Built Condensers.

NATIONAL SCREEN GRID TUNER MB-29

NATIONAL COMPANY INC.

ENGINEERS AND MANUFACTURERS Est. 1914 W. A. Ready, Pres. 61 SHERMAN ST., MALDEN, MASS.