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RADIO WORLD

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The First and Only National Radio Weekly

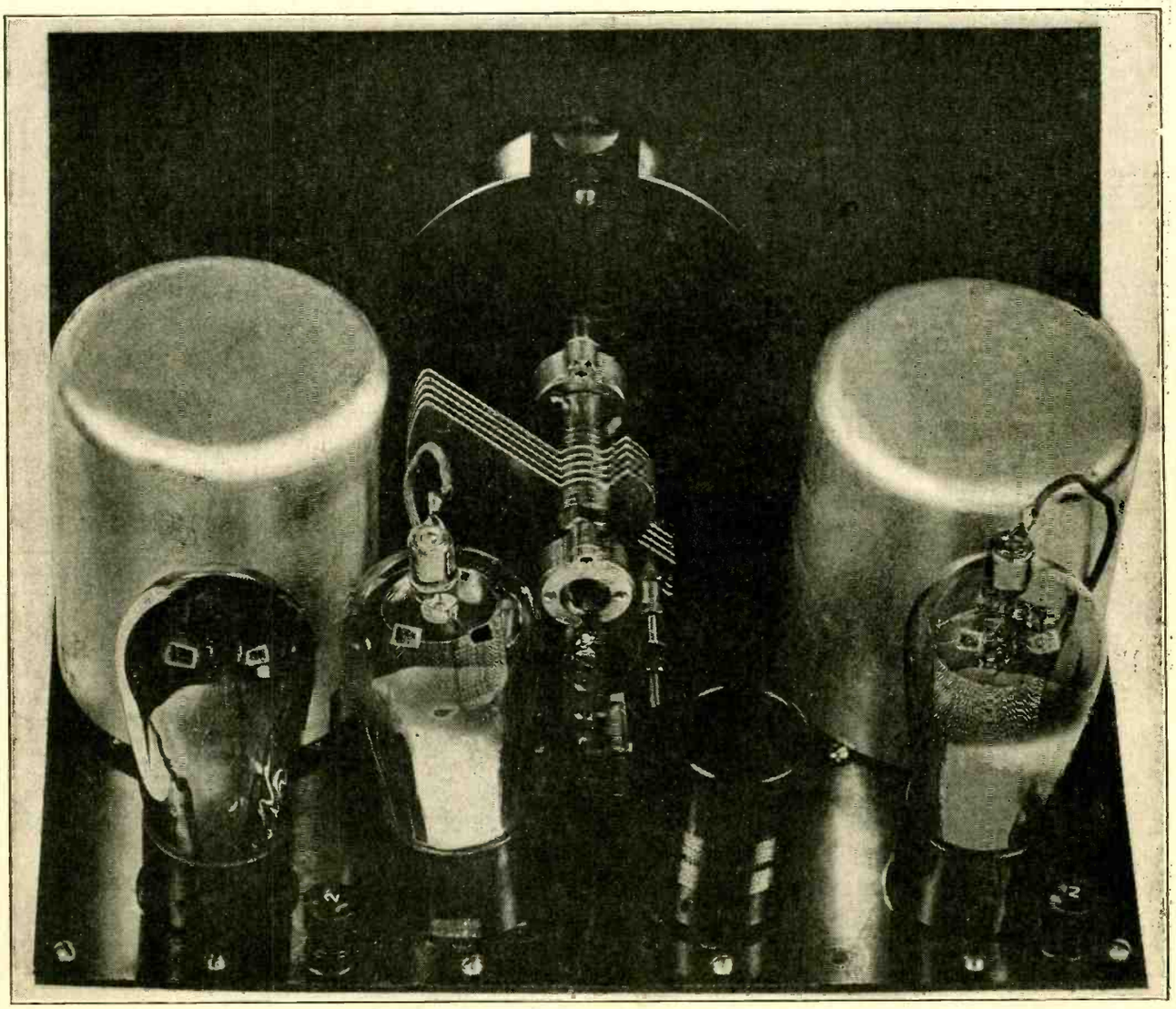
472d Consecutive Issue—TENTH YEAR

USES FOR A 1-TUBE SET

Full Details on New Output Pentode

ALL U. S. BROADCAST STATIONS BY FREQUENCY

(Nine Full Pages)



A new improvement in short-wave condensers is established in the use of a constant impedance pigtail and rear-shortened shaft to prevent the effect of a short-circuited turn. The condenser is shown in an all-wave converter. See pages 10 and 11.

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

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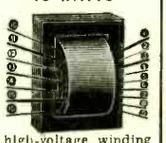
Earl Power Transformer

70 WATTS



Make money revamping the old battery set. This power transformer used in Earl Model 22 receiver supplies "A," "B" and "C" potentials for: two '27's (for screen - grid '24's), three '26's, two '71A's and one '80 rectifier; total current output of high-voltage winding at maximum output (about 200 volts) is 80 ma. High-voltage secondary, filament winding for '27's, and for '71A's are center-tapped. May be used in any number of combinations. Suitable resistors, a couple of 4-mf. filter condensers, two 30-henry chokes and by-pass condensers complete fine power pack. Size 3¾ x 3 x 2¾ inches. 16 long leads and full wiring directions. Shipping weight 5 lbs. List Price $7.50.

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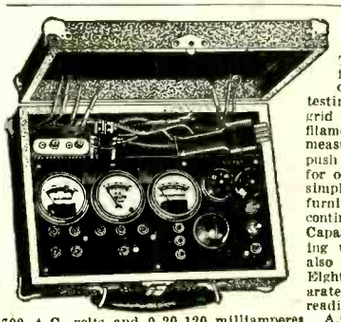

New READRITE Analyzer.

This three-meter analyzer has selector switch for checking all parts of tube circuits by connecting to the set sockets. Selection for testing voltages of plate, grid, cathode and screen-grid done quickly and accurately. Plate current, filament volts, line and power supply volts are measured. Grid swing test for tubes used. Just push one button for screen-grid and other button for other tubes. Makes testing of all type tubes simple and thorough. 4½-volt grid battery is furnished. Battery is used for grid test and continuity testing of transformers, chokes, etc. Capacity and resistance charts furnished showing use of instruments for testing condensers, also measuring resistances up to 100,000 ohms. Eight scale readings of meters may be used separately with the jack terminals provided. Scale readings are 0-60-300-600 D.C. volts, 0-10-140, 700 A.C. volts and 0-20-120 milliamperes. A.C. and D.C. filament voltages are accurately measured on the one meter. Strong case with leatherette covering. Attractive. Compact. Complete. Fills every need for the expert serviceman or the beginner for radio set analyzing. Size 10¾x3½x8 inches. Shipping weight 15 lbs. List Price $25.00.

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Choice of	Choice of	Choice of	Choice of
226	112A	245	222
227	200-A-199UX	280	210
171A	199UV-120	171	250
201A	224		281
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110-volt, 60-cycle A.C. light socket supply for field excitation with Westinghouse dry rectifier. 9 in. high, 9½ in. wide, 7½ in. deep. Speaker comes packed in wooden crate. Weight 19 lbs. It is one of the most powerful as well as best reproducers in the market. 9-inch cone.

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No. 1506—YOUR SPECIAL PRICE **$7.45**

Kolster Power Transformer

85 WATTS

Will supply sufficient current and voltage for push-pull '10's, in conjunction with type '81 half-wave rectifiers. The 2.25-volt secondary output is just below the rated maximum for type '24 and '27 tubes; tubes will last much longer than when heated from a higher-voltage transformer. Four secondaries are rated as follows: Secondary S1, 7.5 V., 1.25 A.; S2, center-tapped, 7.5 V., 1.25 A.; S3, 1.5 V., 4.25 A.; S4, 2.25 V., 1.65 A.; S5, 725 V., 90 Ma. Primary is tapped for low line voltage. For 110-120 volts, 50-60 cycles. 4½ x 4½ x 4½ inches. Shipping weight, 12 lbs. List Price, $19.50

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We guarantee these condensers unconditionally. They are ideal for general replacement purposes and can be installed in any new power-pack. All condensers are furnished with 8-inch lengths of tinned "push-back" wire.

600 VOLTS Cat. No.	Mfd. Capac.	Your Price	800 VOLTS Cat. No.	Mfd. Capac.	Your Price
1702	½	$0.25	1706	1	$0.40
1703	1	.30	1707	2	.70
1704	2	.40	1708	4	1.05
1705	4	.60			

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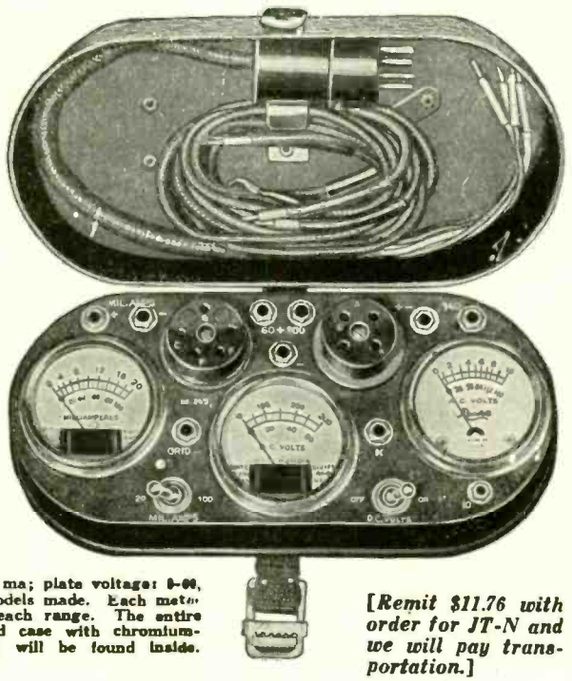
Chromium-Plated Case and Accurate Meters

A NEW and improved Jiffy Tester, improved in both performance and appearance, is Model JT-N. The meters are of the moving iron type. Tested on precise batteries, they show errors not exceeding 2%. As for appearance, the case is first copper plated, then nickel plated, then chromium plated, giving a lustrous, permanent, non-peeling non-rusting finish. It is the same finish found on hardware in fine automobiles. The handle and lock strap are genuine leather.



Jiffy Tester, Model JT-N, consists of three double-reading meters, with cable plug, 4-prong adapter, test cords and screen grid cable, enabling simultaneous reading of plate voltage, plate current and filament or heater voltage (DC or AC), when plugged into the socket of any set. The ranges are filament, heater or other AC or DC: 0-10 v, 0-140 v; plate current: 0-20, 0-100 ma; plate voltage: 0-00, 0-300 v. It makes all tests former models made. Each meter is also independently accessible for each range. The entire device is built in a chromium-plated case with chromium-plated slip-cover. Instruction sheet will be found inside. Order Cat. JT-N.

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PARTS FOR 1-TUBE RECEIVER

Exactly as specified by Herman Bernard

3-circuit coil	$0.75
.00035 mfd. variable	.49
.00025 mfd. grid con.	.25
.00035 mfd. fixed	.10
Two 30 ohm, 2 mounts	.40
"A" switch	.25
Dial	.25
Knob	.08
Binding post-strip	.29
4 blank posts	.40
Bakelite front panel	.88
Alum. subp.. socket	.59
1 dozen screws, nuts	.12
2 flathead screws	.04
4 milled bushings	.29

ORDER ANY OR ALL

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TOTAL $5.18

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.001		12c	money	back if not	
.0015		12c	satisfied	within five	
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8-tube AC tuner, less B supply, complete parts as specified by Herman Bernard. Pre-selector tuning, space-wound shielded coils, aluminum chassis drilled for socket holes. High sensitivity. No cross-modulation. Adequate selectivity. All parts (less tubes, less front panel) order Cat. DHST @ $17.28

AC tuner, with B supply built in, using 227 as rectifier; two 224 RF tubes, 227 detector. Same circuit as DHST, except that special rectifier circuit is added, so that tuner may be worked with audio power amplifier that provides no external voltage. All parts (less tubes, less front panel) order Cat. DHBT @ $21.82

Complete AC receiver, with the same tuner as the others, but with three- stage audio, with 245 output. All parts fit on a 12" wide x 9½" front-to-back chassis, with elevating flap 3" high. Filtration perfect (24 mfd. used). Requires two 224, three 227, one 245, one 280. All parts (less tubes, less front panel) order Cat. DACR @ $31.09

Battery-operated tuner, using two 232 RF and one 231 tube (new 2-volt type), affording same sensitivity and selectivity as either model AC tuner. Just the thing for those whose homes have no electricity. Supplied with cable connector plug for extreme convenience in connecting batteries. All parts (less tubes, less front panel) order Cat. DBTU @ $16.94

The complete battery-operated receiver, six tubes (two 232, three 230, one 231). All parts (less tubes, less front panel) order Cat. DBR @ $23.91
Note: All models use same front panel. Supplied in bakelite, 7 x 12 inches, drilled for REL dial, volume control and switch, to coincide with chassis. Order Cat. DFP-Black, or DFP-Walnut @... $1.62

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—SPECIALS—

Five-lead cable, 2 ft. long, with plug to fit a five-prong (UY) socket. The cable is connected at the factory so that following wires represent the respective prongs of the socket: Blue with white marker—G post of socket; Red—plate of socket; Green—cathode of socket; Yellow—heater adjoining cathode; Black with yellow marker—heater adjoining plate. .....Net 65c

MARCO black bakelite vernier dials. Read 0-100 with a supplementary scale reading 0-10 between figures on large scale. Takes a ¼" shaft...Net 50c

Parts for "A" battery eliminator: Dry rectifier, $2.10; 0-10 ammeter, 75c; 20-volt filament transformer, $2.50. Will handle up to 2 amperes filament current.

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SHORT WAVE STATIONS BY FREQUENCIES

With schedule of hours on the air given for the five time zones. In Radio World dated March 28, 1931. Mailed on receipt of 15c in stamps. Or send subscription order to start with this issue. Radio World, 145 W. 45th St., N. Y. City.

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April 11th, 1931
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TENTH YEAR
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Latest Circuits and News

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Service from One-Tuber

By Herman Bernard

THE one-tube regenerative set, about the simplest set you can build that will give satisfaction, serves several purposes. First, it may be used for earphone reception of broadcast stations, although the tickler, that is, moving plate coil, must not be advanced so far as to cause oscillation and thus create interference due to radiation. Second, it may be calibrated, and thus serve as an oscillating frequency or wave meter, modulated or not, to be used thus only when testing, as the same precautions against interference by radiation must be observed. Third, by placing a small coil in parallel with the secondary, short waves may be tuned in on earphones, and if speaker operation is desired, the B plus connection shown in the diagram may be ignored, and the end of the plate coil, illustrated as one of the phone connections, connected by an insulated wire lead to the plate of the detector socket of a broadcast receiver. Under these circumstances the detector tube would be removed from the broadcast set and the lead from plate of the one-tube device bared at the end and inserted in the set's detector socket at the plate prong.

Principal Components

The device consists primarily of front panel, subpanel, binding post strip, four binding posts, socket, coils, filament resistor or resistors, grid leak and condenser and four insulated wires for battery connection. No cabinet is included, but one may be selected that is large enough to contain two No. 6 dry cells for series connection, to constitute the A battery, and also large enough to contain a small 45-volt B battery, even of the type used in large battery-operated sets for C bias of the power tube, or two small 22½ volt batteries in series. Those who have at hand a battery affording 40½ volts for negative C bias of a 171 or 171A tube may use that.

The layout and the circuit are very simple, and the operation requires only a little skill, principally the ability to tune without causing radiation. The tube should be operated just below the oscillation point for best sensitivity, and this point should be reached by tuning at first with the tickler in such position as to act as a damper, rather than a booster, with gradual advancement of the tickler until sensitivity is highest, which is just before that point where the tube would "spill over."

Coil Data

These directions apply to the reception of broadcast frequencies as well as reception of short waves. For broadcast work the coil consists of two forms, a large one and one that fits inside its mate, so that the small form may be rotated by a knob attached to a shaft actuating the rotor form. For a diameter of 2½ inches for the larger form, using No. 24 silk covered wire, either single or double covered, the secondary turns may be 60, while the primary, separated from the secondary by ⅛ to ¼ inch, may consist of 12 turns of the same kind of wire. The tickler form then should not be more than 1½ inches diameter, to permit free rotation inside the other form.

The wire for the tickler may be either the same as used on the other windings, or may be No. 22 stranded wire or any other insulated wire. The direction of putting on the windings is not important in any instance, except as to the tickler, and even there it is not necessary to pay attention to this detail in the winding, since if, after the set is built, no oscillation can be produced at any setting of the tickler, all that is necessary is to reverse the connections to the tickler, putting to plate the terminal of the tickler that previously went to B plus, and to B plus the terminal of the tickler that previously went to plate.

These data apply to a coil for a .00035 mfd. condenser.

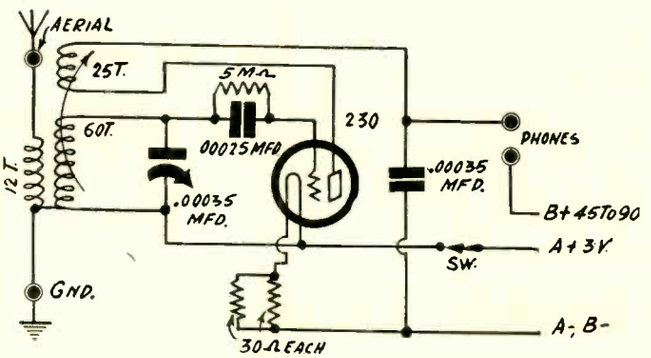


Fig. 1

This simple circuit affords at least three valuable uses, and is excellent for novices as well as for service men. Its purposes are told in the text.

The Parallel Coil

For short-wave work you yourself can wind also the parallel coil. You may use some insulated stiff wire, for instance,

(*Continued on next page*)

LIST OF PARTS

Coils
- **One three-circuit tuner, as described.**
- **One short-wave parallel coil.**

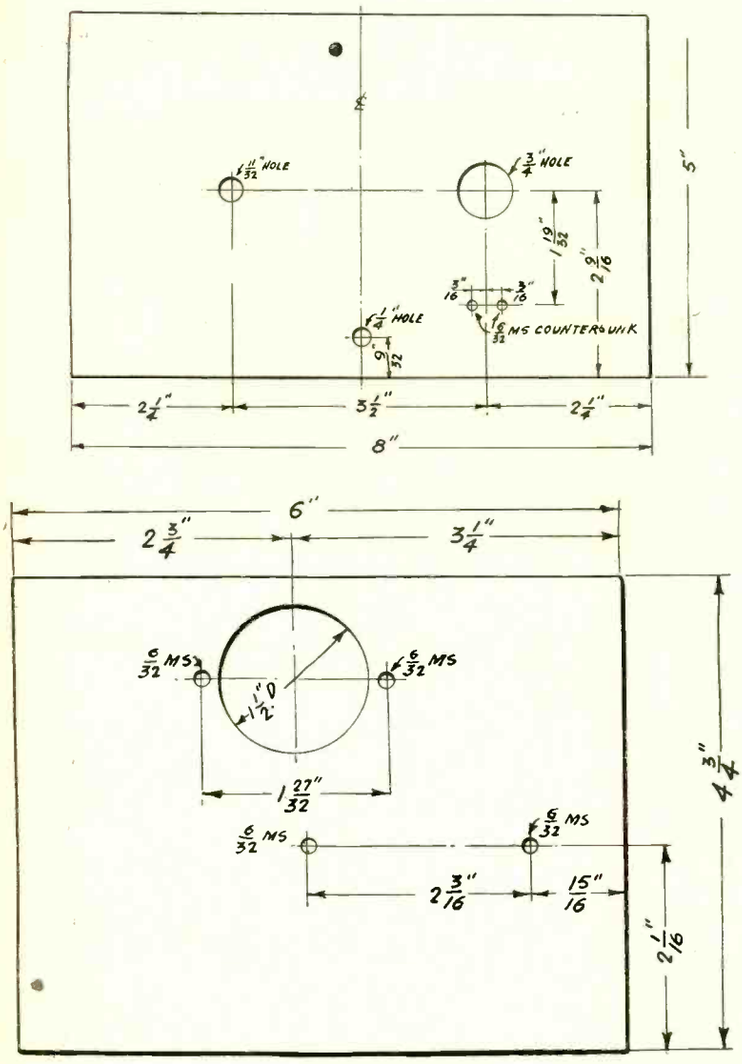
Condensers
- **One .00035 mfd. tuning condenser.**
- **One .00025 mfd. fixed grid condenser with clips.**
- **One .00035 mfd. fixed condenser.**

Resistors
- **Two 30 ohm filament resistors with two mountings.**
- **One 5 meg. grid leak.**

Other Parts
- **One A battery switch.**
- **One dial.**
- **One knob.**
- **One binding post strip, with four unmarked binding posts.**
- **Four insulated wire leads for battery connections.**
- **One 8x5-inch bakelite front panel.**
- **One 6x4¾-inch aluminum subpanel with 4-prong socket attached.**
- **One dozen roundhead 6/32 machine screws and nuts to match.**
- **Two flathead 6/32 machine screws.**
- **Four milled bushings.**

Calibrated Oscillator

Modulation Easily Provided and



FIGS. 2 AND 3
Front panel dimensions at top, subpanel below.

(*Continued from preceding page*)

No. 18 or No. 16, and wind 8 turns on a form 3½ inches in diameter, to pass the knurled nuts of the three-circuit coil. For this winding you certainly can find a can about the house somewhere to use as the temporary form, from which the winding is removed when finished. Get a piece of stiff insulating material, even wood, if you can not lay your hands on bakelite or fibre, and anchor the ends of this special coil to the bracing insulator, using a lug at each end. Drill out a larger hole in one lug and solder a short piece of flexible wire to the other lug. Then, to tune in short waves, you can simply put the drilled lug over a knurled nut representing one secondary terminal and fasten the flexible lead to the other secondary terminal. Leave the secondary connections otherwise just as you found them.

The same coil data apply no matter what type of tube is used. The diagram suggests a 230 tube, because this draws so little filament current (.06 ampere), and works well as a detector with relatively low plate voltage. However, a 199 tube may be used, in which instance another No. 6 dry cell in the series constituting the A battery is advisable, to bring the A voltage up to 4½ volts. The resistance value in the negative filament leg then should be 20 ohms. A 201A tube, from a 6 volt source, would take 4 ohms

Why Two Parallel Resistors Are Used

The value for the 230, with a 3 volt source, is 15 ohms, comprised of two 30 ohm resistors in parallel, because you probably have 30 ohm values, and can improvise the necessary 15 ohms that way. If you have 15 ohms at hand, use that.

The whole outfit, as diagrammed in Fig. 1, with the two No. 6 dry cells and a small 45 volt B battery, or two small 22½ volt B batteries in series, weighs only about 5 pounds, so the portability feature is attractive. As for size, the set is small enough to make a handy package, as well as a light one, even though the front panel's dimensions, 8x5 inches, provide plenty of room behind the panel, for better operating results. The dimensions of the front panel, subpanel and binding post strip are given in accompanying illustrations.

The frequency meter feature will be of importance to many, including service men. The circuit has to be calibrated, and this is done most readily by using broadcast station frequencies. You tune the set and listen in on earphones. Remember when using the device later as a calibrated radio frequency oscillator, modulated or unmodulated, to put the phones just where you had them when the calibration was made, and to have the filament and B voltages the same, as failure to abide by these instructions would change the frequency a little, that is, introduce unnecessary inaccuracy in the settings.

Making the Chart

By noting the dial settings of a dozen or more stations, representing a fair distribution over the entire scale, and including the lowest and highest frequencies receivable, you can transfer these settings to a piece of plotting paper, a point representing each setting, and then draw the resultant curve through the points. The general shape of the curve may be followed arbitrarily, to cover frequencies not otherwise represented. Such plotting paper you may make yourself, by ruling off squares in pencil on a sheet of paper, say of standard size, 8½x11 inches. Draw a line as the base, and divide into 10 equal parts. Draw a perpendicular line at left, and divide into 10 equal squares of the same size as the previous ones. Each square may be ruled off again in fifths or tenths. The base line, or abscissas, will represent dial settings, 0 to 100 or 100 to 0, while in the right angle direction (the ordinates), the frequencies may be put in down. Since the broadcast band is covered by 950 kc, the ten squares will more than suffice "up and down." The direction of the curve will be affected by whether the frequencies increase or decrease, in counting from the base line, but in either instance the curve will be equally effective.

To use the calibrated oscillator, you can couple it to a broadcast set, and tune in stations on the set, using the oscillator

Remote Con

By Brain

"PUSH-button-radio" has long been the dream of radio inventors and manufacturers. One of the obstacles to wider radio use has been the technicalities of the set. Many prospective listeners do not want to learn how to operate the dials, but would prefer simply to press a button for each station.

Conveniently, too, push-button radio may be combined with remote control, so that all one needs in the living-room is a small box with a row of push-buttons, and the loudspeaker.

There are two principal systems in use for remote control systems: (1) the contact method, and (2) the motor method.

The contact system uses a number of push-buttons, depending on the number of stations to be heard. There are separate condensers in the set for each station, which are previously adjusted to the correct setting, and closing the push-button operates a magnet that moves the corresponding set of contacts. This system has not been widely used, principally because one is limited to a few stations only. Of course, most listeners really depend on a few stations for their radio programs, but listeners like the idea of getting others occasionally.

Motor System Uses Dial

The motor system is in wider use for remote control systems. Here a dial is employed, which operates an electric motor, geared to the condenser shaft. A method of synchronizing the control dial and the motor is essential, and numerous difficulties have been encountered. However, several very dependable commercial outfits are on the market utilizing the motor control method.

In addition to adjusting the set to the different stations, a method for regulating the loudness must also be provided in the push-button or remote control box. This is, fortunately, not a difficult matter, and a variable resistor ordinarily handles this requirement nicely.

Aids Service Men

Condenser Sections Lined Up

to determine the frequency of the stations thus received, hence calibrate the set without waiting to ascertain the identity of the stations tuned in.

Modulation of Oscillator

For use as a device for enabling the lining up of gang condensers in circuits, as by trimmer adjustment, modulation of the oscillator is necessary. This is provided very easily, if your home or other place of testing is wired with AC. Simply get an 0.1 mfd. condenser, connect one side of the condenser to one side of the AC line, and the other side of the condenser to the phone binding post that connects to the tickler coil. The 60 cycle hum, or more pronouncedly, the second harmonic thereof, that is, 120 cycle hum, will be heard, and the trimmers can be adjusted in the tested set for loudest hum response. A meter in the output of the tested set's detector would indicate relative sensitivity as to frequencies, if the meter is very sensitive.

The coupling of oscillator and modulator may be effectuated by connecting ground to the ground post of the one tube set, aerial post of this small set to ground of the tested set, and aerial wire to the antenna post of the tested set.

In all calibration work involving a tickler, the position of the tickler should not be changed, so this too alters the frequency. Use the same tickler setting all the time in these tests.

Helpful Hints on Mechanical Features

There are a few special precautions to take to insure utter ease in construction of the set. The tuning condenser has three mounting brackets built in, and also a slotted support. Remove the front mounting bracket and the rear support, which can be done with pliers, although part of the rivets that hold this hardware may remain. Drill where the rivets were, using No. 28 or 29 drill, and the rivet pieces will fall right out. Two holes thus will be cleared at front and meet countersunk front panel holes, through which 6/32 machine screws may be passed, with nut at the back to hold the condenser to the front panel, and in fact attach the front panel and subpanel to each other. Since the coil wiring is a large part of the total, it is preferable to mount front and subpanels at once, and put the coil in position, by single hole mounting on front panel. One more operation concerns the condenser. Remove the pigtail nut and instead solder the pigtail anywhere to the frame, or to the upper nut on the side strip, out of the way of the rotor plates.

The switch goes near the bottom of the front panel, at center, and there is just enough room for it, provided it is mounted with the hooked contact toward the bottom.

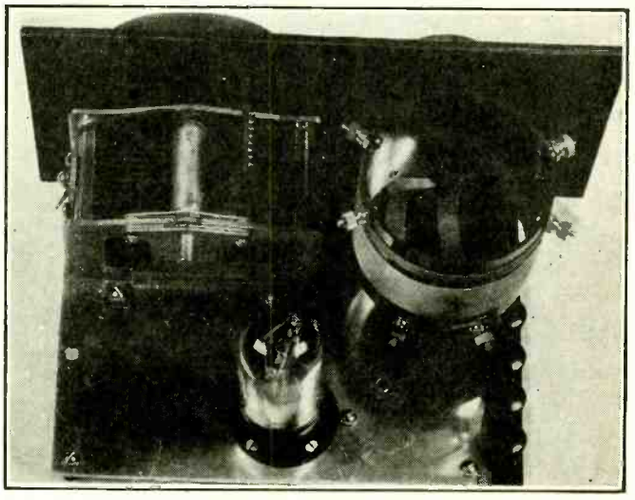


FIG. 4

View of the parts of the one-tube multi-purpose circuit mounted in the correct position.

Lining Up the Panels

The subpanel is elevated to the same height as the bottom of the front panel, principally by use of two milled bushings at rear. These bushings are 5/8 inch high. That is not quite enough, so a screw is placed through holes at rear corners of the subpanel, head up, and two 6/32 nuts are tightened down against the screwheads, from the bottom, adding about 1/8 inch to the elevation, and permitting the tightening down of the bushings, which are threaded for 6/32, for front panel matching. Four bushings are used, but only two need the help of nuts for elevation, as the binding post strip takes care of the rest.

One of the corner holes referred to is used for fastening for binding post strip, at left of the subpanel as you view the set from the front. A corresponding corner hole passes a screw to anchor the other end of the binding post strip. If desired, a third hole in this strip may be used, by drilling through it and through the subpanel (which has not the third hole in this position), for still greater security in anchoring the strip. The four binding posts are for antenna (extreme rear), ground (second from rear), plate coil (third from rear) and B plus (nearest front panel). The battery connections, as stated, are made with separate wires, and their length will depend on how far the batteries will be from the set, but it is assumed they will be just in the rear, so the leads would be short.

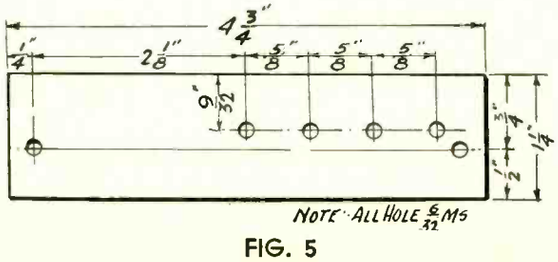


FIG. 5

Detail of binding post strip.

trol Tuning

ard Foote

A number of distinct advantages accrue to the push-button radio method, where the set may be located in some other room. In the first place, the set need not be in the living-room, occupying useful space. Since it is not an article of furniture any longer, the set may be built with less attention to its appearance and more attention to its mechanical and electrical features. It may be larger, which is a good thing, allowing heavier apparatus, which gives better results and with much less danger of breakdown. The safety factor in the design may be larger. It may be designed so that the service-man can get at the important parts more easily, for repairs or replacements.

Avoids Coupling From Speaker

Another point is that of separating the loudspeaker and the set. Where the set is in the same room and in the same cabinet, the vibrations of the speaker may shake the set and cause the elements in the tubes to vibrate. This causes distortion and sometimes what is known as microphonic howling. Where the set is in a different location no trouble of this kind is experienced.

These advantages are, of course, entirely aside from the convenience of being able to sit in your easy chair and select the station you wish with little effort.

Some sets are equipped with push-button or lever or cam controls which the listener may move to adjust the set to a number of different stations. In one type the levers are something like those of a cash-register. They are pulled down to a pre-adjusted stop and this movement is the same as turning the dial around to a certain position. The set may also be regulated by the tuning dial in the usual manner, if desired. This arrangement is convenient, since the well-liked stations may be brought in with hardly a glance at the set, and the DX fan may use the set for radio fishing, too.

Output Pentode En

By J. E.

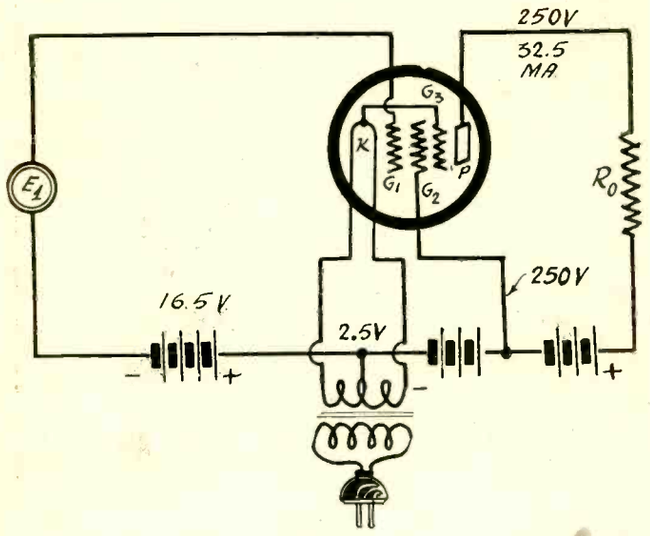


Fig. 1

A circuit showing the connections of a PZ pentode when batteries are used. G1 is the control grid, G2 the space charge grid, and G3 the cathode grid, or pentode grid.

THE pentode power tube has been introduced into American receivers and it is expected that many new circuits will be developed around it. A tube of this type has been in wide use in Europe for many years, but heretofore it has not been available in America, except by importation. It was developed in Europe to meet the conditions existing there, particularly the receiver license fee, which is based on the number of tubes in the set. The main advantage of the pentode power tube is much greater power sensitivity than any other output tube.

The power sensitivity of a tube is defined as the ratio of the square root of the output power to the effective value of the signal voltage impressed on the grid. The following table shows the power sensitivity of five different output tubes, including that of the new pentode, PZ.

Power Sensitivity of Output Tubes

Tube	Ep	Eg	P	S
112A	157.5	10.5	.195	.0594
171A	180	20.5	.700	.0292
245	250	50	1.60	.0358
250	450	84	4.05	.0239
PZ	250	18	2.85	.1236

In this table Ep is the effective DC voltage on the plate, Eg the peak signal voltage on the grid, P the output power, and S the ratio of the square root of P to the effective value of Eg.

It will be noted that the pentode has a power sensitivity of more than twice that of the 112A and nearly four times as great and the most popular power tube, the 245. The 171A and 250 tubes have the lowest power sensitivity of all.

Note in column headed by P that the power sensitivity has little to do with the actual power delivered by the tube, for the greatest power is delivered by the 250. The power sensitivity rather depends on the amplification factor, or on the mutual conductance, called transconductance for the pentode. The square of the power sensitivity is a measure of the power output per volt squared on the grid of the tube.

Advantages of Pentode

The advantage of a tube having a high power sensitivity is that a given power output will be obtained with a small input voltage and hence with a low amplification in the audio frequency amplifier. With the pentode output tube it is possible to connect the tube directly to the power detector by means of resistance coupling and load up the power tube until the maximum of 2.85 watts will be obtained. Thus all the distortion which the omitted tubes and parts would have introduced is avoided and the quality of the output will be considerably better. Not only that, but the output will be obtained at lower initial and maintenance cost. This is true even when the European license fee is not involved. The advantages of the power pentode tube will soon be generally realized in this country.

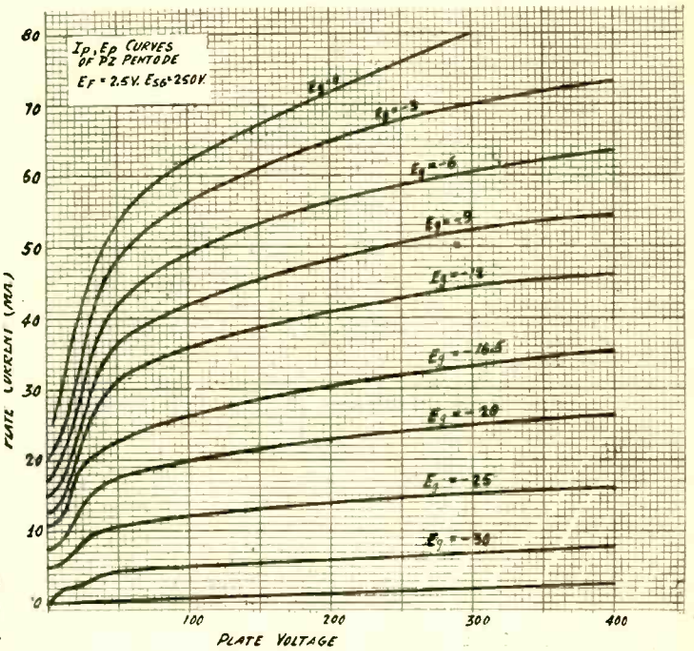


Fig. 2

A family of plate voltage, plate current curves for the PZ pentode power tube.

Characteristics of the Pentode

Filament voltage	2.5
Filament current, amperes	1.5
Plate voltage	250
Plate current, milliamperes	32.5
Control grid bias, volts	16.5
Space charge grid voltages	250
Space charge grid current, ma	7
Cathode potential, volts	0
Plate impedances, ohms	38,000
Transconductance, micromhos	2,500
Amplification factor	95
Power output rating, watts	2.5
Socket	Standard UY

As will be noted, the filament voltage and current ratings are the same for the pentode as for the 245 power tube. Hence no new filament supply need be provided when the pentode is substituted. However, since the socket required by the pentode is a UY and that required by the 245 is a UX, it is necessary to change sockets.

The pentode will probably be used primarily in new receivers in which the detector and the audio coupler have been especially designed for it, but many will want to substitute a pentode in the power stage when the amplification in the audio frequency amplifier is not quite sufficient.

The Circuit for Pentode

In Fig. 1 is a simple circuit showing the connection of the various elements of the tube. G1, the control grid, is connected the same as the control grid of a 227 tube, that is, to the apex prong of the base. The plate P is connected to the same prong as in the 227 and the 224. The space charge grid G2 is connected to the prong to which the cathode is connected in the 227 and the 224 tubes. The two filament terminals are the same as the two heater terminals of these two tubes. Thus the main external difference between the connections of the PZ and the 227 is that the cathode in the 227 becomes the space charge connection in the PZ. This is an important difference, for in the 227 this prong is given a voltage of zero, or a positive voltage equal to the grid bias on the tube, and in the PZ it is given a voltage of 250 volts. It will not do, therefore, to plug in a 227 tube in a socket wired for a PZ.

ters American Arena

Anderson

The screen grid in this pentode is not represented by any external connection because the screen is connected to the center point of the filament. Since the center point is virtually at zero potential the filament voltage is called zero. The screen is indicated by G3 in Fig. 1, and it is shown connected to K, which stands for the combined cathode and filament.

The grid and plate returns are made to the center point of the 2.5 volt filament winding, which is customary when AC is used for heating a filament.

Bias Provision

In Fig. 1 the bias is provided by a battery having a voltage of 16.5 volts. This is the best way, electrically, but it is not the most convenient way. The most practical way is to use a bias resistor. What should be the value of the grid bias resistor We have to compute this from the plate and space charge current and the required grid bias. The plate current is 32.5 milliamperes and the space charge current is 7 milliamperes. Hence the total current is 39.5 milliamperes. Since the required bias is 16.5 volts, the required grid bias resistor is 418 ohms. Since it is not critical, either 400 or 500 ohms may be used if the exact value is not available.

The slope of the output characteristic depends to a great extent on the grid bias resistance. It is less when a bias resistor is used than when a battery is employed to supply the bias, and therefore the output will be less when the bias resistor is used. This effect might be looked upon as a reverse feedback through the bias resistor. Since this effect is not desired, a large condenser should be connected across the bias resistor, and this should not be less than four microfarads, for if it is the low notes will be suppressed.

Characteristic Curves

In Fig. 2 is a family of plate current, plate voltage curves for the PZ pentode between zero and 400 volts on the plate and a grid bias range of zero and 35 volts. The space charge voltage is 250 volts and the filament voltage 2.5 volts.

The maximum output on the fundamental and the minimum second harmonic occur when the plate load resistance is nearly 8,000 ohms. By drawing a load line across the family of curves in Fig. 2 corresponding to a load of 8,000 ohms, we can compute the power output. An 8,000 ohm load line is obtained by drawing it through 400 volts on the voltage axis and 50 milliamperes on the current axis. This would be the proper line for a pure resistance load, but when there is inductance in the circuit the line should be higher up but parallel to the first line. The second line should pass through the 16.5 volt curve at 32.5 m.a. Drawing the line we find that it crosses the zero bias curve at 57 milliamperes and 40 volts. The line also crosses the 33 volt bias curve, assumed to be drawn, at 4 milliamperes and 460 volts. Thus the plate voltage changes from 460 to 40, while the plate current changes from 57 to 4 milliamperes. The product of the current change by the voltage change is $420 \times .053$, or 22.26. This is eight times the power output, which therefore is 2.78 watts. The value given in the table of power sensitivity is 2.85 and that given in the table of tube characteristics is 2.5 watts. The value just obtained lies between these two.

Computing Power Sensitivity

The grid voltage change that produced this power in the plate circuit was 16.5 volts, peak value. The root mean square of this is 11.68 volts. The square root of 2.78 is 1.669 and therefore the power sensitivity is 0.1428. This is approximately the same as that given in the table for a root mean square input voltage of 18 volts.

In Fig. 3 are two curves, one showing the relationship between the grid voltage and the plate current and the other that between the space charge grid current and the grid voltage. These are drawn to the same scale the more clearly to show the difference between them. They were taken with 2.5 volts on the filament, 250 volts on the plate and the same voltage on the space charge grid.

In this graph the plate current changes from 75 to 4 milliamperes, as the grid voltage changes from zero to 33 minus. The space charge grid current remains about one-fourth as great as the plate current at all times.

Variation of Mu

In a three element tube the amplification factor remains practically constant, but in this tube it varies almost directly as the plate voltage, being zero when the plate voltage is zero and about 147 when the plate voltage is 400 volts. At the

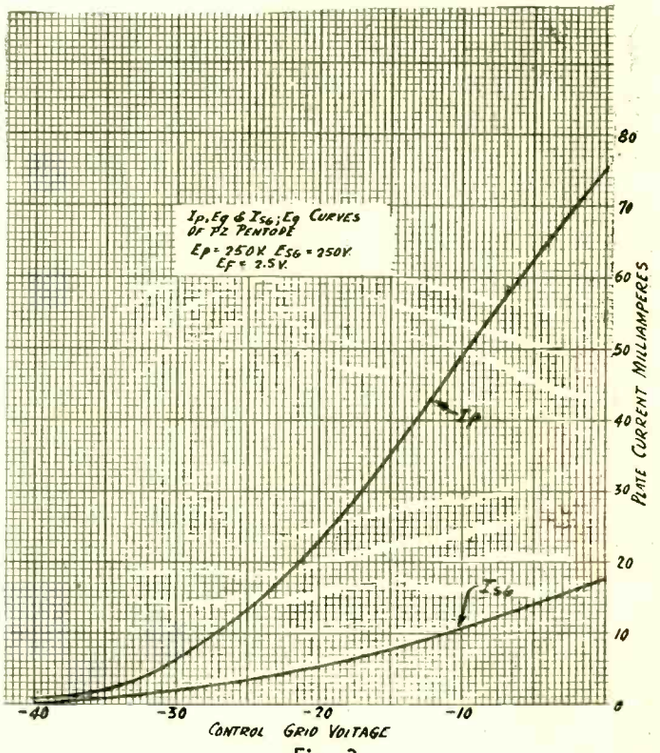


Fig. 3

Curves of the PZ pentode showing the variation in the plate and space charge grid currents with the control grid voltage.

operating point of 250 volts on the plate and 16.5 volts negative on the grid and 250 volts on the space charge grid, the amplification factor is approximately 97. It is listed at 95, but this is an average for a large number of tubes and the factor varies a little with different tubes.

As the space charge grid voltage varies, the other factors remaining constant, the amplification factor varies inversely as the voltage, that is, it decreases as the voltage increases.

Variation of Transconductance

The transconductance, or mutual conductance, increases as the plate voltage increases, at first very rapidly and then more slowly for the higher plate voltages. It also increases in a somewhat similar manner as the grid voltages change from high negative values to less negative values. Its variation with increase of space charge grid voltage is similar, at first very rapidly and then more slowly. It is assumed here that all conditions other than those specifically mentioned remain constant. For example, when the plate voltage is varied, all the other voltages remain constant and it is under these conditions that the mutual conductances vary as stated.

It has been stated that the plate and space charge grid voltages should be the same, but in Fig. 1 the space charge grid is connected to a lower voltage than the plate return. The difference is due to the fact that there is a voltage drop in the load impedance in the plate circuit. In the space charge grid lead there is no impedance and therefore the applied voltage is the same as the effective voltage. The plate return should be connected to a point where the voltage is high enough to make the effective voltage on the plate equal to the space charge grid voltage. If a high resistance voltmeter is used, the applied voltage in the plate circuit can be adjusted accurately enough with its aid, connecting it between the plate and the mid-point of the filament transformer.

Bias Resistance Feedback

We mentioned the fact that a bias resistor that is not by-passed will cause a decrease in the amplification because of reverse feedback. Let us examine this effect in detail. Since the bias on the tube is determined by the sum of the plate and space charge grid current and the resistance used for bias, it is obvious that the actual bias depends on the signal voltage. As the signal voltage makes the grid more negative, the plate and space charge grid current decreases

(*Continued on next page*)

Tuning and Filtration Re

By Henry B.

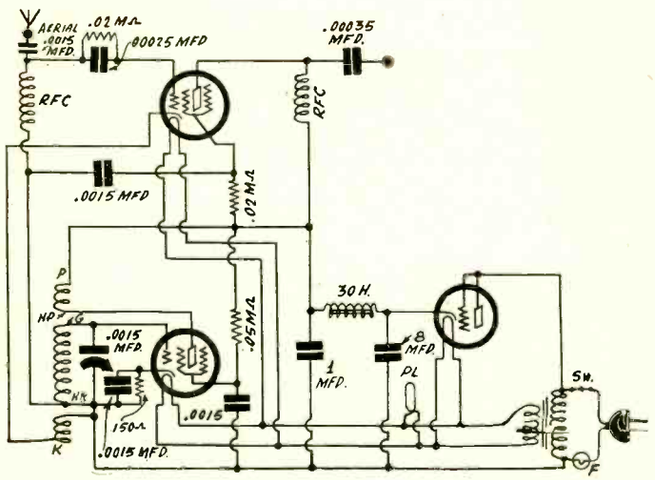


FIG. 1

Circuit diagram of the JA-3 all-wave converter, using the new National Equicycle tuning condenser and four plug-in coils, 15 to 600 meters.

THE NATIONAL COMPANY, of Malden, Mass., has put on the market a new short-wave condenser that has special features. The model SE-100 rotates in an angle of 270 degrees, with straight frequency line tuning and requires a clockwise type dial that will accommodate this large angular displacement of plates, since most dials work in only 180 degrees. The advantage of the greater displacement is improved ease of tuning, the stations being spread farther apart on the dial, hence the danger of not receiving distant stations, because of passing them, is avoided.

The rotor shaft does not protrude through the metal rear support bracket, as in most condensers, as this condition would approximate a short-circuited turn and might give rise to crackling sounds in the tuning process, besides acting as a damper on sensitivity. Therefore a thick pigtail is soldered to the rear of the shaft, being passed through an insulated bushing before being soldered to a lug at rear of the frame. No detuning from the effect of the pigtail then is present, as the pigtail thus included presents a constant impedance.

Important in Short-Wave Work

These considerations, applied to broadcast frequencies, might not be important, but on short waves such improvements are of inestimable value, particularly in the reduction of noise and in the effectuation of a calibration for tuning in stations.

The only successful way of obtaining dependable distance reception is to note the dial settings for the frequencies to be tuned in, and, consulting a list of short-wave stations, such as the one published in the March 28th issue of RADIO WORLD, tune deliberately for the desired stations at a time when they are known to be on the air. The list gave the hours on the air in terms of your time zone. The other method, of simply fishing for stations, is not productive of a big log of distant stations, and often proves so disappointing that one quarrels with the short-wave set or converter, instead of with the method of attempting to bring in the stations.

The JA-3 All-Wave Converter tunes from approximately 15 meters to 600 meters with any broadcast receiver, and has a 227 rectifier built in, so there is no uncertainty about obtaining the B voltage. The plates of the tubes get an applied voltage of 110 volts, while the total current drain is about 10 milliamperes. The bias on the oscillator, resulting from the 150 ohm resistor intercepting the plate current, is .7 volt, so the oscillator plate current is a little less than 5 milliamperes. The response is keener under this condition of low bias.

LIST OF PARTS

Coils

One set of four plug-in coils, tube base type
Two National short wave radio frequency choke coils
One 30 henry B supply choke coil
One 2½ volt filament transformer (center taps on secondary optional).

Condensers

One National Equicycle short-wave condenser, SE-100, capacity .0001 mfd. (270 degrees rotation)
Two National MB 30 shields with four ⅜-inch right-angle brackets.
One .00025 mfd. grid condenser
One .00035 mfd. fixed condenser
Four .0015 mfd. fixed condensers
One 8 mfd. electrolytic condenser.
One 1 mfd. filter condenser.

Resistors

One .02 meg. (20,000 ohm) pigtail resistor
One .05 meg. (50,000 ohm) pigtail resistor
One Electrad 150 ohm flexible biasing resistor.

Other parts

One National clockwise disc type dial with pilot bracket and 2½-volt lamps (270 degrees rotation)
Two National grid clips
One 7 x 10-inch front panel
One 6½ x 9⅞-inch subpanel
Two binding posts
One AC cable with male plug
One General Electric AC toggle switch
One dozen 6-32 machine screws and one dozen nuts to match
Two subpanel support brackets
Two ⅝-inch brass bushings, tapped for 6-32 ms, to augment support brackets
Four UY sockets
One fuse with holder

8 Mfd. Used Next to Rectifier

Altogether satisfactory filtration results from the placement of an 8 mfd. electrolytic condenser next to the rectifier, and a 1 mfd. paper condenser at the end of the B supply choke. However, the choke should have a commercial rating of 30 henries, that is, must be of substantial inductance to insure adequate filtration with the specified capacities.

The effect of poor filtration is not only to introduce hum but to reduce the sensitivity of the converter very sharply. For instance, during the experiments with the circuit 1 mfd. condensers were used in both positions, next to the rectifier and at the other end of the B supply choke. As it remains possible to tune in broadcasting stations with the receivers used, the converter acting as a booster, there was a loud hum when a broadcast carrier was reached. As the set's dial was turned one hum after another was heard, or, rather, the same hum, impressed on each succeeding carrier by the converter.

When the capacity next to the rectifier was increased to 8 mfd. this condition completely disappeared. Of course, the arrangement of 1 mfd. next to the rectifier and 8 mfd. at the other end was tried,

Pentode Power Tube Makes Its Bow

(*Continued from preceding page*)

making the drop in the bias resistance less, which has the effect of reducing the signal voltage as it is impressed on the control grid. As the signal drives the control grid toward the positive, that is, less negative, the current through the bias resistor increases, and again the effect is to oppose the signal voltage.

Now this effect can be counteracted by a by-pass condenser across the resistor, for the condenser acts as a filter, tending to keep the voltage across the bias resistor constant at the mean value, that is, at the value it has when no signal is impressed. The larger the condenser the more nearly is the voltage across it constant and the more nearly does the operation approach that when a battery is used for biasing. The condenser charges up when the plate current is above normal and discharges when it is below normal.

In a push-pull stage the bias resistance need not be by-passed, because the current through the resistance is practically constant, provided that the circuit is balanced, and if it is not balanced the bias resistor helps to bring about balance. Therefore it is not even desirable to by-pass the bias resistor in such circuits. The PZ pentode can be used in push-pull just as any other power tube. When two of them are so used the output will be abount 6 watts without appreciable distortion.

The pentode herein discussed is a power tube, and is not to be confused with the radio frequency amplifying pentode brought out by CeCo last year.

Atwater Kent was the first out with a pentode set.

finements in a Converter

Herman

but proved of little advantage over 1 mfd. in each position. Therefore it is next to the rectifier that large capacity is absolutely needed. Then short wave signals come in without hum, and are louder, besides.

In the model illustrated a dry electrolytic condenser was placed underneath the subpanel, since such a condenser may be put in any position. Results were good. Somewhat better results were obtained when a wet electrolytic was used, of the same capacity rating. A wet electrolytic can be mounted only one way. There are two mounting types, the standard and the inverted. With the inverted type, the condenser is mounted upside down, as it were, with threaded bushing entering a subpanel hole from the top, while a nut is placed over the screw, underneath the subpanel, to hold the condenser in position. Since the subpanel is insulating material, and the condenser can is aluminum and won't take solder, a wire loop or washer is placed between the nut and the subpanel in mounting this type of condenser, and soldered connection made to negative. In electrolytics, the can always is negative, the anode (lug at end) positive.

Acts as Broadcast

The converter is to be worked with a broadcast receiver with some favorable frequency used as the intermediate frequency. Most receivers are more sensitive at the higher frequency settings, so experiment with that extreme of the set dial. The other extreme should be tried, too. Some modern receivers are much more sensitive at the lower frequency end.

Also, many receivers are trimmed at a medium frequency, so that resonance is not so keen at the extremes, though otherwise the tendency would be for greater sensitivity at the higher end. This suggests to users of converters that, if the higher frequency end seems more favorable, retrimming of ganged condensers might well be done at 1,500 kc, so that the set, if tuned a little beyond that, will result in far more and better short-wave reception when the converter is used.

Since the converter tunes the broadcast band as a converter, and the set tunes it as a straight receiver, you may tune in such stations by either method, when the two devices are attached, particularly using the set for this purpose if the converter proves to be a substantial booster of signal strength, as it almost unfailingly will.

Constructional Details

As for the arrangement of parts, the coil socket is naturally right near the tuning condenser, and the modulator and oscillator tubes are on either side of this socket. The coils fit in regular UY sockets.

The tuning condenser is 4½ inches high, with plates half disengaged (the extreme condition) and the dial frame accounts for more than an inch extra, so there are only about 1¼ inches room underneath the subpanel, if the front panel is 7 inches high. However, the largest part underneath clears the bottom by ⅜ inch, since the two large objects, the filament transformer and the choke coil, are placed on top. For symmetrical appearance two aluminum shields are placed over these devices, using two small right-angle brackets for each, these brackets being connected also to B minus, which is automatic ground, due to the power line being grounded.

Do Not Use External Ground

No external ground connection should be used. The two binding posts are for aerial, which is removed from the set and connected here, and for output, which is connected to the vacated antenna post.

It may be noticed that far better results are obtained when the plug is inserted in the convenience outlet or lamp socket in one direction, as compared with the other direction. This would seem to be due to the improvement expected when the natural ground side becomes uninterruptedly the grounded side of the converter, in other words, ground is not intercepted by the impedance of the primary of the filament transformer. So try the plug first one way and then the other.

The case of the 1 mfd. condenser is to be scraped and a lead from B minus soldered thereto, the lug going to positive.

This is a nicely-working converter of dependable performance, and smoothly meets the fundamental requirement of mixing the incoming frequency with the oscillator frequency to produce the intermediate frequency.

[Other Illustration in Front Cover]

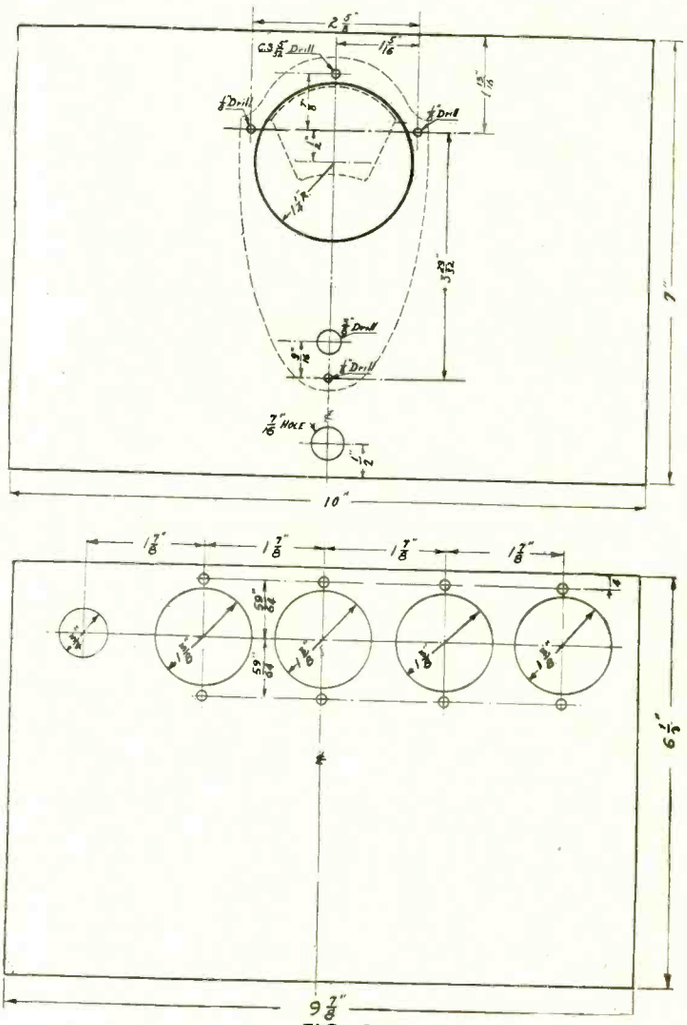


FIG. 2

Front panel and subpanel dimensions for the JA-3 all-wave converter.

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EXPERIENCED SERVICE MANAGER—age 26, married, formerly with RCA-Victor Co., of Camde, N. J., and Elliott-Lewis Electrical Co. of Philadelphia. Three years' Electrical Engineering Course at Drexel Institute. References of highest order. Desire to locate with manufacturer interested in public address systems or centralized radio and antenna work. Position anywhere in U. S. Willing to travel. Arthur W. Greathead, 109 S. Franklin Ave., Morton, Pa.

YOUNG MARRIED MAN, AGE 28 YEARS, wants position as broadcast operator or repairman. Have U. S. Government commercial first-class operator's license and have been connected with the radio game since 1920. References: National Radio Institute, Washington, D. S. Student No. 16089. Will consider position anywhere in U. S. A. Write J. L. Crusoe, P. O. Box 15, Key West, Fla.

Band Pass Pre-Sele

By C. W.

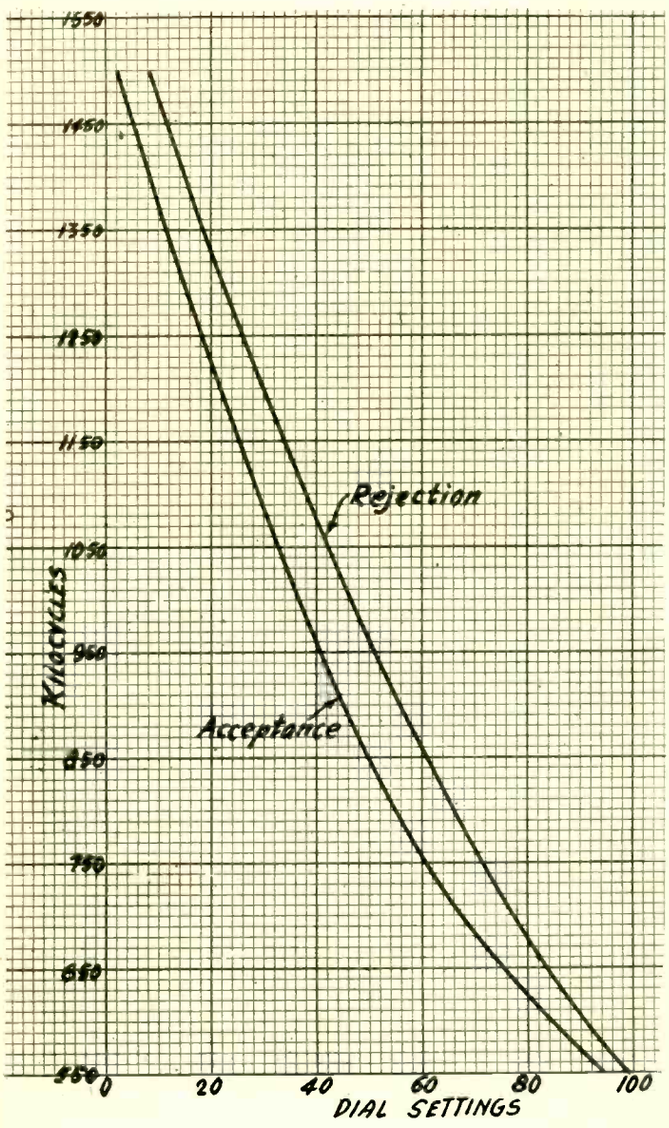


FIG. 1

Calibration curves of the Selectifier. The rejection curve gives the dial settings when the signal is tuned out and the acceptance curve give them when the signal is loudest.

[*Circuit diagram and other details of the Selectifier, which kills off an undesired frequency with absolute certainty, were published in the March 21st issue.*—EDITOR.]

THE Selectifier is a band pass filter to be used in front of a receiver which does not have sufficient selectivity to prevent interference. It may be used either as an acceptor for selecting the desired station with greater sharpness or as a rejector for eliminating some interfering station. In either case it helps to select the one desired without interference from others.

It consists of two tuned circuits coupled loosely by means of a large condenser of 0.05 mfd. capacity. Each of the two tuning condensers contains a trimmer for aligning the two main tuning condensers and enabling them to be put on the same tuning control. In addition to the common coupling condenser there is a small condenser joining the stators of the two tuning condensers to increase the coupling when this is desired. There is a switch in series with the condenser so that it may be cut out when it is not needed.

The circuit is housed in an attractive walnut finish wooden box approximately 8x8x5.5 inches, and the tuning dial and switch control knob are mounted on a black bakelite panel measuring 7 inches square. The tuning condensers, coils and other parts are mounted on a bakelite sub-panel measuring 4.5x5.5 inches. Grooved cleats are fastened on the sides of the box in such a position that the sub-panel slides into the grooves and holds the assembly firmly in place. The assembly may be made still more firm by means of wood screws in the upper two corners of the front panel or at the sides where the grooved cleats abut against the panel.

The tuning condensers are provided with an REL vernier dial by means of which it is easy to set the tuner at any desired position accurately.

The switch in series with the stator-to-stator condenser is mounted directly below the knob with which the circuit is tuned, and it is arranged so that when the switch knob is in the condenser is out. That is, the lead from one of the stators to the condenser is open when the switch knob is all the way in.

Tuning Curves

The calibration curves of the Selectifier are given in Fig. 1. The curve marked "rejection" is that which gives the positions of the dial when the stations not desired are to be tuned out, while the curve marked "acceptance" is that which gives the position of the dial when the desired stations are to be brought in loudest.

A marked advantage of the Selectifier is the nearness with which the acceptor and rejector positions come. If there are two stations operating close together and one interferes with the other, it is usually possible to set the Selectifier so that the acceptor position comes on the desired station, or close to it, and the rejector position directly on the undesired station. Thus the one not wanted is suppressed while the one desired is strengthened.

The coils in the Selectifier have been wound so that the 550 kc channel falls at 100 on the dial for rejector position. This makes the acceptor point for the same frequency fall at a lower point on the dial. At the other extreme of the broadcast band the rejector tunes to 1,500 kc at 8 on the dial and the acceptor 2. Thus the circuit covers the entire broadcast band both for rejection and acceptance.

Midline Tuning

It will be noticed that the curves are nearly straight lines. However, they are not exactly straight line frequency because the tuning condensers employed are of the midline type, that is, about half way between straight line frequency and straight line capacity. For the shorter waves the change follows closely straight line frequency.

Either curve may be used as a guide to identifying stations, particularly the rejection curve because this is the more clearly defined on the dial. Suppose, for example, that a distant unknown station is tuned in with the receiver and then cut out with the rejector, say at 60 on the dial. We note from the rejection curve that this corresponds to a frequency of 860 kc and therefore the station must be operating on this frequency. Three stations are operating on this frequency and we have to judge by the intensity of the signal and the distances as to which is being tuned in at the time. Suppose, again, that another station is tuned out by the Selectifier at 62 on the dial. This corresponds to a frequency of 750 kc. We find two stations operating on this frequency, namely, WSB, Atlanta, Ga. and KMMJ, Clay Center, Neb. The station tuned in must be one of these two.

Connection of Selectifier

There are only three leads coming from the Selectifier circuit. One of these is to be connected to ground post on the receiver. It is imperative that the receiver be grounded, even if for other purposes leaving off the ground "makes no difference." One of the other leads to be connected to aerial and the third to the antenna post on the receiver from which aerial was removed.

When the Selectifier is connected an interfering station will not come in, if the Selectifier is tuned to the station's frequency on the rejection curve, because the suppression is 94 per cent.

The principal function of the Selectifier, as its name implies, is to impart selectivity, which it does most effectively by the rejection method, that is, getting rid of an interfering frequency. It is regarded as the most powerful and effective wave trap ever produced commercially, and can be used by interference sufferers living close to broadcasting stations, even being set to reject the offender, and left thus. Then the offender may not be heard at all, and other stations brought in, or by slight retrieving of the Selectifier you can give the neighboring transmitter some of your listening time.

Coil in Selectifier

There are two identical coils in the Selectifier. Each coil con-

ctor Kills Interference

Burroughs

tains two windings, one of 15 turns and another of 70 turns. The first 15 turn winding is in the antenna circuit and the second is across the input terminals of the receiver. The two 70 turn windings are in between, one of them acting as secondary for the antenna winding and the other as primary for the output winding. All windings are wound with No. 28 enameled wire on 1.75 inch bakelite tubing.

These two coils are mounted under the sub-panel with their axes parallel and their centers 3 and 7/16 inches apart. Thus there is a certain amount of inductive coupling between the two coils in addition to the capacitive coupling afforded by the 0.05 mfd. coupling condenser. This inductive coupling has been proportioned so as to aid in the functioning of the circuit.

Advantage of Symmetrical Layout

The physical layout of the circuit is as nearly symmetrical as practical. So are the electrical features and the physical symmetry helps to bring about electrical symmetry. The two tuning condensers are also alike in their tuning characteristics. Because of the features of symmetry the two circuits remain similar throughout the tuning range and the selectivity is not impaired. However, some differences are bound to occur and it is for this reason that the two trimmer condensers are used so that the differences may be compensated for. To align the trimmer condensers the circuit should be tuned in for the acceptance position for a frequency in the middle of the broadcast band and the two adjusted until the signal is as loud as possible.

Since the two trimmer condensers may be set at different values to bring about alignment it is usually possible to fit the tuning curve to a calibrated curve such as that shown in Fig. 1. The middle frequency on the geometric scale is near 910 kc. Suppose, then, that we wish to fit the tuning curve of a Selectifier to the acceptance curve in Fig. 1. We note that the acceptance curve croshes the 910 kc line at 44 on the scale. Therefore the receiver is tuned to 910 kc and the Selectifier dial is set at 44. Then the two trimmer condensers are adjusted until the 910 kc signal is as loud as possible. The curve has then been fitted at one point and that is the best that can be done for there is no other arbitrary adjustment. But if the tuning condensers in the Selectifier thus adjusted are the same as those used in taking the curve the fitting should be close throughout the scale.

If a 910 kc signal is not available any other signal not too far from the middle of the scale will do just as well, the only difference being that the Selectifier dial is set at a different point.

Advantage of Filter

The Selectifier has several advantages well worthy of consideration when the receiver is not sufficiently selective to tune out interference.

In the first place, it offers another tuner which is adjustable independently of the tuner in the receiver. Thus if the broadcast receiver is not selective because of lack of alignment of the tuning condensers the filter in front of the receivers affords an independent tuner which may be adjusted sharply to the desired station, building up its signal and suppressing others not wanted.

In the second place, it adds to the selectivity even when the broadcast receiver is very selective and permits selection of the desired station to the exclusion of stations not desired. Then there is the suppression feature of the circuit, which is the most important, especially when the interfering station is so close that ordinary tuned circuits cannot separate the two clashing stations. It suppresses the undesired station without at the same time diminishing the desired one.

If the circuit appears to be broad it should be remembered that it contains only two tuned circuits and that the receiver tuner against which it is directly compared may contain as many as six. But tuner for tuner the selector is more selective, and it must be remembered that it affords added selectivity. Its usefulness is particularly great in the vicinity of high power broadcast stations the signals of which are so strong as to override all other stations regardless of the type of receiver that is used. The added selectivity is then most welcome, and, indeed, in such places the Selectifier has met with greatest success.

Variable Selectivity

The switch in series with the midget condenser between the two stators of the tuning condensers and the adjustor on this condenser provide means of varying the selectivity of the device. When the switch is closed the coupling is the closest, the selectivity the lowest, and the signal transfer the greatest. If the midget condenser is set at maximum these effects are very great while when the condenser is set at minimum the effects are not much greater than when the switch is open. If greatest selectivity is desired, either when using the circuit as an acceptor or as a rejector, the switch should be open regardless of the setting of the midget condenser, for the minimum capacity of the midget is of the order of 20 mmfd.

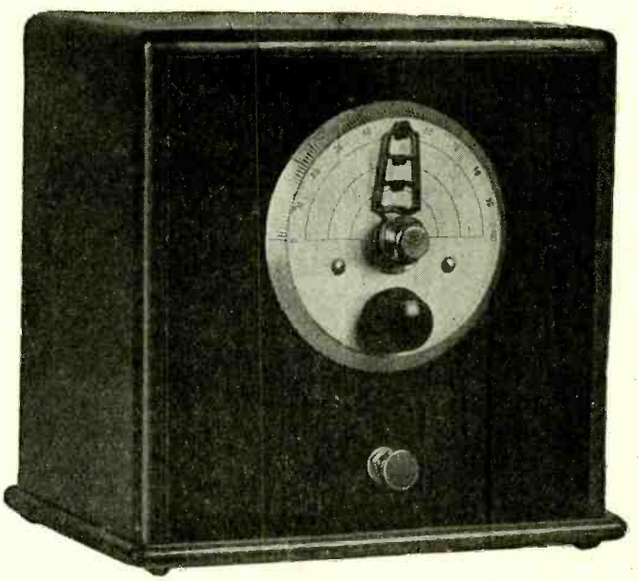


FIG. 2
Front view of the Selectifier in its cabinet showing the REL vernier dial and the condenser switch.

Good Ground Important

A good ground connection is far more important than most listeners believe. Of course, the difference in results from local stations will not be pronounced but on distant and faint stations a good ground will bring a noticeable gain in volume. Furthermore, a good ground will reduce the hum present in sets operated from electric power or sets using electrically-operated accessories.

In an apartment house it is well to make connection with as many radiators, water pipes, etc., as possible. It is easy to test out these additional connections. The daytime is best for such tests as results are not likely to be confused by fading. Tune in a weak station, then try adding new ground connections, retuning if necessary.

The suburban dweller should get a direct wire to the water main where the main enters the cellar. Additional wires to pipes and radiators in the room often help, too.

Farm listeners need to pay special attention to their ground connections. A copper wire screen, heavy and coarse mesh, will be useful. It should have about 10 or more square feet of area. Bury it in a trench 3 feet deep or so, preferably in a damp spot. In dry country, the ground may be a counterpoise, about 100 feet of wire suspended on stakes a foot high, under the aerial. Another good system is 100 feet or more of well-insulatd wire laid in a furrow ploughed in the ground under the aerial.

MERCURY VAPOR RECTIFIER

The DeForest Radio Company, Passaic, N. J., has announced a new half-wave mercury vapor rectifier, Type 575, for use in B supplies of transmitters or other applications requiring a high rectified voltage and current.

The characteristics of the tube are as follows:

Filament voltage	5 volts
Filament current	12.5 amperes
Max. peak inverse voltage	15,000 volts
Max. peak plate current	2.5 amperes
Approximate tube voltage drop	12 volts
Overall length	9 inches
Diameter of bulb	4 inches

The filament must be maintained at not less than 5 volts. The tube is not similar to nor interchangeable with any other make of mercury vapor rectifier now available, but it fits a standard 50-watt base. The filament should always be lighted for 30 seconds before the plate voltage is applied. This is usually provided for by insertion of a time relay in the plate circuit which delays the application of the plate voltage until the filament has been lighted the required length of time.

DX-4 Does Its Stuff

Doubters Turn Into Boosters as Rectifier Model Is Used

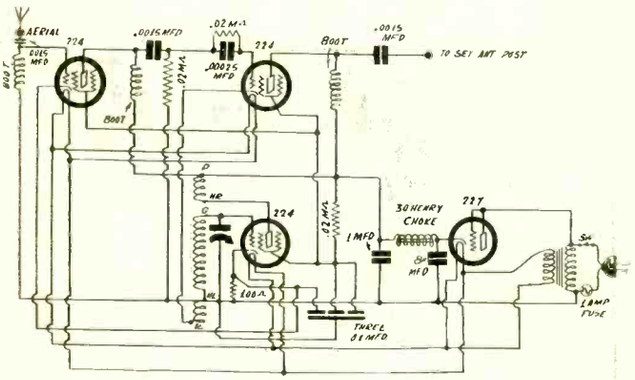


FIG. 1
The DX-4 All-Wave Converter, with constants used in models that won over anti-converter folk.

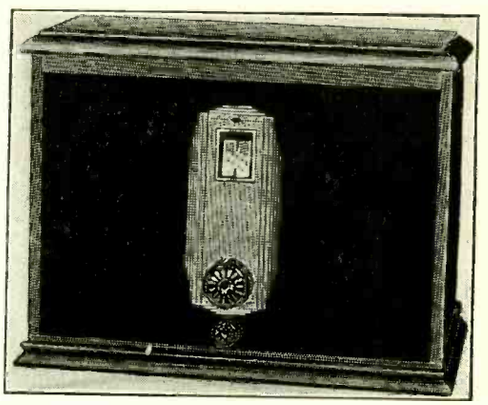


Fig. 2 Front view of the DX-4 All-Wave Converter

"I'M looking for a short-wave set, but a short-wave converter, no." That was what one man said to a fellow radio enthusiast when they met on the street the other day.

The person addressed had no short-wave experience, as yet, so he hesitated to purchase parts for a converter, although he had had one in mind for a week or more. If his friend, who assumptively knew more about it than he did, was off converters for life, and then some, what chance had a converter of winning its way into the disillusioned one's home?

The pair visited a mutual friend that night in a neighboring city. And that mutual friend had a device he was eager to demonstrate. It was in a handsome walnut finish cabinet, small in size, and matching well the console on which it stood. If the thing, obviously a radio device, only worked half as well as it looked, what performance could be expected!

The Demonstration Takes Place

Well, it was indeed a short-wave converter, or, rather, an all-wave converter, and it was built of parts of specified values shown in the diagram, Fig. 1. Every part is duplicated just as he had it.

"It's a DX-4 All-Wave Converter," said the enthusiastic possessor, "and I've had it a week. What fun!"

"Where," asked the doubting Thomas, "does it get its name DX?"

"I don't know where it gets it, but I'm willing to christen it that, after my experience with it. Why, the little thing brings in everything!" And so there was at the beginning a difference of opinion, a sharp difference between the owner of the DX-4 and the friend who was all off converters for life, a rather mild and uncertain difference on the part of the third fellow.

After the demonstration that night the middle-ground man recovered his sensible poise, while the strength of the opposition to converters crumpled up under the showing. Four European stations were tuned in, by using the time table of short-wave stations published in the March 28th issue of RADIO WORLD, as well as a station in Honduras and another in Canada, and any quantity of American stations from all parts of the country, including coast-to-coast reception, all on short waves.

It is hard to imagine a more astonished man than was that anti-converter crab. The question naturally arises as to why persons are opposed to converters.

Must Oscillate

It follows that they tried one and could get no results. But if you will tax the objector, no doubt he will admit that the converter he used required obtaining the B voltage from some external source, and that he tried to fish it out of the receiver itself, somehow.

Methods of doing this have been outlined from time to time in these columns, and an article last week stressed the four principal methods, yet it is a certainty that some who try to obtain the B voltage externally by some attachment simply don't succeed.

The reason is that the receiver's circuit is such that it does not lend itself to yielding the B voltage, because the B current for the converter must flow through some impedance in the set, hence the voltage both to the converter and to the loads supplied at the same voltage in the set, is too low, due to enlarged drop. The converter's oscillator won't oscillate, and when that situation obtains there is no possibility of bringing in short waves.

The built-in rectifier, of course, solves that problem. Several options as to values to use for filtration have been given, regarding the DX-4 and other circuits, while the characters and values of load impedances have been different from time to time, the circuit remaining always the same.

There is a little difference in performance as the character and values are altered.

For instance, if very tiny radio frequency choke coils are used, for example those of ¼ millihenry, the converter will not act as much of a booster for broadcasting reception through the set itself, and there will be less difficulty in finding a quiet spot on the set dial for intermediate frequency.

If medium value resistors are used, or relatively high inductance choke coils, response will be louder when the converter is worked as such as well as when the set is tuned for broadcasts and the converter worked as a booster. On the other hand, the receiver should be able to tune beyond the broadcast band at one extreme, preferably the higher frequency end, so that a quiet intermediate frequency is obtainable. Any fairly sensitive set, being made more sensitive by boosting, naturally affords scarcely any point in the broadcast band itself that will serve as intermediate frequency.

So the parts and constants, shown in Fig. 1, presuppose the use of a receiver that does go a little beyond either extreme. No matter what intermediate frequency is used, the lowest broadcast frequency (550 kc.) can be tuned in with the largest and sometimes with the second largest converter coil, while the highest response frequency is about the same, independent of the intermediate frequency, about 30,000 kc. (10 meters). The reason for the similarity, despite intermediate frequency difference of 950 kc. is that 950 is then only about one-thirtieth of the signal frequency to which the device responds.

A dealer wrote to a manufacturer of parts saying he would like

Queer English

to get a short-wave set made, but wouldn't want a converter. So the manufacturer, who specialized on converters, took pains to inquire what was the objection to a converter.

"She no worka," wrote back the dealer.

The manufacturer wrote back:

"Oh, yes, she do, and we senda you one wired on ten-day money-back jamboree. Whaddye say?"

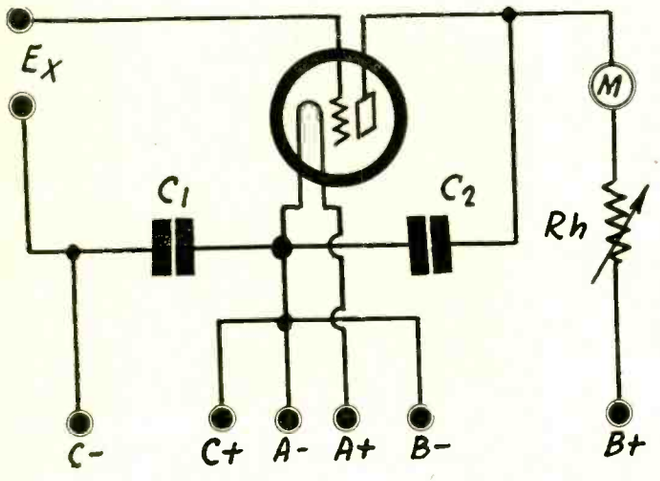
"Me say yes," came the telegraphed reply. (Postal Telegraph, collect.)

Out went the converter. It stayed out. The dealer wrote a letter of thanks and denounced an unnamed local expert who said that converters don't work. Pinned to the letter was a list of 496 stations the dealer's customer (you see, he had designs on dollars) had tuned in during nine days.

And so the story might go on, of one doubter after another overcome—yes, overcome with joy. The circuits referred to were one and the same as Fig. 1 herewith.

A Tube Galvanometer

By Brunsten Brunn



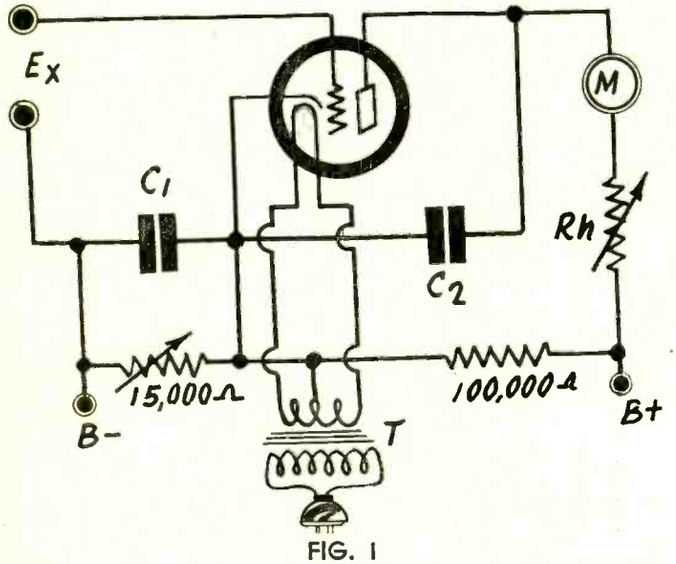


FIG. 1

Circuits of a simple vacuum tube voltmeter for measuring radio and audio voltages.

THERE is no better instrument for making qualitative and quantitative tests on radio apparatus than a vacuum tube voltmeter. There is no other instrument that is so versatile in its application. And the vacuum tube voltmeter is exceptionally simple to construct. In fact, it is only a power detector, or grid bias detector, working into a milliammeter instead of into another tube.

The most difficult part of the construction of a vacuum tube voltmeter is the calibration. This requires instruments which are not always available. But it is not necessary to calibrate the circuit if it to be used only for qualitative or comparative work. Without calibrating it resonance curves may be taken, the effect of coupling may be studied, the relative efficiency of tuners may be determined, the amplification of a stage or of an amplifier chain may be measured, and many other measurements may be done with it. In fact, in most of its applications it is not at all necessary to know the particular relationship that exists between the effective AC grid voltage and the plate current.

Of course, when the circuit is not calibrated in volts it cannot rightly be called a vacuum tube voltmeter, but rather a vacuum tube galvanometer, a vacuum tube comparator, or simply a detector.

Parts Needed

The parts needed for the construction of such an instrument are indicated in Fig. 1. Here we have a condenser CI, which should have a capacity from one to four microfarads. It is used mainly to make the vacuum tube voltmeter applicable to high frequency measurements. For audio frequencies it is not really necessary, but

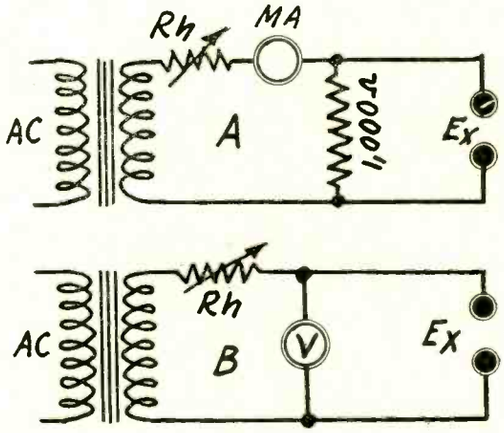


FIG. 2

Two different methods of calibrating a vacuum tube voltmeter. (a) The use of AC milliammeter and a 1,000 ohm non-inductive resistance. (b) The use of an AC voltmeter previously calibrated.

nevertheless it is useful for them, too. Then we have a condenser C2 in the plate circuit. This is the usual plate condenser found in all detectors. In connection with detectors it is said that this condenser provides a low impedance path for the high frequencies. That is just what it does, but it does more. Or what it does do may be looked at in a different light. It is a filter. It has exactly the same effect as the first condenser in a B supply. It may increase the output by a factor of two. Without this condenser we would have a case similar to choke input in a B supply, and the output voltage of such a device may be only about half as great as the output when a fairly large condenser is used next to the rectifier.

In this case the meter is the choke, for the armature coil has considerable inductance in a sensitive instrument. The current pulses flow into the condenser without much opposition until the condenser is charged. During the inactive half-cycle the condenser discharges through the meter and the resistance in series with the meter. Of course, some of the current in the impulses flows through the meter, and it is this part which is the only current when the condenser is not used. With the condenser, current flows through the meter all the time and consequently the average is considerably greater.

The Current Indicator

The current indicator M should be a sensitive milliammeter or a microammeter. In case no such instrument is available it is allowable to use a meter of less sensitivity. The main reason for using a sensitive instrument is to save the tube used as rectifier and to hold the calibration a long time. It is also practical to use a voltmeter as indicator, say one that has a sensitivity of 1,000 ohms per volt. The range of this meter should be about 100 volts. If the range of this meter is too high the maximum deflection will not be high enough on ordinary input voltages to the vacuum tube voltmeter. Moreover, if it is too high it is not possible to adjust the resistance until the deflection has the desired value. The range of the voltmeter is not important otherwise because the only object of the meter is to get a deflection.

In Fig. 1 there is a variable resistance Rh, which is used to adjust the current in the plate current until the deflection has the desired value. Its value depends on the sensitivity of the indicator meter, being greater the greater the sensitivity. It also depends on the voltage applied in the plate circuit of the tube. The higher the voltage the higher the resistance required.

In one case the meter M was a 0-1 milliammeter and the resistance Rh was a 100,000 ohm fixed resistor. This just happened to be right in that case and it was not necessary to use a variable one.

(Continued next week)

LIST OF PARTS

C1—One 4 mfd. by-pass condenser
C2—One 0.1 mfd. by-pass condenser or larger
M—One 0-1 milliammeter
Rh—One variable resistance of about 1000,000 ohms.
Eight binding posts
One socket

Table of Kilocycles(kc) to Met

The columns are interchangeable. The table gives the approximate values in meters corresponding to any number of kilocycles, or in kilocycles corresponding to any number of meters. The table is based on the factor 300,000. To obtain kilocycles (independent of the table), divide 300,000 by the number of meters, or to obtain meters divide 300,000 by the number of kilocycles. The table gives values for every 10 kilocycles or meters between the limits of 10 and 30,000. The table is entirely reversible; that is, for example 80 kilocycles equals 3,750 meters and also 3,750 meters equals

kc or m	m or kc	kc or m	m or kc	kc or m	m or kc	kc or m	m or kc	kc or m	m or kc	kc or m	m or kc	kc or m	m or kc	kc or m	m or kc	kc or m	m or kc	kc or m	m or kc	kc or m	m or kc	kc or m	m or kc	kc or m	m or kc	kc or m	m or kc	kc or m	m or
		1,000	300.0	2,000	150.0	3,000	100.0	4,000	75.00	5,000	60.00	6,000	50.00	7,000	42.86	8,000	37.50	9,000	33.33	10,000	30.00	11,000	27.27	12,000	25.00	13,000	23.08	14,000	21
10	30,000	1,010	297.0	2,010	149.3	3,010	99.7	4,010	74.81	5,010	59.88	6,010	49.92	7,010	42.80	8,010	37.45	9,010	33.30	10,010	29.97	11,010	27.25	12,010	24.98	13,010	23.06	14,010	21.
20	15,000	1,020	294.1	2,020	148.5	3,020	99.3	4,020	74.63	5,020	59.76	6,020	49.83	7,020	42.74	8,020	37.41	9,020	33.26	10,020	29.94	11,020	27.22	12,020	24.96	13,020	23.04	14,020	21.
30	10,000	1,030	291.3	2,030	147.8	3,030	99.0	4,030	74.44	5,030	59.64	6,030	49.75	7,030	42.67	8,030	37.36	9,030	33.22	10,030	29.91	11,030	27.20	12,030	24.94	13,030	23.02	14,030	21.
40	7,500	1,040	288.5	2,040	147.1	3,040	98.7	4,040	74.26	5,040	59.52	6,040	49.67	7,040	42.61	8,040	37.31	9,040	33.19	10,040	29.88	11,040	27.17	12,040	24.92	13,040	23.01	14,040	21.
50	6,000	1,050	285.7	2,050	146.3	3,050	98.4	4,050	74.07	5,050	59.41	6,050	49.59	7,050	42.55	8,050	37.27	9,050	33.15	10,050	29.85	11,050	27.15	12,050	24.90	13,050	22.99	14,050	21.
60	5,000	1,060	283.0	2,060	145.6	3,060	98.0	4,060	73.89	5,060	59.29	6,060	49.50	7,060	42.49	8,060	37.22	9,060	33.11	10,060	29.82	11,060	27.12	12,060	24.88	13,060	22.97	14,060	21.
70	4,286	1,070	280.4	2,070	144.9	3,070	97.7	4,070	73.71	5,070	59.17	6,070	49.42	7,070	42.43	8,070	37.17	9,070	33.08	10,070	29.79	11,070	27.10	12,070	24.86	13,070	22.95	14,070	21.
80	3,750	1,080	277.8	2,080	144.2	3,080	97.4	4,080	73.53	5,080	59.06	6,080	49.34	7,080	42.37	8,080	37.13	9,080	33.04	10,080	29.76	11,080	27.08	12,080	24.83	13,080	22.94	14,080	21.
90	3,333	1,090	275.2	2,090	143.5	3,090	97.1	4,090	73.35	5,090	58.94	6,090	49.26	7,090	42.31	8,090	37.08	9,090	33.00	10,090	29.73	11,090	27.05	12,090	24.81	13,090	22.92	14,090	21.
100	3,000	1,100	272.7	2,100	142.9	3,100	96.8	4,100	73.17	5,100	58.82	6,100	49.18	7,100	42.25	8,100	37.04	9,100	32.97	10,100	29.70	11,100	27.03	12,100	24.79	13,100	22.90	14,100	21.
110	2,727	1,110	270.3	2,110	142.2	3,110	96.5	4,110	72.99	5,110	58.71	6,110	49.10	7,110	42.19	8,110	36.99	9,110	32.93	10,110	29.67	11,110	27.00	12,110	24.77	13,110	22.88	14,110	21.
120	2,500	1,120	267.9	2,120	141.5	3,120	96.2	4,120	72.82	5,120	58.59	6,120	49.02	7,120	42.13	8,120	36.95	9,120	32.89	10,120	29.64	11,120	26.98	12,120	24.75	13,120	22.87	14,120	21.
130	2,308	1,130	265.5	2,130	140.8	3,130	95.8	4,130	72.64	5,130	58.48	6,130	48.94	7,130	42.08	8,130	36.90	9,130	32.86	10,130	29.62	11,130	26.95	12,130	24.73	13,130	22.85	14,130	21.
140	2,143	1,140	263.2	2,140	140.2	3,140	95.5	4,140	72.46	5,140	58.37	6,140	48.86	7,140	42.02	8,140	36.86	9,140	32.82	10,140	29.59	11,140	26.93	12,140	24.71	13,140	22.83	14,140	21.
150	2,000	1,150	260.9	2,150	139.5	3,150	95.2	4,150	72.29	5,150	58.25	6,150	48.78	7,150	41.96	8,150	36.81	9,150	32.79	10,150	29.56	11,150	26.91	12,150	24.69	13,150	22.81	14,150	21.
160	1,875	1,160	258.6	2,160	138.9	3,160	94.9	4,160	72.12	5,160	58.14	6,160	48.70	7,160	41.90	8,160	36.76	9,160	32.75	10,160	29.53	11,160	26.88	12,160	24.67	13,160	22.80	14,160	21.
170	1,765	1,170	256.4	2,170	138.2	3,170	94.6	4,170	71.94	5,170	58.03	6,170	48.62	7,170	41.84	8,170	36.72	9,170	32.72	10,170	29.50	11,170	26.86	12,170	24.65	13,170	22.78	14,170	21.
180	1,667	1,180	254.2	2,180	137.6	3,180	94.3	4,180	71.77	5,180	57.92	6,180	48.54	7,180	41.78	8,180	36.67	9,180	32.68	10,180	29.47	11,180	26.83	12,180	24.63	13,180	22.76	14,180	21.
190	1,579	1,190	252.1	2,190	137.0	3,190	94.0	4,190	71.60	5,190	57.80	6,190	48.47	7,190	41.72	8,190	36.63	9,190	32.64	10,190	29.44	11,190	26.81	12,190	24.61	13,190	22.74	14,190	21.
200	1,500	1,200	250.0	2,200	136.4	3,200	93.8	4,200	71.43	5,200	57.69	6,200	48.39	7,200	41.67	8,200	36.59	9,200	32.61	10,200	29.41	11,200	26.79	12,200	24.59	13,200	22.73	14,200	21.
210	1,429	1,210	247.9	2,210	135.7	3,210	93.5	4,210	71.26	5,210	57.58	6,210	48.31	7,210	41.61	8,210	36.54	9,210	32.57	10,210	29.38	11,210	26.76	12,210	24.57	13,210	22.71	14,210	21.
220	1,364	1,220	245.9	2,220	135.1	3,220	93.2	4,220	71.09	5,220	57.47	6,220	48.23	7,220	41.55	8,220	36.50	9,220	32.54	10,220	29.35	11,220	26.74	12,220	24.55	13,220	22.69	14,220	21.
230	1,304	1,230	243.9	2,230	134.5	3,230	92.9	4,230	70.92	5,230	57.36	6,230	48.15	7,230	41.49	8,230	36.45	9,230	32.50	10,230	29.33	11,230	26.71	12,230	24.53	13,230	22.68	14,230	21.
240	1,250	1,240	241.9	2,240	133.9	3,240	92.6	4,240	70.75	5,240	57.25	6,240	48.08	7,240	41.44	8,240	36.41	9,240	32.47	10,240	29.30	11,240	26.69	12,240	24.51	13,240	22.66	14,240	21.
250	1,200	1,250	240.0	2,250	133.3	3,250	92.3	4,250	70.59	5,250	57.14	6,250	48.00	7,250	41.38	8,250	36.36	9,250	32.43	10,250	29.27	11,250	26.67	12,250	24.49	13,250	22.64	14,250	21.
260	1,154	1,260	238.1	2,260	132.7	3,260	92.0	4,260	70.42	5,260	57.03	6,260	47.92	7,260	41.32	8,260	36.32	9,260	32.40	10,260	29.24	11,260	26.64	12,260	24.47	13,260	22.62	14,260	21.
270	1,111	1,270	236.2	2,270	132.2	3,270	91.7	4,270	70.26	5,270	56.93	6,270	47.85	7,270	41.27	8,270	36.28	9,270	32.36	10,270	29.21	11,270	26.62	12,270	24.45	13,270	22.61	14,270	21.
280	1,071	1,280	234.4	2,280	131.6	3,280	91.5	4,280	70.09	5,280	56.82	6,280	47.77	7,280	41.21	8,280	36.23	9,280	32.33	10,280	29.18	11,280	26.60	12,280	24.43	13,280	22.59	14,280	21.
290	1,034	1,290	232.6	2,290	131.0	3,290	91.2	4,290	69.93	5,290	56.71	6,290	47.69	7,290	41.15	8,290	36.19	9,290	32.29	10,290	29.15	11,290	26.57	12,290	24.41	13,290	22.57	14,290	20.
300	1,000	1,300	230.8	2,300	130.4	3,300	90.9	4,300	69.77	5,300	56.60	6,300	47.62	7,300	41.10	8,300	36.14	9,300	32.26	10,300	29.13	11,300	26.55	12,300	24.39	13,300	22.56	14,300	20.
310	968	1,310	229.0	2,310	129.9	3,310	90.6	4,310	69.61	5,310	56.50	6,310	47.54	7,310	41.04	8,310	36.10	9,310	32.22	10,310	29.10	11,310	26.53	12,310	24.37	13,310	22.54	14,310	20.9
320	938	1,320	227.3	2,320	129.3	3,320	90.4	4,320	69.44	5,320	56.39	6,320	47.47	7,320	40.98	8,320	36.06	9,320	32.19	10,320	29.07	11,320	26.50	12,320	24.35	13,320	22.52	14,320	20.9
330	909	1,330	225.6	2,330	128.8	3,330	90.1	4,330	69.28	5,330	56.29	6,330	47.39	7,330	40.93	8,330	36.01	9,330	32.15	10,330	29.04	11,330	26.48	12,330	24.33	13,330	22.51	14,330	20.9
340	882	1,340	223.9	2,340	128.2	3,340	89.8	4,340	69.12	5,340	56.18	6,340	47.32	7,340	40.87	8,340	35.97	9,340	32.12	10,340	29.01	11,340	26.46	12,340	24.31	13,340	22.49	14,340	20.9
350	857	1,350	222.2	2,350	127.7	3,350	89.6	4,350	68.97	5,350	56.07	6,350	47.24	7,350	40.82	8,350	35.93	9,350	32.09	10,350	28.99	11,350	26.43	12,350	24.29	13,350	22.47	14,350	20.
360	833	1,360	220.6	2,360	127.1	3,360	89.3	4,360	68.81	5,360	55.97	6,360	47.17	7,360	40.76	8,360	35.89	9,360	32.05	10,360	28.96	11,360	26.41	12,360	24.27	13,360	22.46	14,360	20.
370	811	1,370	219.0	2,370	126.6	3,370	89.0	4,370	68.65	5,370	55.87	6,370	47.10	7,370	40.71	8,370	35.84	9,370	32.02	10,370	28.93	11,370	26.39	12,370	24.25	13,370	22.44	14,370	20.
380	789	1,380	217.4	2,380	126.1	3,380	88.8	4,380	68.49	5,380	55.76	6,380	47.02	7,380	40.65	8,380	35.80	9,380	31.98	10,380	28.90	11,380	26.36	12,380	24.23	13,380	22.42	14,380	20.9
390	769	1,390	215.8	2,390	125.5	3,390	88.5	4,390	68.34	5,390	55.66	6,390	46.95	7,390	40.60	8,390	35.76	9,390	31.95	10,390	28.87	11,390	26.34	12,390	24.21	13,390	22.40	14,390	20.
400	750	1,400	214.3	2,400	125.0	3,400	88.2	4,400	68.18	5,400	55.56	6,400	46.88	7,400	40.54	8,400	35.71	9,400	31.91	10,400	28.85	11,400	26.32	12,400	24.19	13,400	22.39	14,400	20.8
410	732	1,410	212.8	2,410	124.5	3,410	88.0	4,410	68.03	5,410	55.45	6,410	46.80	7,410	40.49	8,410	35.67	9,410	31.88	10,410	28.82	11,410	26.29	12,410	24.17	13,410	22.37	14,410	20.8
420	714	1,420	211.3	2,420	124.0	3,420	87.7	4,420	67.87	5,420	55.35	6,420	46.73	7,420	40.43	8,420	35.63	9,420	31.85	10,420	28.79	11,420	26.27	12,420	24.15	13,420	22.35	14,420	20.
430	698	1,430	209.8	2,430	123.5	3,430	87.5	4,430	67.72	5,430	55.25	6,430	46.66	7,430	40.38	8,430	35.59	9,430	31.81	10,430	28.76	11,430	26.25	12,430	24.14	13,430	22.34	14,430	20.7
440	682	1,440	208.3	2,440	123.0	3,440	87.2	4,440	67.57	5,440	55.15	6,440	46.58	7,440	40.32	8,440	35.55	9,440	31.78	10,440	28.74	11,440	26.22	12,440	24.12	13,440	22.32	14,440	20.7
450	667	1,450	206.9	2,450	122.4	3,450	87.0	4,450	67.42	5,450	55.05	6,450	46.51	7,450	40.27	8,450	35.50	9,450	31.75	10,450	28.71	11,450	26.20	12,450	24.10	13,450	22.30	14,450	20.7
460	652	1,460	205.5	2,460	122.0	3,460	86.7	4,460	67.26	5,460	54.95	6,460	46.44	7,460	40.21	8,460	35.46	9,460	31.71	10,460	28.68	11,460	26.18	12,460	24.08	13,460	22.29	14,460	20.7
470	638	1,470	204.1	2,470	121.5	3,470	86.5	4,470	67.11	5,470	54.84	6,470	46.37	7,470	40.16	8,470	35.42	9,470	31.68	10,470	28.65	11,470	26.16	12,470	24.06	13,470	22.27	14,470	20.7
480	625	1,480	202.7	2,480	121.0	3,480	86.2	4,480	66.96	5,480	54.74	6,480	46.30	7,480	40.11	8,480	35.38	9,480	31.65	10,480	28.63	11,480	26.13	12,480	24.04	13,480	22.26	14,480	20.7
490	612	1,490	201.3	2,490	120.5	3,490	86.0	4,490	66.82	5,490	54.64	6,490	46.22	7,490	40.05	8,490	35.34	9,490	31.61	10,490	28.60	11,490	26.11	12,490	24.02	13,490	22.24	14,490	20.7
500	600	1,500	200.0	2,500	120.0	3,500	85.7	4,500	66.67	5,500	54.55	6,500	46.15	7,500	40.00	8,500	35.29	9,500	31.58	10,500	28.57	11,500	26.09	12,500	24.00	13,500	22.22	14,500	20.6
510	588	1,510	198.7	2,510	119.5	3,510	85.5	4,510	66.52	5,510	54.45	6,510	46.08	7,510	39.95	8,510	35.25	9,510	31.55	10,510	28.54	11,510	26.06	12,510	23.98	13,510	22.21	14,510	20.6
520	577	1,520	197.4	2,520	119.0	3,520	85.2	4,520	66.37	5,520	54.35	6,520	46.01	7,520	39.89	8,520	35.21	9,520	31.51	10,520	28.52	11,520	26.04	12,520	23.96	13,520	22.19	14,520	20.6
530	566	1,530	196.1	2,530	118.6	3,530	85.0	4,530	66.23	5,530	54.25	6,530	45.94	7,530	39.84	8,530	35.17	9,530	31.48	10,530	28.49	11,530	26.02	12,530	23.94	13,530	22.17	14,530	20.6
540	556	1,540	194.8	2,540	118.1	3,540	84.7	4,540	66.08	5,540	54.15	6,540	45.87	7,540	39.79	8,540	35.13	9,540	31.45	10,540	28.46	11,540	26.00	12,540	23.92	13,540	22.16	14,540	20.6
550	545	1,550	193.5	2,550	117.6	3,550	84.5	4,550	65.93	5,550	54.05	6,550	45.80	7,550	39.74	8,550	35.09	9,550	31.41	10,550	28.44	11,550	25.97	12,550	23.90	13,550	22.14	14,550	20.6
560	536	1,560	192.3	2,560	117.2	3,560	84.3	4,560	65.79	5,560	53.96	6,560	45.73	7,560	39.68	8,560	35.05	9,560	31.38	10,560	28.41	11,560	25.95	12,560	23.89	13,560	22.12	14,560	20.6
570	526	1,570	191.1	2,570	116.7	3,570	84.0	4,570	65.65	5,570	53.86	6,570	45.66	7,570	39.63	8,570	35.01	9,570	31.35	10,570	28.38	11,570	25.93	12,570	23.87	13,570	22.11	14,570	20.5
580	517	1,580	189.9	2,580	116.3	3,580	83.8	4,580	65.50	5,580	53.76	6,580	45.59	7,580	39.58	8,580	34.97	9,580	31.32	10,580	28.36	11,580	25.91	12,580	23.85	13,580	22.09	14,580	20.5
590	509	1,590	188.7	2,590	115.8	3,590	83.6	4,590	65.36	5,590	53.67	6,590	45.52	7,590	39.53	8,590	34.92	9,590	31.28	10,590	28.33	11,590	25.88	12,590	23.83	13,590	22.08	14,590	20.5
600	500	1,600	187.5	2,600	115.4	3,600	83.3	4,600	65.22	5,600	53.57	6,600	45.45	7,600	39.47	8,600	34.88	9,600	31.25	10,600	28.30	11,600	25.86	12,600	23.81	13,600	22.06	14,600	20.5
610	492	1,610	186.3	2,610	114.9	3,610	83.1	4,610	65.08	5,610	53.48	6,610	45.39	7,610	39.42	8,610	34.84	9,610	31.22	10,610	28.28	11,610	25.84	12,610	23.79	13,610	22.04	14,610	20.5
620	484	1,620	185.2	2,620	114.5	3,620	82.9	4,620	64.94	5,620	53.38	6,620	45.32	7,620	39.37	8,620	34.80	9,620	31.19	10,620	28.25	11,620	25.82	12,620	23.77	13,620	22.03	14,620	20.5
630	476	1,630	184.0	2,630	114.1	3,630	82.6	4,630	64.79	5,630	53.29	6,630	45.25	7,630	39.32	8,630	34.76	9,630	31.15	10,630	28.22	11,630	25.80	12,630	23.75	13,630	22.01	14,630	20.5
640	469	1,640	182.9	2,640	113.6	3,640	82.4	4,640	64.66	5,640	53.19	6,640	45.18	7,640	39.27	8,640	34.72	9,640	31.12	10,640	28.20	11,640	25.77	12,640	23.73	13,640	21.99	14,640	20.49
650	462	1,650	181.8	2,650	113.2	3,650	82.2	4,650	64.52	5,650	53.10	6,650	45.11	7,650	39.22	8,650	34.68	9,650	31.09	10,650	28.17	11,650	25.75	12,650	23.72	13,650	21.98	14,650	20.48
660	455	1,660	180.7	2,660	112.8	3,660	82.0	4,660	64.38	5,660	53.00	6,660	45.05	7,660	39.16	8,660	34.64	9,660	31.06	10,660	28.14	11,660	25.73	12,660	23.70	13,660	21.96	14,660	20.
670	448	1,670	179.6	2,670	112.4	3,670	81.7	4,670	64.24	5,670	52.91	6,670	44.98	7,670	39.11	8,670	34.60	9,670	31.02	10,670	28.12	11,670	25.71	12,670	23.68	13,670	21.95	14,670	20.
680	441	1,680	178.6	2,680	111.9	3,680	81.5	4,680	64.10	5,680	52.82	6,680	44.91	7,680	39.06	8,680	34.56	9,680	30.99	10,680	28.09	11,680	25.68	12,680	23.66	13,680	21.93	14,680	20.
690	435	1,690	177.5	2,690	111.5	3,690	81.3	4,690	63.97	5,690	52.72	6,690	44.84	7,690	39.01	8,690	34.52	9,690	30.96	10,690	28.06	11,690	25.66	12,690	23.64	13,690	21.91	14,690	20.
700	429	1,700	176.5	2,700	111.1	3,700	81.1	4,700	63.83	5,700	52.63	6,700	44.78	7,700	38.96	8,700	34.48	9,700	30.93	10,700	28.04	11,700	25.64	12,700	23.62	13,700	21.90	14,700	20.
710	423	1,710	175.4	2,710	110.7	3,710	80.9	4,710	63.69	5,710	52.54	6,710	44.71	7,710	38.91	8,710	34.44	9,710	30.90	10,710	28.01	11,710	25.62	12,710	23.60	13,710	21.88	14,710	20.
720	417	1,720	174.4	2,720	110.3	3,720	80.6	4,720	63.56	5,720	52.45	6,720	44.64	7,720	38.86	8,720	34.40	9,720	30.86	10,720	27.99	11,720	25.60	12,720	23.58	13,720	21.87	14,720	20.
730	411	1,730	173.4	2,730	109.9	3,730	80.4	4,730	63.42	5,730	52.36	6,730	44.58	7,730	38.81	8,730	34.36	9,730	30.83	10,730	27.96	11,730	25.58	12,730	23.57	13,730	21.85	14,730	20.
740	405	1,740	172.4	2,740	109.5	3,740	80.2	4,740	63.29	5,740	52.26	6,740	44.51	7,740	38.76	8,740	34.32	9,740	30.80	10,740	27.93	11,740	25.55	12,740	23.55	13,740	21.83	14,740	20.
750	400	1,750	171.4	2,750	109.1	3,750	80.0	4,750	63.16	5,750	52.17	6,750	44.44	7,750	38.71	8,750	34.29	9,750	30.77	10,750	27.91	11,750	25.53	12,750	23.53	13,750	21.82	14,750	20.
760	395	1,760	170.5	2,760	108.7	3,760	79.8	4,760	63.03	5,760	52.08	6,760	44.38	7,760	38.66	8,760	34.25	9,760	30.74	10,760	27.88	11,760	25.51	12,760	23.51	13,760	21.80	14,760	20.
770	390	1,770	169.5	2,770	108.3	3,770	79.6	4,770	62.89	5,770	51.99	6,770	44.31	7,770	38.61	8,770	34.21	9,770	30.71	10,770	27.86	11,770	25.49	12,770	23.49	13,770	21.79	14,770	20.
780	385	1,780	168.5	2,780	107.9	3,780	79.4	4,780	62.76	5,780	51.90	6,780	44.25	7,780	38.56	8,780	34.17	9,780	30.67	10,780	27.83	11,780	25.47	12,780	23.47	13,780	21.77	14,780	20.
790	380	1,790	167.6	2,790	107.5	3,790	79.2	4,790	62.63	5,790	51.81	6,790	44.18	7,790	38.51	8,790	34.13	9,790	30.64	10,790	27.80	11,790	25.45	12,790	23.46	13,790	21.75	14,790	20.
800	375	1,800	166.7	2,800	107.1	3,800	78.9	4,800	62.50	5,800	51.72	6,800	44.12	7,800	38.46	8,800	34.09	9,800	30.61	10,800	27.78	11,800	25.42	12,800	23.44	13,800	21.74	14,800	20.
810	370	1,810	165.7	2,810	106.7	3,810	78.7	4,810	62.37	5,810	51.64	6,810	44.05	7,810	38.41	8,810	34.05	9,810	30.58	10,810	27.75	11,810	25.40	12,810	23.42	13,810	21.72	14,810	20.
820	366	1,820	164.8	2,820	106.4	3,820	78.5	4,820	62.24	5,820	51.55	6,820	43.99	7,820	38.36	8,820	34.01	9,820	30.55	10,820	27.73	11,820	25.38	12,820	23.40	13,820	21.71	14,820	20.
830	361	1,830	163.9	2,830	106.0	3,830	78.3	4,830	62.11	5,830	51.46	6,830	43.92	7,830	38.31	8,830	33.98	9,830	30.52	10,830	27.70	11,830	25.36	12,830	23.38	13,830	21.69	14,830	20.
840	357	1,840	163.0	2,840	105.6	3,840	78.1	4,840	61.98	5,840	51.37	6,840	43.86	7,840	38.27	8,840	33.94	9,840	30.49	10,840	27.68	11,840	25.34	12,840	23.36	13,840	21.68	14,840	20.
850	353	1,850	162.2	2,850	105.3	3,850	77.9	4,850	61.86	5,850	51.28	6,850	43.80	7,850	38.22	8,850	33.90	9,850	30.46	10,850	27.65	11,850	25.32	12,850	23.35	13,850	21.66	14,850	20.
860	349	1,860	161.3	2,860	104.9	3,860	77.7	4,860	61.73	5,860	51.19	6,860	43.73	7,860	38.17	8,860	33.86	9,860	30.43	10,860	27.62	11,860	25.30	12,860	23.33	13,860	21.65	14,860	20.
870	345	1,870	160.4	2,870	104.5	3,870	77.5	4,870	61.60	5,870	51.11	6,870	43.67	7,870	38.12	8,870	33.82	9,870	30.40	10,870	27.60	11,870	25.27	12,870	23.31	13,870	21.63	14,870	20.
880	341	1,880	159.6	2,880	104.2	3,880	77.3	4,880	61.48	5,880	51.02	6,880	43.60	7,880	38.07	8,880	33.78	9,880	30.36	10,880	27.57	11,880	25.25	12,880	23.29	13,880	21.61	14,880	20.
890	337	1,890	158.7	2,890	103.8	3,890	77.1	4,890	61.35	5,890	50.93	6,890	43.54	7,890	38.02	8,890	33.75	9,890	30.33	10,890	27.55	11,890	25.23	12,890	23.27	13,890	21.60	14,890	20.
900	333	1,900	157.9	2,900	103.4	3,900	76.9	4,900	61.22	5,900	50.85	6,900	43.48	7,900	37.97	8,900	33.71	9,900	30.30	10,900	27.52	11,900	25.21	12,900	23.26	13,900	21.58	14,900	20.
910	330	1,910	157.1	2,910	103.1	3,910	76.7	4,910	61.10	5,910	50.76	6,910	43.42	7,910	37.93	8,910	33.67	9,910	30.27	10,910	27.50	11,910	25.19	12,910	23.24	13,910	21.57	14,910	20.
920	326	1,920	156.3	2,920	102.7	3,920	76.5	4,920	60.98	5,920	50.68	6,920	43.35	7,920	37.88	8,920	33.63	9,920	30.24	10,920	27.47	11,920	25.17	12,920	23.22	13,920	21.55	14,920	20.
930	323	1,930	155.4	2,930	102.4	3,930	76.3	4,930	60.85	5,930	50.59	6,930	43.29	7,930	37.83	8,930	33.59	9,930	30.21	10,930	27.45	11,930	25.15	12,930	23.20	13,930	21.54	14,930	20.
940	319	1,940	154.6	2,940	102.0	3,940	76.1	4,940	60.73	5,940	50.51	6,940	43.23	7,940	37.78	8,940	33.56	9,940	30.18	10,940	27.42	11,940	25.13	12,940	23.18	13,940	21.52	14,940	20.
950	316	1,950	153.8	2,950	101.7	3,950	75.9	4,950	60.61	5,950	50.42	6,950	43.17	7,950	37.74	8,950	33.52	9,950	30.15	10,950	27.40	11,950	25.10	12,950	23.17	13,950	21.51	14,950	20.
960	313	1,960	153.1	2,960	101.4	3,960	75.8	4,960	60.48	5,960	50.34	6,960	43.10	7,960	37.69	8,960	33.48	9,960	30.12	10,960	27.37	11,960	25.08	12,960	23.15	13,960	21.49	14,960	20.
970	309	1,970	152.3	2,970	101.0	3,970	75.6	4,970	60.36	5,970	50.25	6,970	43.04	7,970	37.64	8,970	33.44	9,970	30.09	10,970	27.35	11,970	25.06	12,970	23.13	13,970	21.47	14,970	20.
980	306	1,980	151.5	2,980	100.7	3,980	75.4	4,980	60.24	5,980	50.17	6,980	42.98	7,980	37.59	8,980	33.41	9,980	30.06	10,980	27.32	11,980	25.04	12,980	23.11	13,980	21.46	14,980	20.
990	303	1,990	150.8	2,990	100.3	3,990	75.2	4,990	60.12	5,990	50.08	6,990	42.92	7,990	37.55	8,990	33.37	9,990	30.03	10,990	27.30	11,990	25.02	12,990	23.09	13,990	21.44	14,990	20.0

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ers (m), or Meters to Kilocycles

80 kilocycles. The range of the table is easily extended by shifting the decimal point; the shift is in opposite directions for each pair of values. For example, one cannot find 567 in the first column, but its equivalent is obtained by finding later in the table that 5,670 kilocycles or meters equals 52.91 meters or kilocycles, from which 567 kilocycles or meters equals 529.1 meters or kilocycles. Again, one cannot find 11 meters in the first column but 110 is given opposite 2,727, from which we obtain 11 meters equalling 27,270 kilocycles.

kc or m	m or kc	kc or m	m or kc	kc or m	m or kc	kc or m	m or kc	kc or m	m or kc
15,000	20.000	16,000	18.750	17,000	17.647	18,000	16.667	19,000	15.789
15,010	19.987	16,010	18.738	17,010	17.637	18,010	16.657	19,010	15.781
15,020	19.973	16,020	18.727	17,020	17.626	18,020	16.648	19,020	15.773
15,030	19.960	16,030	18.715	17,030	17.616	18,030	16.639	19,030	15.765
15,040	19.947	16,040	18.703	17,040	17.606	18,040	16.630	19,040	15.756
15,050	19.934	16,050	18.692	17,050	17.595	18,050	16.620	19,050	15.748
15,060	19.919	16,060	18.680	17,060	17.585	18,060	16.611	19,060	15.740
15,070	19.907	16,070	18.668	17,070	17.575	18,070	16.602	19,070	15.732
15,080	19.894	16,080	18.657	17,080	17.564	18,080	16.593	19,080	15.723
15,090	19.881	16,090	18.645	17,090	17.554	18,090	16.584	19,090	15.715
15,100	19.868	16,100	18.634	17,100	17.544	18,100	16.575	19,100	15.707
15,110	19.854	16,110	18.622	17,110	17.534	18,110	16.565	19,110	15.699
15,120	19.841	16,120	18.610	17,120	17.523	18,120	16.556	19,120	15.690
15,130	19.828	16,130	18.599	17,130	17.513	18,130	16.547	19,130	15.682
15,140	19.815	16,140	18.587	17,140	17.503	18,140	16.538	19,140	15.674
15,150	19.802	16,150	18.576	17,150	17.493	18,150	16.529	19,150	15.666
15,160	19.789	16,160	18.564	17,160	17.483	18,160	16.520	19,160	15.658
15,170	19.776	16,170	18.553	17,170	17.472	18,170	16.511	19,170	15.649
15,180	19.763	16,180	18.541	17,180	17.462	18,180	16.502	19,180	15.641
15,190	19.750	16,190	18.530	17,190	17.452	18,190	16.493	19,190	15.633
15,200	19.737	16,200	18.519	17,200	17.443	18,200	16.484	19,200	15.625
15,210	19.724	16,210	18.507	17,210	17.432	18,210	16.474	19,210	15.617
15,220	19.711	16,220	18.496	17,220	17.422	18,220	16.465	19,220	15.609
15,230	19.698	16,230	18.484	17,230	17.411	18,230	16.456	19,230	15.601
15,240	19.685	16,240	18.473	17,240	17.401	18,240	16.447	19,240	15.593
15,250	19.672	16,250	18.462	17,250	17.391	18,250	16.438	19,250	15.584
15,260	19.659	16,260	18.450	17,260	17.381	18,260	16.429	19,260	15.576
15,270	19.646	16,270	18.439	17,270	17.371	18,270	16.420	19,270	15.568
15,280	19.634	16,280	18.428	17,280	17.361	18,280	16.411	19,280	15.560
15,290	19.621	16,290	18.416	17,290	17.351	18,290	16.402	19,290	15.552
15,300	19.608	16,300	18.405	17,300	17.341	18,300	16.393	19,300	15.544
15,310	19.595	16,310	18.394	17,310	17.331	18,310	16.384	19,310	15.536
15,320	19.582	16,320	18.382	17,320	17.321	18,320	16.376	19,320	15.528
15,330	19.569	16,330	18.371	17,330	17.311	18,330	16.367	19,330	15.520
15,340	19.557	16,340	18.360	17,340	17.301	18,340	16.358	19,340	15.512
15,350	19.544	16,350	18.349	17,350	17.291	18,350	16.349	19,350	15.504
15,360	19.531	16,360	18.337	17,360	17.281	18,360	16.340	19,360	15.496
15,370	19.519	16,370	18.326	17,370	17.271	18,370	16.331	19,370	15.488
15,380	19.506	16,380	18.315	17,380	17.261	18,380	16.322	19,380	15.480
15,390	19.493	16,390	18.304	17,390	17.251	18,390	16.313	19,390	15.472
15,400	19.481	16,400	18.293	17,400	17.241	18,400	16.304	19,400	15.464
15,410	19.468	16,410	18.282	17,410	17.231	18,410	16.295	19,410	15.456
15,420	19.455	16,420	18.270	17,420	17.222	18,420	16.287	19,420	15.448
15,430	19.443	16,430	18.259	17,430	17.212	18,430	16.278	19,430	15.440
15,440	19.430	16,440	18.248	17,440	17.202	18,440	16.269	19,440	15.432
15,450	19.417	16,450	18.237	17,450	17.192	18,450	16.260	19,450	15.424
15,460	19.405	16,460	18.226	17,460	17.182	18,460	16.251	19,460	15.416
15,470	19.392	16,470	18.215	17,470	17.172	18,470	16.243	19,470	15.408
15,480	19.380	16,480	18.204	17,480	17.162	18,480	16.234	19,480	15.400
15,490	19.367	16,490	18.193	17,490	17.153	18,490	16.225	19,490	15.393
15,500	19.355	16,500	18.182	17,500	17.143	18,500	16.216	19,500	15.385
15,510	19.342	16,510	18.171	17,510	17.133	18,510	16.207	19,510	15.377
15,520	19.330	16,520	18.160	17,520	17.123	18,520	16.199	19,520	15.369
15,530	19.317	16,530	18.149	17,530	17.114	18,530	16.190	19,530	15.361
15,540	19.305	16,540	18.138	17,540	17.104	18,540	16.181	19,540	15.353
15,550	19.293	16,550	18.127	17,550	17.094	18,550	16.173	19,550	15.345
15,560	19.280	16,560	18.116	17,560	17.084	18,560	16.164	19,560	15.337
15,570	19.268	16,570	18.105	17,570	17.075	18,570	16.155	19,570	15.330
15,580	19.255	16,580	18.094	17,580	17.065	18,580	16.146	19,580	15.322
15,590	19.243	16,590	18.083	17,590	17.055	18,590	16.138	19,590	15.314
15,600	19.231	16,600	18.072	17,600	17.045	18,600	16.129	19,600	15.306
15,610	19.218	16,610	18.061	17,610	17.036	18,610	16.120	19,610	15.298
15,620	19.206	16,620	18.051	17,620	17.026	18,620	16.112	19,620	15.291
15,630	19.194	16,630	18.040	17,630	17.016	18,630	16.103	19,630	15.283
15,640	19.182	16,640	18.029	17,640	17.007	18,640	16.094	19,640	15.275
15,650	19.169	16,650	18.018	17,650	16.997	18,650	16.086	19,650	15.267
15,660	19.157	16,660	18.007	17,660	16.988	18,660	16.077	19,660	15.259
15,670	19.145	16,670	17.996	17,670	16.978	18,670	16.069	19,670	15.252
15,680	19.133	16,680	17.986	17,680	16.968	18,680	16.060	19,680	15.244
15,690	19.120	16,690	17.975	17,690	16.959	18,690	16.051	19,690	15.236
15,700	19.108	16,700	17.964	17,700	16.949	18,700	16.043	19,700	15.228
15,710	19.096	16,710	17.953	17,710	16.940	18,710	16.034	19,710	15.221
15,720	19.084	16,720	17.943	17,720	16.930	18,720	16.026	19,720	15.213
15,730	19.072	16,730	17.932	17,730	16.920	18,730	16.017	19,730	15.205
15,740	19.060	16,740	17.921	17,740	16.911	18,740	16.009	19,740	15.198
15,750	19.048	16,750	17.910	17,750	16.901	18,750	16.000	19,750	15.190
15,760	19.036	16,760	17.899	17,760	16.892	18,760	15.991	19,760	15.182
15,770	19.023	16,770	17.889	17,770	16.882	18,770	15.983	19,770	15.175
15,780	19.011	16,780	17.878	17,780	16.873	18,780	15.974	19,780	15.167
15,790	18.999	16,790	17.868	17,790	16.863	18,790	15.966	19,790	15.159
15,800	18.987	16,800	17.857	17,800	16.854	18,800	15.957	19,800	15.151
15,810	18.975	16,810	17.847	17,810	16.844	18,810	15.949	19,810	15.144
15,820	18.963	16,820	17.836	17,820	16.835	18,820	15.940	19,820	15.136
15,830	18.951	16,830	17.825	17,830	16.826	18,830	15.932	19,830	15.129
15,840	18.939	16,840	17.815	17,840	16.816	18,840	15.924	19,840	15.121
15,850	18.927	16,850	17.804	17,850	16.807	18,850	15.915	19,850	15.113
15,860	18.912	16,860	17.794	17,860	16.797	18,860	15.907	19,860	15.106
15,870	18.904	16,870	17.783	17,870	16.788	18,870	15.898	19,870	15.098
15,880	18.892	16,880	17.773	17,880	16.779	18,880	15.890	19,880	15.091
15,890	18.880	16,890	17.762	17,890	16.769	18,890	15.881	19,890	15.083
15,900	18.868	16,900	17.751	17,900	16.760	18,900	15.873	19,900	15.075
15,910	18.856	16,910	17.741	17,910	16.750	18,910	15.865	19,910	15.068
15,920	18.844	16,920	17.730	17,920	16.741	18,920	15.856	19,920	15.060
15,930	18.832	16,930	17.720	17,930	16.732	18,930	15.848	19,930	15.053
15,940	18.821	16,940	17.710	17,940	16.722	18,940	15.839	19,940	15.045
15,950	18.809	16,950	17.700	17,950	16.713	18,950	15.831	19,950	15.038
15,960	18.797	16,960	17.689	17,960	16.704	18,960	15.823	19,960	15.030
15,970	18.785	16,970	17.678	17,970	16.694	18,970	15.814	19,970	15.023
15,980	18.773	16,980	17.668	17,980	16.685	18,980	15.806	19,980	15.015
15,990	18.762	16,990	17.657	17,990	16.676	18,990	15.798	19,990	15.008

kc or m	m or kc	kc or m	m or kc	kc or m	m or kc	kc or m	m or kc	kc or m	m or kc
20,000	15.000	21,000	14.286	22,000	13.636	23,000	13.043	24,000	12.500
20,010	14.993	21,010	14.279	22,010	13.630	23,010	13.038	24,010	12.495
20,020	14.985	21,020	14.272	22,020	13.624	23,020	13.032	24,020	12.490
20,030	14.978	21,030	14.265	22,030	13.618	23,030	13.026	24,030	12.484
20,040	14.970	21,040	14.259	22,040	13.612	23,040	13.020	24,040	12.479
20,050	14.963	21,050	14.252	22,050	13.605	23,050	13.015	24,050	12.474
20,060	14.955	21,060	14.245	22,060	13.599	23,060	13.010	24,060	12.469
20,070	14.948	21,070	14.238	22,070	13.593	23,070	13.004	24,070	12.464
20,080	14.940	21,080	14.231	22,080	13.587	23,080	12.998	24,080	12.458
20,090	14.933	21,090	14.225	22,090	13.581	23,090	12.993	24,090	12.453
20,100	14.925	21,100	14.218	22,100	13.575	23,100	12.987	24,100	12.448
20,110	14.918	21,110	14.211	22,110	13.569	23,110	12.981	24,110	12.443
20,120	14.911	21,120	14.205	22,120	13.562	23,120	12.976	24,120	12.438
20,130	14.903	21,130	14.198	22,130	13.556	23,130	12.970	24,130	12.433
20,140	14.896	21,140	14.191	22,140	13.550	23,140	12.965	24,140	12.428
20,150	14.888	21,150	14.184	22,150	13.544	23,150	12.959	24,150	12.422
20,160	14.881	21,160	14.178	22,160	13.538	23,160	12.953	24,160	12.417
20,170	14.874	21,170	14.171	22,170	13.532	23,170	12.948	24,170	12.412
20,180	14.866	21,180	14.164	22,180	13.526	23,180	12.942	24,180	12.407
20,190	14.859	21,190	14.158	22,190	13.520	23,190	12.937	24,190	12.402
20,200	14.851	21,200	14.151	22,200	13.514	23,200	12.931	24,200	12.397
20,210	14.844	21,210	14.144	22,210	13.507	23,210	12.925	24,210	12.392
20,220	14.837	21,220	14.138	22,220	13.501	23,220	12.920	24,220	12.387
20,230	14.829	21,230	14.131	22,230	13.495	23,230	12.914	24,230	12.381
20,240	14.822	21,240	14.124	22,240	13.489	23,240	12.909	24,240	12.376
20,250	14.815	21,250	14.118	22,250	13.483	23,250	12.903	24,250	12.371
20,260	14.808	21,260	14.111	22,260	13.477	23,260	12.898	24,260	12.366
20,270	14.800	21,270	14.104	22,270	13.471	23,270	12.892	24,270	12.361
20,280	14.793	21,280	14.098	22,280	13.465	23,280	12.887	24,280	12.356
20,290	14.786	21,290	14.091	22,290	13.459	23,290	12.881	24,290	12.351
20,300	14.778	21,300	14.085	22,300	13.453	23,300	12.876	24,300	12.346
20,310	14.771	21,310	14.078	22,310	13.447	23,310	12.870	24,310	12.341
20,320	14.764	21,320	14.071	22,320	13.441	23,320	12.864	24,320	12.336
20,330	14.757	21,330	14.065	22,330	13.435	23,330	12.859	24,330	12.330
20,340	14.749	21,340	14.058	22,340	13.429	23,340	12.853	24,340	12.325
20,350	14.742	21,350	14.052	22,350	13.423	23,350	12.848	24,350	12.320
20,360	14.735	21,360	14.045	22,360	13.417	23,360	12.842	24,360	12.315
20,370	14.728	21,370	14.038	22,370	13.411	23,370	12.837	24,370	12.310
20,380	14.720	21,380	14.032	22,380	13.405	23,380	12.831	24,380	12.305
20,390	14.713	21,390	14.025	22,390	13.399	23,390	12.826	24,390	12.300
20,400	14.706	21,400	14.019	22,400	13.393	23,400	12.821	24,400	12.295
20,410	14.699	21,410	14.012	22,410	13.387	23,410	12.815	24,410	12.290
20,420	14.691	21,420	14.006	22,420	13.381	23,420	12.810	24,420	12.285
20,430	14.684	21,430	13.999	22,430	13.375	23,430	12.804	24,430	12.280
20,440	14.677	21,440	13.993	22,440	13.369	23,440	12.799	24,440	12.275
20,450	14.670	21,450	13.986	22,450	13.363	23,450	12.793	24,450	12.270
20,460	14.663	21,460	13.979	22,460	13.357	23,460	12.788	24,460	12.265
20,470	14.656	21,470	13.973	22,470	13.351	23,470	12.782	24,470	12.260
20,480	14.648	21,480	13.966	22,480	13.345	23,480	12.777	24,480	12.255
20,490	14.641	21,490	13.960	22,490	13.339	23,490	12.771	24,490	12.250
20,500	14.634	21,500	13.953	22,500	13.333	23,500	12.766	24,500	12.245
20,510	14.627	21,510	13.947	22,510	13.327	23,510	12.761	24,510	12.240
20,520	14.620	21,520	13.941	22,520	13.321	23,520	12.755	24,520	12.235
20,530	14.613	21,530	13.934	22,530	13.316	23,530	12.750	24,530	12.230
20,540	14.606	21,540	13.928	22,540	13.310	23,540	12.744	24,540	12.225
20,550	14.599	21,550	13.921	22,550	13.304	23,550	12.739	24,550	12.220
20,560	14.591	21,560	13.915	22,560	13.298	23,560	12.733	24,560	12.215
20,570	14.584	21,570	13.908	22,570	13.292	23,570	12.728	24,570	12.210
20,580	14.577	21,580	13.902	22,580	13.286	23,580	12.723	24,580	12.205
20,590	14.570	21,590	13.895	22,590	13.280	23,590	12.717	24,590	12.200
20,600	14.563	21,600	13.889	22,600	13.274	23,600	12.712	24,600	12.195
20,610	14.556	21,610	13.882	22,610	13.268	23,610	12.706	24,610	12.190
20,620	14.549	21,620	13.876	22,620	13.263	23,620	12.701	24,620	12.185
20,630	14.542	21,630	13.870	22,630	13.257	23,630	12.696	24,630	12.180
20,640	14.535	21,640	13.863	22,640	13.251	23,640	12.690	24,640	12.175
20,650	14.528	21,650	13.857	22,650	13.245	23,650	12.685	24,650	12.170
20,660	14.521	21,660	13.850	22,660	13.239	23,660	12.680	24,660	12.165
20,670	14.514	21,670	13.844	22,670	13.233	23,670	12.674	24,670	12.161
20,680	14.507	21,680	13.838	22,680	13.228	23,680	12.669	24,680	12.156
20,690	14.500	21,690	13.831	22,690	13.222	23,690	12.664	24,690	12.151
20,700	14.493	21,700	13.825	22,700	13.216	23,700	12.658	24,700	12.146
20,710	14.486	21,710	13.819	22,710	13.210	23,710	12.653	24,710	12.141
20,720	14.479	21,720	13.812	22,720	13.204	23,720	12.648	24,720	12.136
20,730	14.472	21,730	13.806	22,730	13.198	23,730	12.642	24,730	12.131
20,740	14.465	21,740	13.799	22,740	13.193	23,740	12.637	24,740	12.126
20,750	14.458	21,750	13.793	22,750	13.187	23,750	12.632	24,750	12.121
20,760	14.451	21,760	13.787	22,760	13.181	23,760	12.626	24,760	12.116
20,770	14.444	21,770	13.780	22,770	13.175	23,770	12.621	24,770	12.111
20,780	14.437	21,780	13.774	22,780	13.169	23,780	12.616	24,780	12.107
20,790	14.430	21,790	13.768	22,790	13.164	23,790	12.610	24,790	12.102
20,800	14.423	21,800	13.761	22,800	13.158	23,800	12.605	24,800	12.097
20,810	14.416	21,810	13.755	22,810	13.152	23,810	12.600	24,810	12.092
20,820	14.409	21,820	13.749	22,820	13.146	23,820	12.594	24,820	12.087
20,830	14.402	21,830	13.743	22,830	13.141	23,830	12.589	24,830	12.082
20,840	14.395	21,840	13.736	22,840	13.135	23,840	12.584	24,840	12.077
20,850	14.388	21,850	13.730	22,850	13.129	23,850	12.579	24,850	12.072
20,860	14.382	21,860	13.724	22,860	13.123	23,860	12.573	24,860	12.068
20,870	14.375	21,870	13.717	22,870	13.118	23,870	12.568	24,870	12.063
20,880	14.368	21,880	13.711	22,880	13.112	23,880	12.563	24,880	12.058
20,890	14.361	21,890	13.705	22,890	13.106	23,890	12.558	24,890	12.053
20,900	14.354	21,900	13.699	22,900	13.100	23,900	12.552	24,900	12.048
20,910	14.347	21,910	13.692	22,910	13.095	23,910	12.547	24,910	12.043
20,920	14.340	21,920	13.686	22,920	13.089	23,920	12.542	24,920	12.039
20,930	14.333	21,930	13.680	22,930	13.083	23,930	12.537	24,930	12.034
20,940	14.327	21,940	13.674	22,940	13.078	23,940	12.531	24,940	12.029
20,950	14.320	21,950	13.667	22,950	13.072	23,950	12.526	24,950	12.024
20,960	14.313	21,960	13.661	22,960	13.066	23,960	12.521	24,960	12.019
20,970	14.306	21,970	13.655	22,970	13.060	23,970	12.516	24,970	12.014
20,980	14.299	21,980	13.649	22,980	13.055	23,980	12.510	24,980	12.010
20,990	14.293	21,990	13.643	22,990	13.049	23,990	12.505	24,990	12.005

kc or m	m or kc	kc or m	m or kc	kc or m	m or kc	kc or m	m or kc	kc or m	m or kc
25,000	12.000	26,000	11.538	27,000	11.111	28,000	10.714	29,000	10.345
25,010	11.995	26,010	11.534	27,010	11.107	28,010	10.710	29,010	10.341
25,020	11.990	26,020	11.530	27,020	11.103	28,020	10.707	29,020	10.338
25,030	11.986	26,030	11.525	27,030	11.099	28,030	10.703	29,030	10.334
25,040	11.981	26,040	11.521	27,040	11.095	28,040	10.699	29,040	10.331
25,050	11.976	26,050	11.516	27,050	11.091	28,050	10.695	29,050	10.327
25,060	11.971	26,060	11.512	27,060	11.086	28,060	10.691	29,060	10.323
25,070	11.966	26,070	11.507	27,070	11.082	28,070	10.688	29,070	10.320
25,080	11.962	26,080	11.503	27,080	11.078	28,080	10.684	29,080	10.316
25,090	11.957	26,090	11.499	27,090	11.074	28,090	10.680	29,090	10.313
25,100	11.952	26,100	11.494	27,100	11.070	28,100	10.676	29,100	10.309
25,110	11.947	26,110	11.490	27,110	11.066	28,110	10.672	29,110	10.306
25,120	11.943	26,120	11.485	27,120	11.062	28,120	10.669	29,120	10.302
25,130	11.938	26,130	11.481	27,130	11.058	28,130	10.665	29,130	10.299
25,140	11.933	26,140	11.477	27,140	11.054	28,140	10.661	29,140	10.295
25,150	11.928	26,150	11.472	27,150	11.050	28,150	10.657	29,150	10.292
25,160	11.924	26,160	11.468	27,160	11.046	28,160	10.653	29,160	10.288
25,170	11.919	26,170	11.464	27,170	11.042	28,170	10.650	29,170	10.285
25,180	11.914	26,180	11.459	27,180	11.038	28,180	10.646	29,180	10.281
25,190	11.909	26,190	11.455	27,190	11.033	28,190	10.642	29,190	10.277
25,200	11.905	26,200	11.450	27,200	11.029	28,200	10.638	29,200	10.274
25,210	11.900	26,210	11.446	27,210	11.025	28,210	10.635	29,210	10.270
25,220	11.895	26,220	11.442	27,220	11.021	28,220	10.631	29,220	10.267
25,230	11.891	26,230	11.437	27,230	11.017	28,230	10.627	29,230	10.263
25,240	11.886	26,240	11.433	27,240	11.013	28,240	10.623	29,240	10.260
25,250	11.881	26,250	11.429	27,250	11.009	28,250	10.619	29,250	10.256
25,260	11.876	26,260	11.424	27,260	11.005	28,260	10.616	29,260	10.253
25,270	11.872	26,270	11.420	27,270	11.001	28,270	10.612	29,270	10.249
25,280	11.867	26,280	11.416	27,280	10.997	28,280	10.608	29,280	10.246
25,290	11.862	26,290	11.411	27,290	10.993	28,290	10.604	29,290	10.242
25,300	11.858	26,300	11.407	27,300	10.989	28,300	10.601	29,300	10.239
25,310	11.853	26,310	11.403	27,310	10.985	28,310	10.597	29,310	10.235
25,320	11.848	26,320	11.398	27,320	10.981	28,320	10.593	29,320	10.232
25,330	11.844	26,330	11.394	27,330	10.977	28,330	10.589	29,330	10.228
25,340	11.839	26,340	11.390	27,340	10.973	28,340	10.586	29,340	10.225
25,350	11.834	26,350	11.385	27,350	10.969	28,350	10.582	29,350	10.221
25,360	11.830	26,360	11.381	27,360	10.965	28,360	10.578	29,360	10.218
25,370	11.825	26,370	11.377	27,370	10.961	28,370	10.575	29,370	10.215
25,380	11.820	26,380	11.372	27,380	10.957	28,380	10.571	29,380	10.211
25,390	11.816	26,390	11.368	27,390	10.953	28,390	10.567	29,390	10.208
25,400	11.811	26,400	11.364	27,400	10.949	28,400	10.563	29,400	10.204
25,410	11.806	26,410	11.359	27,410	10.945	28,410	10.560	29,410	10.201
25,420	11.802	26,420	11.355	27,420	10.941	28,420	10.556	29,420	10.197
25,430	11.797	26,430	11.351	27,430	10.937	28,430	10.552	29,430	10.194
25,440	11.792	26,440	11.346	27,440	10.933	28,440	10.549	29,440	10.190
25,450	11.788	26,450	11.342	27,450	10.929	28,450	10.545	29,450	10.187
25,460	11.783	26,460	11.338	27,460	10.925	28,460	10.541	29,460	10.183
25,470	11.779	26,470	11.334	27,470	10.921	28,470	10.537	29,470	10.180
25,480	11.774	26,480	11.329	27,480	10.917	28,480	10.534	29,480	10.176
25,490	11.769	26,490	11.325	27,490	10.913	28,490	10.530	29,490	10.173
25,500	11.765	26,500	11.321	27,500	10.909	28,500	10.526	29,500	10.169
25,510	11.760	26,510	11.316	27,510	10.905	28,510	10.523	29,510	10.166
25,520	11.755	26,520	11.312	27,520	10.901	28,520	10.519	29,520	10.163
25,530	11.751	26,530	11.308	27,530	10.897	28,530	10.515	29,530	10.159
25,540	11.746	26,540	11.304	27,540	10.893	28,540	10.512	29,540	10.156
25,550	11.742	26,550	11.299	27,550	10.889	28,550	10.508	29,550	10.152
25,560	11.737	26,560	11.295	27,560	10.885	28,560	10.504	29,560	10.149
25,570	11.732	26,570	11.291	27,570	10.881	28,570	10.501	29,570	10.145
25,580	11.728	26,580	11.287	27,580	10.877	28,580	10.497	29,580	10.141
25,590	11.723	26,590	11.282	27,590	10.874	28,590	10.493	29,590	10.139
25,600	11.719	26,600	11.278	27,600	10.870	28,600	10.490	29,600	10.135
25,610	11.714	26,610	11.274	27,610	10.866	28,610	10.486	29,610	10.132
25,620	11.710	26,620	11.270	27,620	10.862	28,620	10.482	29,620	10.128
25,630	11.705	26,630	11.265	27,630	10.858	28,630	10.479	29,630	10.125
25,640	11.700	26,640	11.261	27,640	10.854	28,640	10.475	29,640	10.121
25,650	11.696	26,650	11.257	27,650	10.850	28,650	10.471	29,650	10.118
25,660	11.691	26,660	11.253	27,660	10.846	28,660	10.468	29,660	10.115
25,670	11.687	26,670	11.249	27,670	10.842	28,670	10.464	29,670	10.111
25,680	11.682	26,680	11.244	27,680	10.838	28,680	10.460	29,680	10.108
25,690	11.678	26,690	11.240	27,690	10.834	28,690	10.457	29,690	10.104
25,700	11.673	26,700	11.236	27,700	10.830	28,700	10.453	29,700	10.101
25,710	11.669	26,710	11.232	27,710	10.826	28,710	10.449	29,710	10.098
25,720	11.664	26,720	11.228	27,720	10.823	28,720	10.446	29,720	10.094
25,730	11.660	26,730	11.223	27,730	10.819	28,730	10.442	29,730	10.091
25,740	11.655	26,740	11.219	27,740	10.815	28,740	10.438	29,740	10.087
25,750	11.650	26,750	11.215	27,750	10.811	28,750	10.435	29,750	10.084
25,760	11.646	26,760	11.211	27,760	10.807	28,760	10.431	29,760	10.081
25,770	11.641	26,770	11.207	27,770	10.803	28,770	10.428	29,770	10.077
25,780	11.637	26,780	11.203	27,780	10.799	28,780	10.424	29,780	10.074
25,790	11.632	26,790	11.198	27,790	10.795	28,790	10.420	29,790	10.070
25,800	11.628	26,800	11.194	27,800	10.791	28,800	10.417	29,800	10.067
25,810	11.623	26,810	11.190	27,810	10.787	28,810	10.413	29,810	10.064
25,820	11.619	26,820	11.186	27,820	10.784	28,820	10.409	29,820	10.060
25,830	11.614	26,830	11.182	27,830	10.780	28,830	10.406	29,830	10.057
25,840	11.610	26,840	11.177	27,840	10.776	28,840	10.402	29,840	10.054
25,850	11.605	26,850	11.173	27,850	10.772	28,850	10.399	29,850	10.050
25,860	11.601	26,860	11.169	27,860	10.768	28,860	10.395	29,860	10.047
25,870	11.596	26,870	11.165	27,870	10.764	28,870	10.391	29,870	10.044
25,880	11.592	26,880	11.161	27,880	10.760	28,880	10.388	29,880	10.040
25,890	11.587	26,890	11.157	27,890	10.757	28,890	10.384	29,890	10.037
25,900	11.583	26,900	11.152	27,900	10.753	28,900	10.381	29,900	10.033
25,910	11.579	26,910	11.148	27,910	10.749	28,910	10.377	29,910	10.030
25,920	11.574	26,920	11.144	27,920	10.745	28,920	10.373	29,920	10.027
25,930	11.570	26,930	11.140	27,930	10.741	28,930	10.370	29,930	10.023
25,940	11.565	26,940	11.136	27,940	10.737	28,940	10.366	29,940	10.020
25,950	11.561	26,950	11.132	27,950	10.733	28,950	10.363	29,950	10.017
25,960	11.556	26,960	11.128	27,960	10.730	28,960	10.359	29,960	10.013
25,970	11.552	26,970	11.123	27,970	10.726	28,970	10.356	29,970	10.010
25,980	11.547	26,980	11.119	27,980	10.722	28,980	10.352	29,980	10.007
25,990	11.543	26,990	11.115	27,990	10.718	28,990	10.348	29,990	10.003

A Question and Answer Department conducted by Radio World's Technical Staff. Only Questions sent in by University Club Members are answered. Answers printed herewith have been mailed to University Members.

Radio University

To obtain a membership in Radio World's University Club, for one year, send $6 for one year's subscription (52 issues of Radio World) and you will get a University number. Put this number at top of letter (not envelope) containing questions.. Address, Radio World, 145 West 45th Street, New York, N. Y.

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

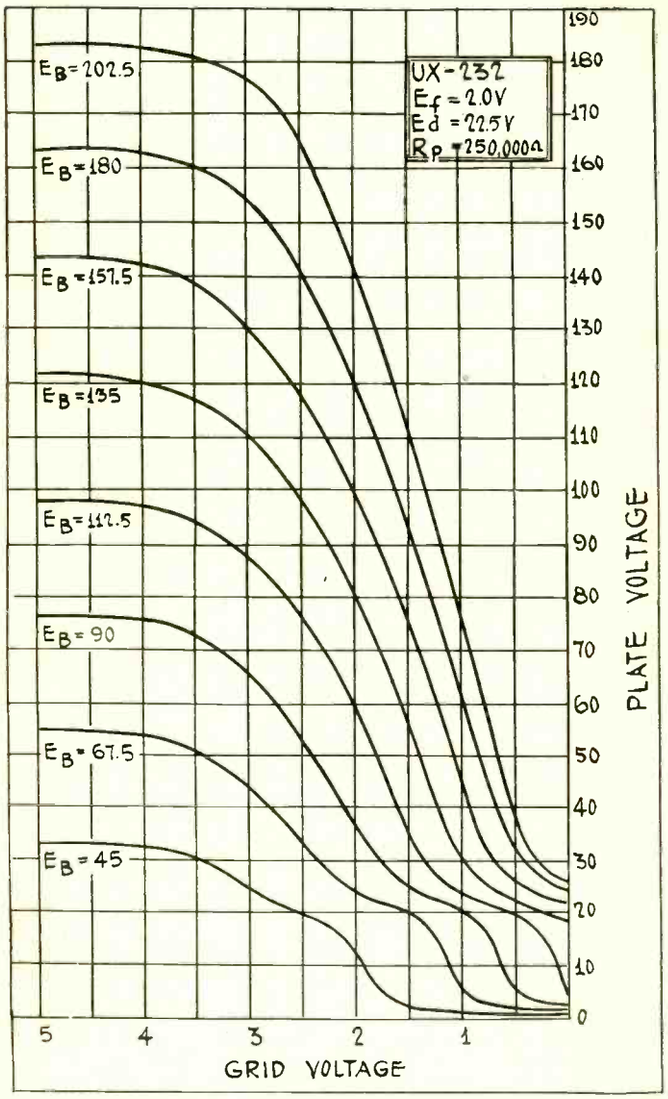


FIG. 906
A family of grid voltage, plate output voltage curves for the 232 tube working into 250,000 ohms.

Tapped Coils Versus Plug-ins

WHICH is better, to cover the short-wave band with one coil having a number of taps or with plug-in coils without any taps? What are the advantages and disadvantages of each?—T. H. E.

It is better from the electrical point of view to use plug-in coils. From the mechanical point of view it may be better to use taps on a single coil. The advantage of the plug-in coil system is that all the windings on the form may be proportioned for best efficiency. This is not practical with the tapped-coil system because there would be two or three switches to contend with. Losses in the leads to the switches and the coils and capacity couplings are the adverse points about the tapped coil.

* * *

Characteristics of 232 Tube

I AM interested in the 232 tube and should like to have curves showing its characteristics. For example, I should like to know what can be expected from the tube when it is working in a resistance coupled audio frequency amplifier. I should also like to know the relationship between the plate current and the screen current.—W. H. J.

In Fig. 906 is a family of grid voltage. plate output voltage curves for the 232 tube working into a 250,000 ohm resistance, the screen voltage being 22.5 volts. The Eb voltages given at the left and associated with the curves represent applied voltages in the plate circuit and not effective plate voltages. The curves clearly show that the applied voltage should be high if a wide signal swing without distortion is to be obtained. The best curve in the family is the highest for which the applied voltage is 202.5 volts. The voltage may be made considerably higher to advantage. With 202.5 volts in the plate circuit the best grid bias is about 1.25 volts. In Fig. 907 are three curves of plate and screen grid current for the same tube. The plate current is shown for self bias as well as for battery bias. Note that the effect of self bias is to reduce the amplification. This reduction is prevented by connecting a large condenser across the bias resistor.

* * *

Voltage for Series Filaments

WHAT is the secondary voltage of a series heater type transformer per tube, or for six type 27 tubes in series?—J. A. P.

The voltage across the terminals of the transformer when all the tubes are getting their full heater current should be 2.5 volts times the number of tubes in the series. For six tubes, therefore, the voltage should be 15 volts. If the voltage is higher it is necessary to put in a ballast resistor in series to drop the excess. This does not mean that the voltage of the secondary of the transformer should necessarily read 15 volts when no current is drawn. If the regulation is poor the no-load voltage may be considerably higher. Indeed, it must be considerably higher if the voltage is to be 2.5 volts per tube under load conditions.

* * *

Selectivity of Receivers

AS a rule, is the selectivity of a receiver better at the low frequency end of the broadcast band than at the high frequency end? I understand that this is a fact. If this is so, what makes the selectivity better at the low end?—B. W. C.

It depends on how selectivity is defined and measured. If the selectivity is based in kilocycles off resonance, it is considerably greater at the low frequency end that at the high, and this is the only view which has a real significance. When the selectivity is viewed on the frequency ratio basis there is not so much difference, but even then the circuit is usually more selective at the low end. The main reason for the greater selectivity at the low frequency end is that the resistance of a circuit is lower at the lower frequencies. The difference in selectivity on the basis of kilocycles off resonance is not so large as appears in many commercial receivers having ganged tuning controls for the lack of selectivity in them at the higher frequency end is mostly a matter of lack of tuning. All the tuned circuits on the gang are not tuned to the same frequency.

* * *

Radiation of a Superheterodyne

DOES a superheterodyne radiate any of the energy put out by the oscillator? If so, is the radiation sufficient to cause interference with other radio receivers in the neighborhood? What can be done to eliminate the radiation?—F. W. N.

Yes, a superheterodyne radiates but only if the coils are exposed, especially the oscillator coil. The radiation is very small, however, but still enough to cause interference with other receivers located near it. Shielding the oscillator is about the best way of eliminating the radiation. The superheterodyne may cause considerable interference with other receivers even if there is no trace of it in the output of the super.

* * *

Calculating Mutual Inductance

I HAVE two equal coils wound on the same tubing an inch apart. I can calculate the inductance of either coil but I should like to know what the mutual inductance is because I want to use the coils in a band pass filter, tuning both windings. Is there a simple way of calculating the mutual inductance? If so, please explain it.—Y. B.

In a case like this there is a simple way. First imagine that the blank space between the two coils is wound just like the other parts of the tubing, that is, assume that there is one continuous winding. Calculate the inductance of this imaginary coil. Then calculate the inductance of an imaginary coil consisting of one of the coils and the supposedly filled-in section. Again, calculate the inductance of the imaginary coil made up of the other actual coil and the supposedly filled in section. Finally calculate the inductance of the middle section if it were filled with wire. Add the inductance first obtained, that is. of the total to the inductance of the imaginary coil in the center. Then subtract the sum of the inductances of the other

two. Divide the result by 2 and the quotient is the mutual inductance sought. Let us express this in symbols. The coil is divided into three parts, 1, 2, and 3. Let the inductance of the total be L123 and that of the middle section L2. Also let the inductance of the first and second sections be L12 and that of the second and third L23. Then the mutual inductance M13 between the first and the third sections is (L123 + L2 — L12 — L23) ÷ 2. If the two coils are equal the formula takes the form (L123 + L2) / 2 — L12.

* * *

Variable Mu Tube Detector

I HAVE a RCA 235 variable mu tube which I wish to use as a power detector. What should the bias be for the best results?—W. G. N.

Don't use it as a detector. It is an amplifier tube designed so that it will not detect well.

* * *

Rectifying Efficiency of A Tube

WHEN a screen grid tube is used as power detector and working into a resistance load is the rectified output voltage smaller than the effective AC input voltage, or is it of about the same magnitude?—W. D.

In the case of the 232 screen grid tube working into a resistance load of 200,000 ohms the rectified output voltage is about 14.3 times greater than the effective AC input voltage. This holds also for other tubes, although the gain factor is smaller or larger, depending on the amplification factor of the tube.

* * *

Dial With 270 Degree Rotation

WHAT is the advantage of using a condenser which has a rotation of 270 degrees for short-wave tuning purposes? Would a 180 degree condenser be just as effective?—J. M.

The only object of having a 270 degree tuning condenser for short-wave receivers is to spread out the stations more. Instead of covering a certain number of stations on 180 degrees, the same are spread out over 270 degrees. The tuning becomes less critical. About the same effect can be produced by using a small tuning condenser so that the distributed capacity is a large percentage of the total. But this requires more plug-in coils to cover the short-wave band.

* * *

Broadcast Interference on Converters

HOW do you explain the fact that broadcast signals come in on short wave converters when the intermediate frequency is higher than any broadcast station frequency and when the circuit is otherwise extremely selective? Could it be that the broadcast stations are sending out harmonics which are tuned in with the converter?—S. G.

Harmonics generated by the broadcast stations may be partly responsible for the interference but it is more likely that it is the receiver which generates the harmonics from the strong broadcast fundamental. If the short-wave signals are tuned in before the first detector with a sharp tuner and if the coupling between the oscillator and the modulator is loose, there should be no trouble from this source. The variable mu tubes might help, especially if one is placed before the first detector. Shielding from the broadcast stations will also help.

* * *

Television of the Future

THERE are many different ways of scanning in television, most of which depend on some rotating device. Do you think that one of these will be adopted as standard in the future when television becomes a means of public entertainment? Or is there some other means more likely to be adopted?—P. C.

Television is still in so rudimentary a state that it is impossible at this time to foretell what type of scanner will be adopted as standard. Indeed, there is even no certainty that television will ever become a means of public entertainment and instruction. The cathode ray method of scanning seems to offer greater practical possibilities than any mechanical devices. The absence of rotating mechanical parts is the principal advantage. But this, too, has its disadvantages. The light is very feeble, for one thing, and then there is yet no means of making the cathode ray move at a uniform rate across the screen. Both of these difficulties may be overcome in the near future, and they must be before the system can be adopted.

* * *

Pentode Output Tubes

IN Europe they have used pentode output tubes for a long while as a means of saving tubes in the receivers. If the pentode is a satisfactory tube for this purpose, why has it not appeared on the American market? Is there any likelihood that it will be offered to the American buyers?—C. W. G.

It will soon appear. In fact, even now one tubemaker has announced that the tube is ready for distribution. Plenty of circuits incorporating the tube will be published as soon as the tube is available and its characteristics are known.

* * *

Radio From Submarines

IN a recent issue you had a news story to the effect that Sir Hubert Wilkins plans to send out reports by radio from his submarine, the Nautilus. Since he plans to travel under the ice the radio waves must come through, not only the water but a thick layer of ice and possibly the hull of the ship besides. Does this look feasible? Is it not a fact that water and ice stop radio waves? Steel most certainly does.—H. H. B.

Sir Hubert does not intend to stay under the ice all the time, for that would be planning suicide. The aim is to come up for air now and then by cutting holes in the ice over the submarine. When they come up they can erect antennas either on the submarine or on the ice and thus they can transmit radio waves just as well as anybody. Whether they put the antenna on the ship or on the ice the transmitting conditions will probably be excellent.

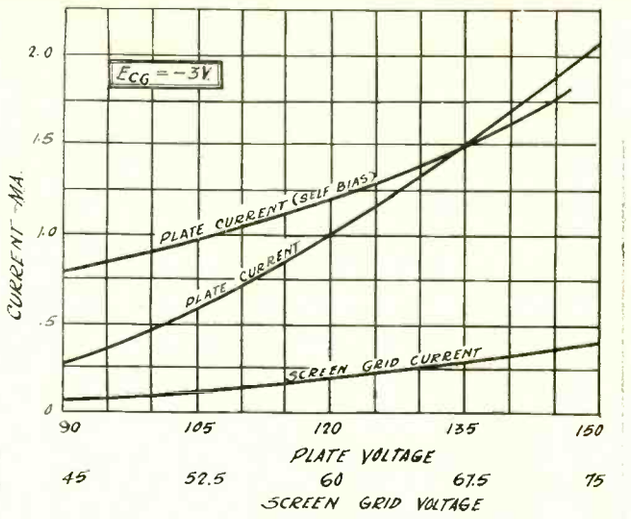


FIG. 907

These curves give the relationships between the screen grid current and the screen voltage and the plate current and the plate voltage. The plate current is given both for self bias (resistor) and battery bias. The self bias is —3 volts only at one point, namely, 135 v. and 1.5 milliamperes.

* * *

IF Tuner for Short-Wave Sets

I WISH to build an intermediate frequency amplifier in which the frequency is around 1,500 kc. I have one inch tubing and some No. 36 double silk wire which I wish to use. Will you kindly suggest what kind of tuning condensers would be the most suitable and how many turns should be used to give the right amount of inductance? Would it be better to wind the two coils of each transformer on separate forms or on the same form? If on the same form, please give the correct distance between the two windings.—F. W. C.

The most suitable tuning condensers are the 100 mmfd. midgets used for modern superheterodynes and also for trimming radio frequency tuners. We may arbitrarily assume that the tuning capacity in each circuit is 75 mmfd., partly made up by distributed capacity and partly by the capacity in the midgets. This capacity requires an inductance of 150 microhenries. This requires 86 turns of the wire specified. It is best to put the coils on different forms because in that manner it is possible to make a more compact assembly. If they are put on the same form the two windings will be far apart and the tubing will take much space. The mutual inductance should only be about one microhenry for a 10 kc. band.

* * *

Effective and Efficient

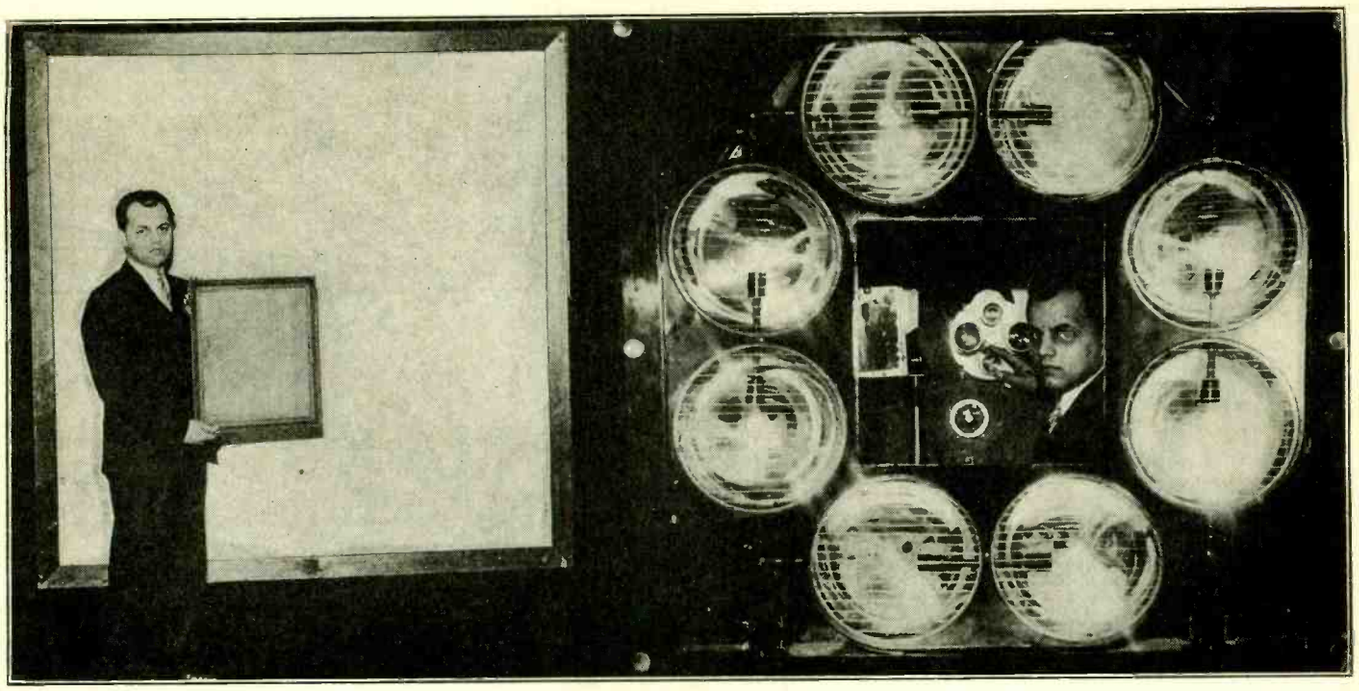
SOMETIMES you speak of a circuit as being effective and sometimes as efficient, frequently using the two at the same time. Don't these mean the same thing?—C. N.

No, they do not mean the same thing. Something is effective when it produces results, and something else, or the same thing, is efficient when it produces a given effect with least expense. Efficiency is a precise scientific term and means the ratio of the output to the input. For example, if 1,000 kilowatts are put into a radio transmitter and only 750 kilowatts are radiated into space, the transmitter is 75 per cent efficient. Of course, the term efficiency is not always used in this precise way.

HOW TO GET QUESTIONS ANSWERED

QUESTIONS of general interest are answered by publication in this department, and the answers invariably are to questions submitted by members of RADIO WORLD'S *University Club. Copies of the answers, in such instances, are mailed promptly to the inquirers, so they will not have to wait to see the answers published in this department. We can not undertake to answer questions except those submitted by members of the University Club. For details of acquiring membership in this Club please see notice printed in the heading of this department.—Editor.*

TELEVISION PROJECTED ON 10-FOOT SCREEN



(Acme)
Projection of television on a 10-foot screen has been accomplished by U. A. Sanabria, 24, of Chicago. He is shown holding a screen of the largest size previously used for home entertainment, contrasted with his larger effort. At right he is shown behind the eight photo-electric cells of a transmitter.

RCA SUES 3 ON SET PATENTS

The Radio Corporation of America has filed suits against three manufacturers of broadcast receiving sets for alleged infringement of patent rights.

Those named in the actions are Forrest R. Smith, doing business under the name of Westerner Manufacturing Company, of Los Angeles; Trav-Ler Manufacturing Corporation, of St. Louis, and Zaney-Gill Corporation, of Chicago. All the suits are in United States District Courts. The suit against Smith is in the Southern Division of the Southern District of California; that against Trav-Ler in the Eastern District of Missouri, and that against Zaney-Gill in the Eastern Division of the Northern District of Illinois.

They Say

H. R. BROWN, principal of the Condit School of Ashland, Ky.: "After a year's test I am glad to state that radio in the school has fully vindicated itself. The rebellious child can be more easily reached by educational radio than by any other means I have ever tried. In spite of himself, the rebellious child becomes interested in the gripping programs that come to him. He heard an Indian battle over the radio and is surprised to find it is a part of American History. It sends him to his textbooks to find out more about this subject that appears dry and dull before. It peps him up, vitalizes his studies, gives his imagination a chance to act, and guides him along the right pathway. Sets for each room will come when the radio has been made a more intimate part of classroom study and the idea has been sold to the public and school boards."

Forum

LIKES SHORT-WAVE LIST

PERMIT me to congratulate you on the excellent list of short-wave stations, contained in your issue of March 28th, 1931. It is the most complete and comprehensive list that I have ever seen in any radio publication. It fills a long-felt want for a good list of broadcasting short-wave stations, and when used in connection with a similar list of amateur and commercial stations, should enable one to identify any short-wave station that he may hear.

Now I am more satisfied than ever that I have been a subscriber for several years for RADIO WORLD.

HENRY C. GRAY.

Box 283, Chico, Calif.

A THOUGHT FOR THE WEEK

DR. FRANK H. VIZETELLY, lexicographer, editor and envoy extraordinary to the great open spaces from which come new words and phrases, tells us that the English language would be flat, stale and unprofitable if it were not for idioms. He holds, therefore, that "listening in" is now good English and consequently that "listener-in" comes of good parentage. Dr. Vizetelly may be a little late in succumbing to the onslaught of those millions who have been using these combinations because they were sensible and comprehensive rather than for any cultural or other reason. The learned savant also tells us that Shakespeare, Coleridge and Bulwer-Lytton were among those who fought valiantly against mussing up the purity of the language and that they are dead and the words and phrases they abhorred are still alive and flourishing. Custom is long but men are fleeting!

CANADIAN LIST NEXT WEEK

The complete list of Canadian stations will be published next week, issue of April 18th.

KENT PRODUCES PENTODE SET

A. Atwater Kent announced a pentode compact superheterodyne weighing thirty pounds.

The pentode tube, through the proper use of which scientists have foreseen superior reception, has excited the interest of American radio engineers for more than two years. Its power has been generally acknowledged but the problem, engineers found, was the development of a circuit for the fullest utilization of the tube's remarkable qualities.

The development of the new pentode circuit, Atwater Kent engineers say, has enabled them to pack into a minimum space equipment which equals or surpasses in performance that which formerly has required a large cabinet to house.

The pentode tube itself is a five-element power amplifier which does the work which formerly required three tubes. It has twice the available undistorted output and six times greater amplification than the customary three-element tube. Its efficiency also is much higher than three-element power tubes.

While the pentode tube itself utilizes the principle of the screen grid tube to obtain exceedingly high amplification, the new set which Mr. Kent announces also employs three screen grid tubes, one as first detector, one as intermediate frequency amplifier, and one as second detector.

The new set complete, including receiving equipment and speaker, is housed in a walnut cabinet nineteen inches high, sixteen inches wide and ten inches deep.

A statement issued by the Atwater Kent engineers says:

"Until recently, the pentode tube was not sufficiently perfected for use in modern high-powered receivers. The pentode now ranks with the screen grid tube as being one of the most valuable, practical developments in radio in the last five years."

U. S. Broadcast Stations by Frequencies

[*A conversion table for equivalent wavelengths will be found on pages 16 and 17*]

550 KILOCYCLES

Call letters	Main studio location	Licensee	Power	Time of operation
WGR	Buffalo, N. Y. T—Amherst, N.Y.	Buffalo Broadcasting Corporation	1KW	Unlimited.
WKRC	Cincinnati, Ohio	WKRC (Inc.)	1KW	Do.
KFUO	Clayton, Mo.	Evangelical Lutheran Synod of Missouri, Ohio, and other States, Rev. R. Kretzschmar, chair man of Control of Concordia Seminary	500W 1KW—LS.	Shares With KSD.
KSD	St. Louis, Mo.	Pulitzer Publishing Co.	500W	Shares with KFUO.
KFDY	Brookings, S. Dak.	South Dakota State College	500 W 1KW—LS.	Shares with KFYR.
KFYR	Bismarck, N. Dak	Meyer Broadcasting Co.	1KW 2½KW—LS[1]	Shares with KFDY.
KOAC	Corvallis, Oreg.	Oregon State Agricultural College	1KW	Unlimited.

560 KILOCYCLES

WLIT	Philadelphia, Pa.	Lit Bros.	500W	Shares with WFI.
WFI	Do.	Strawbridge & Clothier	500W	Shares with WLIT.
WQAM	Miami, Fla.	Miami Broadcasting Co.	1KW	Unlimited.
KFDM	Beaumont, Tex.	Magnolia Petroleum Co.	500W 1KW—LS.	Do.
WNOX	Knoxville, Tenn.	Sterchi Bros.	1KW 2KW—LS.	Do.
WIBO	Chicago, Ill. T—Des Plaines, Ill.	Nelson Bros. Bond & Mortgage Co.	1KW 1½KW—LS.	Shares with WPCC and WISJ.[2]
WPCC	Chicago, Ill.	North Shore Church	500W	Shares with WIBO and WISJ.[2]
KLZ	Denver, Colo.	Reynolds Radio Co. (Inc.)	1KW	Unlimited.
KTAB	San Francisco, Calif. T—Oakland, Calif.	The Associated Broadcasters (Inc.)	1KW	Do.

570 KILOCYCLES

WNYC	New York, N. Y.	City of New York, Department of Plant and Structures	500W	Shares with WMCA.
WMCA	New York, N. Y. T—Hoboken, N. J.	Knickerbocker Broadcasting Co. (Inc.)	500W	Shares with WNYC.
WSYR-WMAC	Syracuse, N. Y.	Clive B. Meredith	250W	Unlimited.
WKBN	Youngstown, Ohio.	W. P. Williamson, Jr.	500W	Shares with WEAO.
WEAO	Columbus, Ohio.	Ohio State University	750W	Shares with WKBN.
WWNC	Asheville, N. C.	Citizen Broadcasting Co.	1KW	Unlimited.
KGKO	Wichita Falls, Tex.	Wichita Falls Broadcasting Co, Inc.,	250W 500W—LS.	Do.
WNAX	Yankton, S. Dak.	The House of Gurney (Inc.)	1KW	Do.
KXA	Seattle, Wash.	American Radio Telephone Co.	500W	Do.
KMTR	Los Angeles, Calif.	KMTR Radio Corporation	500W	Do.

580 KILOCYCLES (Canadian Shared)

WTAG	Worcester, Mass.	Worcester Telegram Publishing Co. (Inc.)	250W	Unlimited.
WOBU	Charleston, W. Va.	WOBU (Inc.)	250W	Shares with WSAZ.
WSAZ	Huntington, W. Va.	WSAZ (Inc.)	250W	Shares with WOBU.
KGFX	Pierre, S. Dak.	Dana McNeil	200W	Daytime.
WIBW	Topeka, Kans.	Topeka Broadcasting Association (Inc.)	1KW[3]	Shares with KSAC.
KSAC	Manhattan, Kans.	Kansas State Agricultural College	500W 1KW—LS.	Shares with WIBW.

590 KILOCYCLES

WEEI	Boston, Mass. T—Weymouth, Mass.	Edison Electric Illuminating Co. of Boston	1KW	Unlimited.
WKZO	Berrien Springs, Mich.	WKZO (Inc.)	1KW	Daytime.
WCAJ	Lincoln, Nebr.	Nebraska Wesleyan University	500W[4]	Shares with WOW.
WOW	Omaha, Nebr.	Woodman of the World Life Insurance Association	1KW	Shares with WCAJ.
KHQ	Spokane, Wash.	Louis Wasmer (Inc.)	1KW 2KW—LS.	Unlimited.

600 KILOCYCLES (Canadian Shared)

WICC	Bridgeport, Conn. T—Easton, Conn.	Bridgeport Broadcasting Station (Inc.)	500W	Shares with WCAC
WCAC	Storrs, Conn.	Connecticut Agricultural Collegs	250W	Shares with WGBS.
WCAO	Baltimore, Md.	Monumental Radio (Inc.)	250W	Unlimited.
WGBS[5]				
WREC-WOAN	Memphis, Tenn. T—Whitehaven, Tenn	WREC (Inc.)	500W 1KW—LS.	Unlimited.
WMT	Waterloo, Iowa	Waterloo Broadcasting Co.	500W	Do.
KFSD	San Diego, Calif.	Airfan Radio Corporation (Ltd.)	500W 1KW—LS.	Do.

610 KILOCYCLES

WJAY	Cleveland, Ohio	Cleveland Radio Broadcasting Corporation	500W	Daytime.
WIP	Do.	Gimbel Brothers (Inc.)	500W	Shares with WFAN.
WDAF	Kansas City, Mo.	Kansas City Star Co.	1KW	Unlimited.
KFRC	San Francisco, Calif.	Don Lee (Inc.)	1KW	Do.

620 KILOCYCLES

WLBZ	Bangor, Me.	Maine Broadcasting Co. (Inc.)	500W	Unlimited.
WFLA-WSUN	Clearwater, Fla.	Clearwater Chamber of Commerce and St. Petersburg Chamber of Commerce	1KW 2½KW—LS.	Do.
WTMJ	Milwaukee, Wis. T—Brookfield, Wis.	The Journal Co. (Milwaukee Journal)	1KW 2½KW—LS	Do.
KGW	Portland, Oreg.	Oregonian Publishing Co.	1KW	Do.
KTAR	Phoenix, Ariz.	KTAR Broadcasting Co.	500W 1KW—LS.	Do.

630 KILOCYCLES (Canadian Shared)

WMAL	Washington, D. C.	M. A. Leese	250W 500W-LS.	Unlimited.
WOS	Jefferson City, Mo.	Missouri State Marketing Bureau	500W	Shares with WGBF and KFRU.
KFRU	Columbia, Mo.	Stephens College	500W	Shares with WOS and WGBF.
WGBF	Evansville, Ind.	Evansville on the Air (Inc.)	500W	Shares with WOS and KFRU.

640 KILOCYCLES

WAIU	Columbus, Ohio	American Insurance Union	500W	Limited.
WOI	Ames, Iowa	Iowa State College of Agriculture and Mechanic Arts	5KW	Daytime.
KFI	Los Angeles, Calif.[6]	Earle C. Anthony (Inc.)	5KW	Unlimited.

650 KILOCYCLES

WSM	Nashville, Tenn.	National Life & Accident Insurance Co.	5KW	Unlimited.
KPCB	Seattle, Wash.	Queen City Broadcasting Co.	100W	Limited.

660 KILOCYCLES

WEAF	New York, N. Y. T—Bellmore, N. Y.	National Broadcasting Co. (Inc.)	50KW-LP	Unlimited.
WAAW	Omaha, Nebr.	Omaha Grain Exchange	500W	Daytime.

670 KILOCYCLES

WMAQ	Chicago, Ill. T—Addison, Ill.	WMAQ (Inc.)	5KW	Unlimited.

[1] Experimentally.
[2] WISJ temporarily operating on 780 kilocycles.
[3] Experimentally.
[4] C. P. to decrease power to 250 watts.
[5] Transferred to 1180 kc.
[6] C. P. to move transmitter to Buena Park and increase power to 50 KW-LP.

BROADCASTING STATIONS BY FREQUENCIES—*Continued*

680 KILOCYCLES

Call letters	Main studio location	Licensee	Power	Time of operation
WPTF	Raleigh, N. C.	Durham Life Insurance Co.	1KW	Limited.
KFEQ	St. Joseph, Mo.	Scroggin & Co. Bank	2½KW	Daytime.
KPO	San Francisco, Calif.	Hale Bros. Stores (Inc.), and the Chronicle Publishing Co.	5KW	Unlimited.

690 KILOCYCLES (Canadian Exclusive)

700 KILOCYCLES

WLW	Cincinnati, O. T—Mason, Ohio.	Crosley Radio Corporation	50KW-LP	Unlimited.

710 KILOCYCLES

WOR	Newark, N. J. T—Kearny, N. J.	Bamberger Broadcasting Service (Inc.)	5KW	Unlimited.
KMPC	Beverly Hills, Calif.	R. S. MacMillan	500W	Limited.

720 KILOCYCLES

WGN—WLIB	Chicago, Ill. T—Elgin, Ill.	The Tribune Co.	25KW	Unlimited.

730 KILOCYCLES (Canadian Exclusive)

740 KILOCYCLES

WSB	Atlanta, Ga.	Atlanta Journal Co.	5KW	Unlimited.
KMMJ	Clay Center, Nebr.	The M. M. Johnson Co.	1KW	Limited.

750 KILOCYCLES

WJR	Detroit, Mich. T—Sylvan Lake Village, Mich.	WJR, The Goodwill Station (Inc.)	5KW	Unlimited.

760 KILOCYCLES

WJZ	New York, N. Y. T—Bound-brook, N. J.	National Broadcasting Co. (Inc.)	30KW-LP	Unlimited.
WEW	St. Louis, Mo.	St. Louis University	1KW	Daytime.
KVI	Tacoma, Wash. T—Des Moines, Wash.	Puget Sound Broadcasting Co. (Inc.)	1KW	Limited.

770 KILOCYCLES

KFAB	Lincoln, Nebr.	KFAB Broadcasting Co.	5KW	Shares with WBBM-WJBT.
WBBM-WJBT	Chicago, Ill. T. Glenview, Ill.	The Atlass Co. (Inc)	25KW	Shares with KFAB.

780 KILOCYCLES (Canadian Shared)

WEAN	Providence, R. I.	Shepard Broadcasting Service (Inc.)	250W 500W-LS	Unlimited.
WTAR-WPOR	Norfolk, Va.	WTAR Radio Corporation	500W	Do.
WMC	Memphis, Tenn. T—Bartlett, Tenn.	Paul Dillard and Enoch Brown, jr., receivers.	500W 1KW-LS	Do.
WISJ	South Madison, Wis.	The Wisconsin State Journal Co.[7]	250W 500W-LS	Do.
KELW	Burbank, Calif.	Union Bank & Trust Co. of Los Angeles, guardian of estate of Earl L. White	500W	Shares with KELW.
KTM	Los Angeles, Calif. T—Santa Monica, Calif.	Pickwick Broadcasting Corporation	500W 1KW-LS	Shares with KTM.

790 KILOCYCLES

WGY	Schenectady, N. Y. T—South Schenectady, N. Y.	General Electric Co.	50KW	Unlimited.
KGO	San Francisco, Calif. T—Oakland, Calif.	National Broadcasting Co. (Inc.)	7½KW	Do.
WFAN	Philadelphia, Pa.	Keystone Broadcasting Co.	250W 500W-LS	Unlimited

800 KILOCYCLES

WBAP	Fort Worth, Tex.	Carter Publications (Inc)	50KW-LP[8]	Shares with WFAA.
WFAA	Dallas, Tex. T—Grapevine, Texas.	Dallas News and Dallas Journal A. H. Belo Corporation	50KW-LP	Shares with WBAP.

810 KILOCYCLES

WPCH	New York, N. Y. T—Hoboken, N. J.	Eastern Broadcasters (Inc.)	500W	Daytime.
WCCO	Minneapolis, Minn. T—Anoka, Minn.	Northwestern Broadcasting (Inc.)	7½KW	Unlimited.

820 KILOCYCLES

WHAS	Louisville, Ky. T—Jefferson-town, Ky.	The Courier Journal Co. and The Louisville Times Co.	10KW	Unlimited.

830 KILOCYCLES

WHDH	Boston, Mass. T—Gloucester, Mass.	Matheson Radio Co. (Inc.)	1KW	Daytime until sunset at Denver, Colo.
WRUF	Gainesville, Fla.	University of Florida.	5KW	Limited.
KOA	Denver, Colo.	National Broadcasting Co. (Inc.)	12½KW	Unlimited.

840 KILOCYCLES (Canadian Exclusive)

850 KILOCYCLES

KWKH	Shreveport, La. T—Kennonwood, La.	Hello World Broadcasting Corporation	10KW	Shares with WWL.
WWL	New Orleans, La.	Loyola University	5KW	Shares with KWKH.

860 KILOCYCLES

WABC-WBOQ	New York, N. Y. T—West of Cross Bay Blvd. Queens Co., N. Y.[9]	Atlantic Broadcasting Corporation	5KW	Unlimited.
WHB	Kansas City, Mo. T—North Kansas City, Mo.	WHB Broadcasting Co.	500W	Daytime.
KMO	Tacoma, Wash.	KMO (Inc.)	500W	Limited.

870 KILOCYCLES

WLS	Chicago, Ill. T—Crete, Ill.	Agricultural Broadcasting Co.	5KW[10]	Shares with WENR-WBCN.
WENR-WBCN	Chicago, Ill. T—Downers Grove, Ill.	Great Lakes Broadcasting Co.	50KW	Shares with WLS.

880 KILOCYCLES (Canadian Shared)

WGBI	Scranton, Pa.	Scranton Broadcasters (Inc.)	250W	Shares with WQAN.
WQAN	Scranton, Pa.	E. J. Lynett, prop. the Scranton Times	250W	Shares with WGBI.
WCOC	Meridian, Miss.	Mississippi Broadcasting Co. (Inc.)	500W 1KW-LS	Unlimited.
WSUI	Iowa City, Iowa.	State University of Iowa	500W	Three-sevenths time.
KLX	Oakland, Calif.	The Tribune Publishing Co.	500W	Unlimited.
KPOF	Denver, Colo.	Pillar of Fire	500W	Shares with KFKA.
KFKA	Greeley, Colo.	The Mid-Western Radio Corporation	500W 1KW-LS	Shares with KPOF.

890 KILOCYCLES (Canadian Shared)

WJAR	Providence, R. I.	The Outlet Co.	250W 400W-LS	Unlimited.
WKAQ	San Juan, P. R.	Radio Corporation of Porto Rico	500W	Do.
WMMN	Fairmount, W. Va.	Holt-Rowe Novelty Co.	250W 500W-LS	Do.
WMAZ	Macon, Ga.	Macon Junion Chambers of Commerce	250W 500W-LS	Shares with WGST.

[7]Experimentally on 780 Kilocycles.
[8]Licensed at present for 10 KW only.
[9]C. P. to move transmitter to Wayne, N. J., and increase power to 50 KW-LP.
[10]C. P. to increase power to 50 KW-LP.

BROADCASTING STATIONS BY FREQUENCIES—*Continued*

890 KILOCYCLES—(Cont.)

Call letters	Main studo location	Licensee	Power	Time of operation
WGST	Atlanta, Ga.	Georgia School of Technology	250W / 500W-LS	Shares with WMAZ.
KGJF	Little Rock, Ark.	First Church of the Nazarene	250W	Unlimited.
WILL	Urbana, Ill.	University of Illinois	250W / 500W-$3	Shares with KUSD and KFNF.
KUSD	Vermillion, S. Dak.	University of South Dakota	500W-LS / 750W-LS	Shares with WILL and KFNF.
KFNF	Shenandoah, Iowa	Henry Field Co.	500W / 1KW-LS	Shares with WILL and KUSD.

900 KILOCYCLES

WBEN	Buffalo, N. Y. T—Martinsville, N. Y.	Edward H. Butler, trustee for Ada Butler, Mitchell and Edward H. Butler, trading as Buffalo Evening News.	1KW	Unlimited.
WKY	Oklahoma City, Okla.	WKY Radiophone Co.	1KW	Do.
WJAX	Jacksonville, Fla.	City of Jacksonville	1KW	Do.
WLBL	Stevens Point, Wis.	State of Wisconsin, Department of Agriculture and Markets.	2KW	Daytime.
KHJ	Los Angeles, Calif.	Don Lee (Inc.)	1KW	Unlimited.
KSEI	Pocaello, Idaho	KSEI Broadcasting Association (Inc.)	250W	Do.
KGBU	Ketchikan, Alaska	Alaska Radio and Service Co. (Inc.)	500W	Do.

910 KILOCYCLES (Canadian Exclusive)

920 KILOCYCLES

WBSO	Needham, Mass.	Babson's Statistical Organization (Inc.)	500W	Daytime.
WWJ	Detroit, Mich.	The Evening News Association (Inc.)	1KW	Unlimited.
KPRC	Houston, Tex. T—Sugarland, Texas.	Houston Printing Co.	1KW / 2½KW-LS	Do.
WAAF	Chicago, Ill.	Drovers Journal Publishing Co.	500W	Daytime.
KOMO	Seattle, Wash.	Fisher's Blend Station (Inc.)	1KW	Unlimited.
KFEL	Denver, Colo.[11]	Eugene P. O'Fallon (Inc.)	500W	Shares with KFXF.
KFXF	Denver, Colo.	Colorado Radio Corporation.	500W	Shares with KFEL.

930 KILOCYCLES (Canadian Shared)

WIBG	Elkins Park, Pa.	St. Paul's P. E. Church	50W	Daytime.
WDBJ	Roanoke, Va.	Richardson-Wayland Electrical Corporation	250W / 500W—LS	Unlimited.
WBRC	Birmingham, Ala.	Birmingham Broadcasting Co. (Inc.)	500W / 1KW—LS	Do.
KGBZ	York, Nebr.	Dr. George R. Miller	500W / 1KW—LS	Shares with KMA.
KMA	Shanandoah, Iowa	May Seed & Nursery Co.	500W / 1KW—LS	Shares with KGBZ.
KFWI	San Francisco, Calif.	Radio Entertainments (Inc.)	500W	Shares with KROW.
KROW	Oakland, Calif. T—Richmond, Calif.	Educational Broadcasting Corporation	500W / 1KW—LS	Shares with KFWI.

940 KILOCYCLES

WAAT	Jersey City, N. J.	Bremer Broadcasting Corporation.	300W	Daytime until 6 p. m. eastern standard time.
WCSH	Portland, Me. T—Scarboro, Me.	Congress Square Hotel Co.	1KW	Unlimited.
WFIW	Hopkinsville, Ky.	WFIW (Inc.)	1KW	Do.
WHA	Madison, Wis.	University of Wisconsin	750W	Daytime.
WDAY	Fargo, N. Dak. T—West Fargo, N. Dak.	WDAY (Inc.).	1KW	Unlimited.
KOIN	Portland, Oreg. T—Sylvan, Oreg.	KOIN (Inc.)	1KW	Do.
KGU	Honolulu, Hawaii	Marion A. Mulrony and Advertiser Publishing Co. (Ltd.).	1KW	Do.

950 KILOCYCLES

WRC	Washington, D. C.	National Broadcasting Co. (Inc.)	500W	Unlimited.
KMBC	Kansas City, Mo. T—Independence, Mo.	Midland Broadcasting Co.	1KW	Do.
KFWB	Hollywood, Calif.	Warner Bros. Broadcasting Corporation	1KW	Do.
KGHL	Billings, Mont.	Northwestern Auto Supply Co. (Inc.)	1KW	Do.

960 KILOCYCLES (Canadian Exclusive)

970 KILOCYCLES

WCFL	Chicago, Ill.	Chicago Federation of Labor	1½KW	Limited.
KJR	Seattle, Wash.	Northwest Broadcasting System (Inc.)	5KW	Unlimited.

980 KILOCYCLES

KDKA	Pittsburgh, Pa. T—Caxonburg, Pa.	Westinghouse Electric & Manufacturing Co.	50KW—LP	Unlimited.

990 KILOCYCLES

WBZ	Springfield, Mass. T—East Springfield, Mass.[12]	Westinghouse Electric & Manufacturing Co.	15KW	Shares with WBZA.
WBZA	Boston, Mass.[13]	Westinghouse Electric & Manufacturing Co.	500W	Shares with WBZ.

1000 KILOCYCLES

WHO	Des Moines, Iowa	Central Broadcasting Co.	5KW	Synchronizes with WOC experimentally.
WOC	Davenport, Iowa	do	5KW	Synchronizes with WHO experimentally.
KFVD	Culver City, Calif.	Los Angeles Broadcasting Co.	250W	Limited.

1010 KILOCYCLES (Canadian Shared)

WQAO-WPAP	New York, N. Y. T—Cliffside, N. J.	Calvary Baptist Church	250W	Shares with WHN and WRNY.
WHN	New York, N. Y.	Marcus Loew Booking Agency	250W	Shares with WQAO-WPAP and WRNY.
WRNY	New York, N. Y. T—Coytesville, N. J.	Aviation Radio Station (Inc.)	250W	Shares with WQAO-WPAP and WHN.
KGGF	South Coffeyville, Okla.	Hugh J. Powell and Stanley Platz, doing business as Powell & Platz.	500W	Shares with WNAD.
WNAD	Norman, Okla.	Pniversity of Oklahoma.	500W	Shares with KGGF.
WIS	Columbia, S. C.	South Carolina Broadcasting Co. (Inc.)	500W / 1KW—LS	Unlimited.
KQW	San Jose, Calif.	University of Oklahoma	500W	Do.

1020 KILOCYCLES

WRAX	Philadelphia, Pa.	WRAX Broatcasting Co.	250W	Daytime.
KYW—KFKX	Chicago, Ill. T—Bloomingdale Township, Ill.	Westinghouse Electric & Manufacturing Co.	10KW	Unlimitet.

1030 KILOCYCLES (Canadian Exclusive)

1040 KILOCYCLES

WMAK	Buffalo, N. Y. T—Grand Island, N. Y.[14]	Buffalo Broadcasting Corporation	1KW	Limited.
WKAR	East Lansing, Mich.	Michigan State College	1KW	Daytime.
KTHS	Hot Springs National Park, Ark.	Hot Springs Chamber of Commerce	10KW	Shares with KRLD.
KRLD	Dallas, Tex.	KRLD Radio Corporation	10KW	Shares with KTHS.

[11] C. P. to move transmitter to Edgewater, Colo.
[12] Licensed to move transmitter to Millis Township, Mass., and studio to Boston, Mass., and consolidate with WBZA.
[13] C. P. to move transmitter to East Springfield and increase power to 1KW.
[14] C. P. to move transmitter to Amherst, N. Y.

BROADCASTING STATIONS BY FREQUENCIES—*Continued*

1050 KILOCYCLES

Call letters	Main studo location	Licensee	Power	Time of operation
KFKB	Milford, Kans.	The KFB Broadcasting Association (Inc.)	5KW	Limited.
KNX	Hollywood, Calif. T—Los Angeles, Calif.	Western Broadcast Co.	5KW[16]	Unlimited.

1060 KILOCYCLES

WBAL	Baltimore, Md. T—Glen Morris, Md.	Consolidated Gas, Electric Light & Power Company of Baltimore.	10KW	Shaes with WTIC.[15a]
WTIC	Hartford, Conn. T—Avon, Conn.	Travelers Broadcasting Service Corporation	50KW—LP	Shaes with WBAL.[15b]
WJAG	Norfolk, Nebr.	Norfolk Daily News	1KW	Limited.
KWJJ	Portland, Oreg.	KWJJ Broadcast Co. (Inc.)	500W	Do.

1070 KILOCYCLES

WTAM	Cleveland, Ohio. T—Brecksville Village, Ohio.	National Broadcasting Co. (Inc.)	50KW—LP	Unlimited.
WCAZ	Carthage, Ill.	Superior Broadcasting Service (Inc.)	50W	Daytime.
WDZ	Tuscola, Ill.	James L. Bush	100W	Do.
KJBS	San Francisco, Calif.	Julius Brunton & Sons Co.	100W	12.01 a. m. to local sunset.

1080 KILOCYCLES

WBT	Charlotte, N. C.	Station WBT (Inc.)	5KW	Unlimited.
WCBD	Zion, Ill.	Wilbur Glenn Voliva	5KW	Limited. Shares with WMBI.
WMBI	Chicago, Ill. T—Addison, Ill.	The Moody Bible Institute Radio Station	5KW	Limited. Shares with WCBD.

1090 KILOCYCLES

KMOX	St. Louis, Mo.	Voice of St. Louis (Inc.)	5KW—LP	Unlimited.

1100 KILOCYCLES

WPG	Atlantic City, N. J.	WPG Broadcasting Corporation	5KW	Shares with WLWL.
WLWL	New York, N. Y. T—Kearny, N. J.	Missionary Society of St. Paul the Apostle	5KW	Shares with WPG.
KGDM	Stockton, Calif.	E. F. Peffer	250W	Daytime.

1110 KILOCYCLES

WRVA	Richmond, Va. T—Mechanicsville, Va.	Larus & Brother Co. (Inc.)	5KW	Unlimited.
KSOO	Sioux Falls, S. Dak.	Sioux Falls Broadcast Association (Inc.)	2KW	Limited.

1120 KILOCYCLES (Canadian Shared)

WDEL	Wilmington, Del.	WDEL (Inc.)	250W 350W-LS[16]	Unlimited
WDBO	Orlando, Fla.	Orlando Broadcasting Co. (Inc.)	500W 1KW-LS.	One-half time.
WTAW	College Station, Tex.	Agricultural and Medical College of Texas.	500W	Shares with KTRH.
KTRH	Houston, Tex.	Rice Hotel	500W	Shares with WTAW.
WISN	Milwaukee, Wis.	Evening Wisconsin Co.	250W	Shares with WHAD.
WHAD	do	Marquette University	250W	Shares with WISN.
KFSG	Los Angeles, Calif.	Echo Park Evangelistic Association	500W	Shares with KMCS.
KMCS	Inglewood, Calif.	Dalton's (Inc.)	500W	Shares with KFSG.
KRSC	Seattle, Wash.	Radio Sales Corporation	50W	Daytime
KFIO	Spokane, Wash.	Spokane Broadcasting Corporation	100W	Do.

1130 KILOCYCLES

WOV	New York City. T—Secaucus, N. J.	International Broadcasting Corporation	1KW	Daytime until 6 p. m.
WJJD	Moosehart, Ill.	Supreme Lodge of the World, Loyal Order of Moose.	20KW	Limited.
KSL	Salt Lake City, Utah.	Radio Service Corporation of Utah	5KW	Unlimited.

1140 KILOCYCLES

WAPI	Birmingham, Ala.	Alabama Polytechnic Institute, University of Alabama and Alabama College	5KW	Shares with KVOO.
KVOO	Tulsa, Okla.	Southwestern Sales Corporation	5KW	Shares with WAPI.

1150 KILOCYCLES

WHAM	Rochester, N. Y. T—Victor Township, N. Y.	Stromberg-Carlson Telephone Manufacturing Co.	5KW	Unlimited.

1160 KILOCYCLES

WWVA	Wheeling, W. Va.	West Virginia Broadcasting Corporation	5KW	Shares with WOWO.
WOWO	Fort Wayne, Ind.	Main Auto Supply Co.	10KW	Shares with WWVA.

1170 KILOCYCLES

WCAU	Philadelphia, Pa. T—Byberry, Pa.	Universal Broadcasting Co.	10KW	Unlimited.
KTNT	Muscatine, Iowa	Norman Baker	5KW	Limited.

1180 KILOCYCLES

WGBS	New York, N. Y. T—Astoria, L. I., N. Y.	General Broadcasting System (Inc.)	250w 500W-LS	Shares with WCAC.
WDGY	Minneapolis, Minn.	Dr. George W. Young	1KW	Limited. Shares with WHDI.
WHDI	do	William Hood Dunwoody Industrial Institute	500W	Limited. Shares with WDGY.
KEX	Portland, Oreg.	Western Broadcasting Co.	5KW	Shares with KOB.
KOB	State College, N. Mex.	New Mexico College of Agriculture and Mechanic Arts.	20KW	Shares with KEX.

1190 KILOCYCLES

WOAI	San Antonio, Tex. T—Selma, Tex.	Southern Equipment Co.	50KW—LP	Unlimited.

1200 KILOCYCLES (Canadian Shared)

WABI	Bangor, Me.	Pine Tree Broadcasting Corporation	100W	Unlimited.
WNBX	Springfield, Vt.	First Congregational Church Corporation	10W	Shares with WCAX.
WCAX	Burlington, Vt.	University of Vermont	100W	Shares with WNBX.
WORC—WEPS	Worcester, Mass. T—Auburn, Mass.	Albert Frank Kleindienst	100W	Unlimited.
WIBX	Utica, N. Y.	WIBX (Inc.)	100W 300W—LS	Do.
WFBE	Cincinnati, Ohio	Radio Station WFBE (Inc.)	100W 250W—LS	Do.
WHBC	Canton, Ohio.	St. John's Catholic Church	10W	Shares with WNBO Sundays.
WLAP	Louisville, Ky.	American Broadcasting Corporation of Kentucky.	100W 250W—LS	Unlimited.
WEHC	Emory, Va.	Emory and Henry College	100W 250W—LS	Do.
WLBG	Petersburg, Va. T—Ettrick, Va.	Robert Allen Gamble	100W 250W—LS	Do.

[15] C. P. to increase power to 50 KW—LP
[15a] Synchronizes with WJZ on 760 kc.
[15b] Synchronizes with WEAF on 660 kc.
[16] C. P. to increase power to 500 Watts-LS.

BROADCASTING STATIONS BY FREQUENCIES—*Continued*

1200 KILOCYCLES (Canadian Shared)—*Continued*

Call letters	Main Studio location	Licenses	Power	Tome of operation
WNBO	Silver Haven, Pa.	John Brownlee Spriggs	100W	Shares with WHBC Sundays.
WCOD	Harrisburg, Pa.	Keystone Broadcasting Corporation	100W	Shares with WKJC.
WKJC	Lancaster, Pa.	Kirk Johnson & Co.	100W	Shares with WCOD.
WNBW	Carbondale, Pa.	C. F. Schiessler and M. E. Stephens, doing business as Home Cut Glass & China Co.	10W	Unlimited.
KMLB	Monroe, La.	J. C. Liner	50W	Daytime.
WABZ	New Orleans, La.	Coliseum Place Baptist Church	100W	Shares with WJBW.
WJBW	do	C. Carlson	100W [17]	Shares with WABZ.
WBBZ	Ponca City, Okla.	C. L. Carrell	100W	Unlimited.
WFBC	Knoxville, Tenn.	First Baptist Church	50W	Do.
WRBL	Columbus, Ga.	David Parmer	50W	Do.
KGHI	Little Rock, Ark.	Berean Bible Class, First Baptist Church	100W	Do.
KBTM	Paragould, Ark.	W. J. Beard, Beard's Temple of Music	100W	Daytime.
WJBC	La Salle, Ill.	Wayne Hummer & H. J. Dee, doing business as Kaskaskia Broadcasting Co.	100W	Shares with WJBL.
WJBL	Decatur, Ill.	Commodore Broadcasting Corporation	100W	Shares with WJBC.
WWAE	Hammond, Ill.	Hammond-Calumet Broadcasting Corporation	100W	Shares with WRAF.
WRAF	Laporte, Ind.	Charles Middleton	100W	Shares with WWAE.
KFJB	Marshalltown, Iowa.	Marshall Electric Co. (Inc.)	100W / 250W—LS	One-half time.
KGCU	Mandan, N. Dak.	Mandan Radio Association	100W	Unlimited.
WCAT	Rapid City, S. Dak.	South Dakota State School of Mines	100W	Do.
KGDY	Huron, S. Dak.	Voice of South Dakota	100W	Do.
KFWF	St. Louis, Mo.	St. Louis Truth Center (Inc.)	100W	Shares Shares with WIL.
KGDE	Fergus Falls, Minn.	C. L. Jaren	100W / 250W—LS	Unlimited.
WCLO	Janesville, Wis.	WCLO Radio Corporation	100W	Do.
WHBY	Green Bay, Wis. T—West De Pere, Wis.	St. Norbert College	100W	Do.
WIL	St. Louis, Mo.	Missouri Broadcasting Corporation	100W / 250W—LS	Shares with KFWF.
KGFJ	Los Angeles, Calif.	Ben S. McGlashan	100W	Unlimited.
KSMR	Santa Maria, Calif.	Santa Maria Radio	100W	Do.
KWG	Stockton, Calif.	Portable Wireless Telephone Co. (Inc.)	100W	Do.
KGEK	Yuma, Colo.	Elmer C. Beehler, trading as Beehler Electrical Equipment Co.	50W	Shares with KGEW.
KGEW	Fort Morgan, Colo.	City of Fort Morgan	100W	Shares with KGEK.
KVOS	Bellingham, Wash.	KVOS (Inc.)	100W	Unlimited.
KGY	Lacey, Wash.	St. Martin's College	10W	Do.

1210 KILOCYCLES (Canadian Shared)

WMRJ	Jamaica, N. Y.	Peter J. Prinz	100W	Shares with WCOH, WGBB, and WJBI.
WJBI	Redbank, N. J.	Monmouth Broadcasting Co.	100W	Shares with WCOH, WGBB, and WMRJ.
WGBB	Freeport, N Y.	Harry H. Carman	100W	Shares with WCOH, WJBI, and WMRJ.
WCOH	Yonkers, N. Y. T—Greenville, N. Y.	Westchester Broadcasting Corporation	100W	Shares with WJBI, WGBB, and WMRJ.
WOCL	Jamestown, N. Y.	A. E. Newton	25W	Unlimited.
WLCI	Ithaca, N. Y.	Lutheran Association of Ithaca, N. Y.	50W	Do.
WPAW	Pawtucket, R. I.	Shartenberg & Robinson Co.	100W	Shares with WDWF-WLSI.
WDWF-WLSI	Providence, R. I. T—Cranston, R. I.	Dutee Wilcox Flint & Lincoln Studios (Inc.).	100W	Shares with WPAW.
WSEN	Columbus, Ohio.	Columbus Broadcasting Corporation	100W	Unlimited.
WJW	Mansfield, Ohio.	John F. Weimer (owner Mansfield Broadcasting Association).	100W	Do.
WALR	Zanesville, Ohio.	Roy W. Waller	100W	Do.
WBAX	Wilkes-Barre, Pa. T—Plains Township, Pa.	John H. Stenger, Jr.	100W	Shares with WJBU.
WJBU	Lewisburg, Pa.	Bucknell University	100W	Shares with WBAX.
WBBL	Richmond, Va.	Grace Covenant Presbyterian Church	100W	Certain hours Sunday only.
WMBG	Richmond, Va.	Havens & Martin (Inc.)	100W	Unlimited, except Sundays shares with WBBL.
WSIX	Springfield, Tenn.	Jack M. and Louis R. Draughon, doing business as 638 Tire and Vulcanizing Co.	100W	Unlimited.
WSOC	Gastonia, N. C.	WSOC (Inc.)	100W	Do.
WJBY	Gadsden, Ala.	Gadsden Broadcasting Co. (Inc.)	50W	Do.
WQDX	Thomasville, Ga.	Stevens Luke	50W	Do.
KGMP	Elk City, Okla.	Homer F. Bryant, trading as Bryant Radio & Electric Co.	100W	Do.
WRBQ	Greenville, Miss.	J. Pat Scully	100W / 250W-LS	Do.
WGCM	Gulfport, Miss. T—Mississippi City, Miss.	Great Southern Land Co.	100W.	Do.
KWEA	Shreveport, La.	Hello World Broadcasting Corporation	100W.	Do.
KDLR	Devils Lake, N. Dak.	KDLR (Inc.)	100W.	Do.
KGCR	Watertown, S. Dak.	Cutler's Radio Broadcasting Service (Inc.)	100W.	Do.
KFOR	Lincoln, Nebr.	Howard A. Shuman	100W / 250-LS	Do.
WHBU	Anderson, Ind.	Citizens Bank	100W.	Do.
KFVS	Cape Girardeau, Mo.	Oscar C. Hirsch, trading as Hirsch Battery & Radio Co.	100W.	Shares with WEBQ.
WEBQ	Harrisburg, Ill.	First Trust & Savings Bank of Harrisburg, Ill.	100W.	Shares with KFVS.
KGNO	Dodge City, Kans.	Dodge City Broadcasting Co. (Inc.)	100W.	Unlimited.
WSBC	Chicago, Ill.	World Battery Co. (Inc)	100W.	Shares with WEDC and WCRW.
WCRW	Chicago, Ill.	Clinton R. White	100W.	Shares with WEDC and WSBC.
WEDC	Chicago, Ill.	Emil Denemark (Inc.)	100W.	Shares with WSBC and WCRW.
WCBS	Springfield, Ill.	Chas. H. Messter and Harold L. Dewing	100W.	Shares with WTAX.
WTAX	Springfield, Ill.	WTAX (Inc.)	100W.	Shares with WCBS.
WHBF	Rock Island, Ill.	Beardsley Specialty Co.	100W.	Unlimited.
WOMT	Manitowoc, Wis.	Francis M. Kadow	100W.	Do.
WIBU	Poynette, Wis.	William C. Forrest	100W.	Do.
KMJ	Fresno, Calif.	James McClatchy Co.	100W.	Do.
KFXM	San Bernardino, Calif.	J. C. & E. W. Lee (Lee Bros. Broadcasting Co.)	100W.	Shares with KPPC.
KPPC	Pasadena, Calif.	Pasadena Presbyterian Church	50W	Shares with KFXM.
KDFN	Casper, Wyo.	Donald Lewis Hathaway	100W.	Unlimited.

1220 KILOCYCLES

WCAD	Canton, N. Y.	St. Lawrence University	500W	Daytime.
WCAE	Pittsburgh, Pa.	Kaufman & Baer Co.	1KW	Unlimited.
WDAE	Tampa, Fla.	Tampa Publishing Co.	1KW	Do.
WREN	Lawrence, Kans.	Jenny Wren Co.	1KW	Shares with KFKU.
KFKU	Lawrence, Kans.	University of Kansas	500W	Shares with WREN.
KWSC	Pullman, Wash.	State College of Washington	1KW / 2KW-LS	Unlimited.

1230 KILOCYCLES

WNAC-WBIS	Boston, Mass. T—Quincy, Mass.	Shepard Broadcasting Service (Inc.)	1KW	Unlimited.
WPSC	State College, Pa.	The Pennsylvania State College	500W	Daytime.
WSBT	South Bend, Ind.	South Bend Tribune	500W	Shares with WFBM.
WFBM	Indianapolis, Ind.	Indianapolis Power & Light Co.	1KW	Shares with WSBT.
KGGM	Albuquerque, N. Mex.	New Mexico Broadcasting Co.	250W / 500W1LS	Unlimited.
KYA	San Francisco, Calif.	Pacific Broadcasting Corporation	1KW	Do.
KFQD	Anchorage, Alaska	Anchorage Radio Club	100W	Do.

17 license granted to increase power to this amount.

BROADCASTING STATIONS BY FREQUENCIES—*Continued*

1240 KILOCYCLES

WXYZ	Detroit, Mich.	Kunsky-Trendle Broadcasting Corporation	1KW	Unlimited.
KTAT	Fort Worth, Tex. T—Birdville, Tex.	S. A. T. Broadcast Co.	1KW	Shares with WACO.
WACO	Waco, Tex.	Central Texas Broadcasting Co. (Inc.)	1KW	Shares with KTAT.

1250 KILOCYCLES

WGCP	Newark, N. J.	May Radio Broadcast Corporation	250W	Shares with WODA and WAAM.
WODA	Paterson, N. J.	Richard E. O'Dea	1KW	Shares with WGCP and WAAM.
WAAM	Newark, N. J.	WAAM (Inc.)	1KW / 2KW-LS[18]	Shares with WODA and WGCP.
WDSU	New Orleans, La.	T—Gretna, La. Joseph H. Uhalt	1KW	Unlimited.
WLB-WGMS	Minneapolis, Minn.	T—St. Paul, Minn. University of Minnesota	1KW	Shares with WRHM, KFMX, and WCAL.
WRHM	Minneapolis, Minn.	T—Fridley, Minn. Minnesota Broadcasting Corporation	1KW	Shares with WLB, KFMX, and WCAL.
KFMX	Northfield, Minn.	Carlton College	1KW	Shares with WLB, WRHM, and WCAL.
WCAL	Northfield, Minn.	St. Olaf College	1KW	Shares with WLB, WRHM, and KFMX.
KFOX	Long Beach, Calif.	Nichols and Warriner (Inc.)	1KW	Unlimited.
KIDO	Boise, Idaho.	Frank L. Hill and C. G. Phillips, doing business as Boise Broadcast Station.	1KW	Do.

1260 KILOCYCLES

WLBW	Oil City, Pa.	Radio-Wire Program Corporation of America	500W / 1K-LS	Unlimited.
KWWG	Brownsville, Tex.	The Brownsville Herald Publishing Co.	500W	Shares with KRGV.
WTOC	Savannah, Ga.	Savannah Bradcasting Co. (Inc.)	500W	Unlimited.
KRGV	Harlingen, Tex.	KRGV (Inc.)	500W	Shares with KWWG.
KOIL	Council Bluffs, Iowa.	Mona Motor Oil Co.	1KW	Unlimited.
KVOA	Tuscon, Ariz.	Robert M. Riculfi	500W	Daytime.

1270 KILOCYCLES

WEAI	Ithaca, N. Y.	Cornell University	1KW	Daytime.
WFBR	Baltimore, Md.	Baltimore Radio Show (Inc)	500W	Unlimited.
WASH	Grand Rapids, Mich.	WASH Bradcasting Corporation	500W	Shares with WOOD.
WOOD	Grand Rapids, Mich. T—Furnwood, Mich.	Kunsky-Trendle Broadcasting Corp.	500W	Shares with WASH.
WJDX	Jackson, Miss.	Lamar Life Insurance Co.	1KW	Unlimited.
KWLC	Decorah, Iowa.	Luther College	100W	Daytime. Shares with KGCA.
KGCA	Decorah, Iowa.	Charles W. Greenley	50W	Daytime. Shares with KWLC.
KTW	Seattle, Wash.	The First Presbyterian Church of Seattle, Wash.	1KW	Shares with KOL.
KOL	Seattle, Wash.	Seattle Broadcasting Co. (Inc.)	1KW	Shares with KTW.
KFUM	Colorado Springs, Colo.	W. D. Corley	1KW	Unlimited.

1280 KILOCYCLES

WCAM	Camden, N. J.	City of Camden	500W	Shares with WOAX and WCAP.
WCAP	Asbury Park, N. J.	Radio Industries Broadcast Co.	500W	Shares with WCAM and WOAX.
WOAX	Trenton, N. J.	WOAX (Inc.)	500W	Shares with WCAM and WCAP.
WDOD	Chattanooga, Tenn. T—Brainerd, Tenn.	WDOD Broadcasting Corporation	1KW / 2½KW-LS	Unlimited.
WRR	Dallas, Tex.	City of Dallas, Tex.	500W	Do.
WIBA	Madison, Wis.	The Capital Times Co.	500W	Do.
KFBB	Great Falls, Mont.	Buttrey Broadcast (Inc.)	1KW / 2½KW-LS	Do.

1290 KILOCYCLES

WNBZ	Saranac Lake, N. Y.	Earl J. Smith and William Mace, doing business as Smith & Mace.	50W	Daytime.
WJAS	Pittsburgh, Pa. T—North Fayette Township, Pa.	Pittsburgh Radio Supply House	1KW / 2½KW-LS	Unlimited.
KTSA	San Antonio, Tex.	Lone Star Broadcasting Co. (Inc.)	1KW / 2KW-LS	Shares with KFUL.
KFUL	Galveston, Tex.	Will H. Ford	500W	Shares with KTSA.
KLCN	Blytheville, Ark.	Charles Leo Lintzenich	50W	Daytime.
WEBC	Superior, Wis.	Head of the Lakes Broadcasting Co.	1KW / 2½KW-LS	Unlimited.
KDYL	Salt Lake City, Utah.	Intermountain Broadcasting Corporation	1KW	Do.

1300 KILOCYCLES

WBBR	Brooklyn, N. Y. T—Rossville, N. Y. (Staten Island).	Peoples Pulpit Association	1KW	Shares with WEVD, WHAZ, and WHAP.
WHAP	New York, N. Y. T—Carlstadt, N. J.	Defenders of Truth Society (Inc.)	1KW	Shares with WEVD, WHAZ, and WBRR.
WEVD	New York, N. Y. T—Forest Hills, N. Y.	Debs Memorial Radio Fund (Inc.)	500W	Shares with WHAP, WHAZ, and WBBR.
WHAZ	Troy, N. Y.	Rensselaer Polytechnic Institute	500W	Shares with WEVD, WHAP, and WBBR.
WIOD-WMBF	Miami, Fla. T—Miami Beach, Fla.	Isle of Dreams Broadcasting Corporation	1KW	Unlimited.
KFH	Wichita, Kans.	Radio Station KFH Co.	1KW	Shares with WOQ.
WOQ	Kansas City, Mo.	Unity School of Christianity	1KW	Shares with KFH.
KGEF	Los Angeles, Calif.	Trinity Methodist Church, South	1KW	Shares with KTBI.
KTBI	Los Angeles, Calif.	Bible Institute of Los Angeles	1KW	Shares with KGEF.
KFJR	Portland, Oreg.	Ashley C. Dixon, trading as Ashley C. Dixon & Son.	500W	Shares with KTBR'
KTBR	Portland, Oreg.	M. E. Brown	500W	Shares with KFPR.

1310 KILOCYCLES

WKAV	Laconia, N. H.	Laconia Radio Club	100W	Unlimited.
WEBR	Buffalo, N. Y.	Howell Broadcasting Co. (Inc.)	100W / 200W-LS	Do
WMBO	Auburn, N. Y.	George I. Stevens, trading as Radio Service Laboratories.	100W	Do.
WNBH	New Bedford, Mass. T—Fairhaven, Mass.	Irving Vermilya, trading as New Bedford Broadcasting Co.	100W	Do.
WOL	Washington, D. C.	American Broadcasting Co.	100W	Do.
WGH	Newport News, Va.	Hampton Roads Broadcasting Corporation	100W	Do.
WEXL	Royal Oak, Mich.	Royal Oak Broadcasting Co.	50W	Do.
WFDF	Flint, Mich.	Frank D. Fallain	100W	Do.
WBEO	Marquette, Mich.	Charles C. MacLeod	100W	Unlimited. (C. P. only.)
WHAT	Philadelphia, Pa.	Independence Broadcasting Co.	100W	Shares with WTEL.
WTEL	Philadelphia, Pa.	Foulkrod Radio Engineering Co.	100W[19]	Shares with WHAT, WCAM.
WJAC	Johnstown, Pa.	Johnstown Automobile Co.	100W	Shares with WFBG.
WFBG	Altoona, Pa.	William F. Gable Co.	100W[20]	Shares with WJAC.
WRAW	Reading, Pa.	Reading Broadcasting Co.	50W[21]	Shares with WGAL.
WGAL	Lancaster, Pa.	WGAL, Incorporated	100W	Shares with WRAW.
WSAJ	Grove City, Pa.	Grove City College	100W	Unlimited.
WBRE	Wilkes-Barre, Pa.	Louis G. Baltimore	100W	Do.
WKBC	Birmingham, Ala.	R. B. Broyles, trading as R. B. Broyles Furniture Co.	100W	Unlimited.
WRBI	Tifton, Ga.	Oglethorpe University	20W[22]	One-half time.

[18]C. P. to increase power to 2½ KW-LS.
[19]License granted to increase power to 100 w.
[20]C. P. to increase power to 250 watts-LS.
[21]C. P. to increase power to 100 watts.
[22]C. P. to increase power to 100 watts.

BROADCASTING STATIONS BY FREQUENCIES—*Continued*

1310 KILOCYCLES—(Cont.)

WOBT	Union City, Tenn.	A. F. Tittsworth, trading as Tittsworth's Radio & Music Shop.	100W / 250W-LS	Unlimited.
WROL	Knoxville, Tenn.	Stuart Broadcasting Corporation	100W	Do.
KRMD	Shreveport, La.	Robert M. Dean	50W	Shares with KTSL.
KTSL	Shreveport, La.	G. A. Houseman	100W	Shares with KRMD.
WSJS	Winston-Salem, N. C.	Winston-Salem Journal Co.	100W	Unlimited.
KTLC	Houston, Tex.	Houston Broadcasting Co.	100W	Do.
KFPM	Greenville, Tex.	Dave Ablowich, trading as The New Furniture Co.	15W	Do.
KTSM	El Paso, Tex.	W. S. Bledsoe and W. T. Blackwell	100W	Shares with WDAH.
WDAH	El Paso, Tex.	E. E., C. T., E. M., and Ernest Wilson, doing business as Eagle Broadcasting Co.	100W	Shares with KTSM.
KFPL	Dublin Tex.	C. C. Baxter	100W	Unlimited.
KFXR	Oklahoma City, Okla.	Exchange Avenue Baptist Church	100W / 250W-LS	Do.
WKBS	Galesburg, Ill.	Permil N. Nelson	100W	Do.
WCLS	Joliet, Ill.	WCLS (Inc.)	100W	Shares with WKBB.
WKBB	Joliet, Ill.	Sanders Brothers Radio Station	100W	Shares with WCLS.
KWCR	Cedar Rapids, Iowa	Harry F. Parr	100W	Shares with KFGQ and KFJY.
KFJY	Fort Dodge, Iowa	C. S. Tunwall	100W	Shares with KFGQ and KWCR.
KFGQ	Boone, Iowa	Boon Biblical College	100W	Shares with KWCR and KFJY.
KGFW	Ravenna, Nebr.	Central Nebraska Broadcasting Corporation	100W	Unlimited.
WBOW	Terre Haute, Ind.	Banks of Wabash (Inc.)	100W	Do.
WJAK	Marion, Ind.	Marion Broadcast Co.	50W	Shares with WLBC.
WLBC	Muncie, Ind.	Donald A. Burton	50W	Shares with WJAK.
KGBX	St. Joseph, Mo.	KGBX (Inc.)	100W	Unlimited.
KFIU	Juneau, Alaska	Alaska Electric Light & Power Co.	10W	Do.
KFBK	Sacramento, Calif.	James McClatchy Co.	100W	Do.
KCRJ	Jerome, Ariz.	Charles C. Robinson	100W	Do.
KGCX	Wolf Point, Mont.	First State Bank of Vida	100W / 250W-LS	One-half time.
KGEZ	Kalispell, Mont.	Donald C. Treloar and Stanley R. Church, doing business as Treloar-Church Broadcasting Co.	100W	Unlimited.
KFUP	Denver, Colo.	Fitzsimmons General Hospital, U. S. Army	100W	Shares with KFXJ.
KFXJ	Edgewater, Colo.[23]	R. G. Howell and Charles Howell, doing business as Western Slope Broadcasting Co.	50W	Shares with KFUP.
KMED	Medford, Oreg.	Mrs. W. J. Virgin	50W	Unlimited.
KXRO	Aberdeen, Wash.	KXRO (Inc.)	75W[24]	Do.
KIT	Yakima, Wash.	Carl E. Haymond	50W	Do.

1320 KILOCYCLES

WADC	Tallmadge, Ohio.	Allen T. Simmons	1KW	Unlimited.
WSMB	New Orleans, La.	Saenger Theatres (Inc.) and Maison Blanche Co.	500W	Do.
KTFI	Twin Falls, Idaho.	Radio Broadcasting Corporation	250W[25]	Shares with KID at night
KID	Idaho Falls, Idaho.	KID Broadcasting Co.	250W / 500W-LS	Shares with KTFI at night.
KGHF	Pueblo, Colo.	Curtis P. Ritchie and Joe E. Finch	250W / 500W-LS	Unlimited.
KGMB	Honolulu, Hawaii.	Honolulu Broadcasting Co. (Ltd.)	500W	Do.

1330 KILOCYCLES

WDRC	Hartford, Conn. T. Bloomfield, Conn.	WDRC (Inc.),	500W	Unlimited.
WSAI	Cincinnati, O. T. Mason, Ohio.	Crosley Radio Corporation (lessee)	500W	Do.
WTAQ	Eau Claire, Wis. T—Township of Washington, Wis.	Gillette Rubber Co.	1KW	Shares with KSCJ.
KSCJ	Sioux City, Iowa	Perkins Brothers Co.	1KW / 2½KW-LS.	Shares with WTAQ.
KGB	San Diego, Calif.	Pickwick Broadcasting Corporation	250W[26]	Unlimited.

1340 KILOCYCLES

WSPD	Toledo, Ohio.	Toledo Broadcasting Co.	500W / 1KW-LS	Unlimited.
KFPW	Fort Smith, Ark.	Southwestern Hotel Co.	50W	50W. Daytime.
WCOA	Pensacola, Fla.	City of Pensacola, Fla.	500W	Unlimited.
KFPY	Spokane, Wash.	Symons Broadcasting Co.	1KW	Do.

1350 KILOCYCLES

WAWZ	Zarephath, N. J.	Pillar of Fire	250W	Shares with WMSG, WCDA, and WBNX. (C. P. only.)
WMSG	New York, N. Y.	Madison Square Garden Broadcast Corporation	250W	Shares with WAWZ, WCDA, and WBNX.
WCDA	New York, N. Y. T—Cliffside Park, N. J.	Italian Educational Broadcasting Co. (Inc.)	250W	Shares with WAWZ, WMSG, and WBNX.
WBNX	New York, N. Y.	Standard Cahill Co. (Inc.)	250W	Shares with WAWZ, WMSG, and WCDA.
KWK	St. Louis, Mo. T—Kirkwood, Mo.	Greater St. Louis Broadcasting Corporation.	1KW	Unlimited.
WKBQ	New York, N. Y.	Standard Cahill Co. (Ic.)	250W	Shares with WBNT, WMSC and WCDA

1360 KILOCYCLES

WFBL	Syracuse, N. Y.[27]	Onondaga Radio Broadcastting Corporation	1KW	Unlimited.
WQBC	Vicksburg, Miss.	Delta Broadcasting Co. (Inc.)	300W	Daytime. (C. P. only.)
WCSC	Charleston, S. C.	Fred Jordan and Lewis Burk	500W	Unlimited.
WJKS	Gary, Ill.	Johnson-Kennedy Radio Corporation	1KW / 1¼KW-LS	Shares with WGES.
WGES	Chicago, Ill.	Oak Leaves Broadcasting Station (Inc.)	500W / 1KW-LS[28]	Shares with WJKS.
KGIR	Butte, Mont.	KGIR (Inc.)	500W	One-half time.
KGER	Long Beach, Calif.	C. Merwin Dobyns	1KW	Shares with KPSN.
KPSN	Pasadena, Calif.	Pasadena Star-News Publishing Co.	1KW	Shares with KGER.

1370 KILOCYCLES

WRDO	Augusta, Me.	Albert S. Woodman	100W	Unlimited (C. P. only).
WQDM	St. Albans, Vt.	A. J. St. Antoine	5W[29]	Daytime.
WLEY	Lexington, Mass.	Carl S. Wheeler, trading as Lexington Air Stations.	100W / 250W-LS	One-half time.
WSVS	Buffalo, N. Y.	Elmer S. Pierce, principal, Seneca Vocational High School.	50W	Unlimited.
WBGF	Glens Falls, N. Y.	W. Neal Parker and Herbert H. Metcalfe	50W	Do.
WPOE	Patchogue, N. Y.	Nassau Broadcasting Corporation	100W	Do.
WCBM	Baltimore, Md.	Baltimore Broadcasting Corporation	100W / 250W-LS	Do.
WBTM	Danville, Va.	L. H., R. G., and A. S. Clarke, doing business as Clarke Electric Co.	100W	Shares with WLVA.
WLVA	Lynchburg, Va.	Lynchburg Broadcasting Corporation	100W	Shares with WBTM.
WHBD	Mount Orab, Ohio.	F. P. Moler	100W	Unlimited.
WHDF	Calumet, Mich.	Upper Michigan Broadcasting Co.	100W / 250W-LS	Do.
WJBK	Highland Park, Mich.	James F. Hopkins (Inc.)	50W	Shares with WIBM.
WIBM	Jackson, Mich.	WIBM (Inc.)	100W	Shares with WJBK.
WRAK	Williamsport, Pa.	Clarence R. Cummins	50W[30]	Unlimited.
WELK	Philadelphia, Pa.	WELK Broadcasting Station (Inc.)	100W / 250W-LS	Do.

[23]C. P. to move transmitter and studio to Grand Junction, Colo., and increase power to 100 watts.
[24]C. P. to increase power to 100 watts.
[25]C. P. to increase power to 500 watts—LS.
[26]C. P. to increase power to 500 watts.
[27]C. P. to move transmitter to Collamer, N. Y., and increase power to 2½ KW—LS.
[28]On Sundays.

BROADCASTING STATIONS BY FREQUENCIES—*Continued*

1370 KILOCYCLES—(Cont.)

WFDV	Rome, Ga.	Dolies Goings	100W	Do.
WRBJ	Hattiesburg, Miss.	Woodruff Furniture Co. (Inc.)	10W	Do.
WHBQ	Memphis, Tenn.	Broadcasting Station WHBQ (Inc.)	100W	Do.
WRBT	Wlimington, N. C.	Wilmington Radio Association (Inc.)	100W	Do.
KGFG	Oklahoma City, Okla.	Oklahoma Broadcasting Co. (Inc.)	100W	Shares with KCRC.
KCRC	Enid, Okla.	Champlin Refining Co.	100W / 250W-LS	Shares with KGFG.
WMBR	Tampa, Fla.	F. J. Reynolds	100W	Unlimited.
KMAC	San Antonio, Tex.	W. W. McAllister	100W	Shares with KONO.
KFJZ	Fort Worth, Tex.	Margaret Meacham Hightower, Minnie Meacham Smith, and Mary Meacham, executrices of estate of H. C. Meacham, deceased.	100W	Unlimited.
KONO	San Antonio, Tex.	Mission Broadcasting Co.	100W	Shares with KMAC.
KGKL	San Angelo, Tex.	KGKL (Inc.)	100W	Unlimited.
KFLX	Galveston, Tex.	George Roy Clough	100W	Do.
WGL	Fort Wayne, Ind.	Fred C. Zeig (Allen-Wayne Co.)	100W	Do.
KGDA	Mitchell, S. Dak.	Mitchell Broadcasting Corporation	100W	Do.
KFJM	Great Forks, N. Dak.	University of North Dakota	100W	Do.
KWKC	Kansas City, Mo.	Wilson Duncan, trading as Wilson Duncan Broadcasting Co.	100W	One-half time.
WRJN	Racine, Wis.	Racine Broadcasting Corporation	100W	Unlimited.
KGAR	Tucson, Ariz.	Tucson Motor Service	100W / 250W-LS	Do.
KRE	Berkeley, Calif.	First Congregational Church of Berkeley	100W	Shares with KZM.
KZM	Hayward, Calif.	Leon P. Tenney	100W	Shares with KRE.
KOOS	Marshfield, Oreg.	H. H. Hansets (Inc.)	100W	Unlimited.
KFBL	Everett, Wash.	Otto Leese and Robert Leese, doing business as Leese Bros.	50W	Shares with KVL.
KVL	Seattle, Wash.	KVL, Incorporated	100W	Shares with KFBL.
KFJI	Astoria, Oreg.	KFJI Broadcasters, Inc.	100W	Unlimited.
KGFL	Ratorr, N. Mex.	W. E. Whitmore	50W	Do.
KUJ	Walla Walla, Wash.	Paul R. Heitmeyer	100W	One-half time (C. P. only).

1380 KILOCYCLES

WSMK	Dayton, Ohio.	Stanley M. Krohn, Jr.	200W	Shares with KQV at night.
KQV	Pittsburgh, Pa.	Doubleday-Hill Electric Co.	500W	Shares with WSMK at night
KSO	Clarinda, Iowa	Berry Seed Co.	500W	Shares with WKBH.
WKBH	LaCrosse, Wis.	WKBH (Inc.)	1KW	Shares with KSO.
KOH	Reno, Nev.	Jay Peters (Inc.)	500W	Unlimited.

1390 KILOCYCLES

WHK	Cleveland, Ohio. T—Seven Hills, Ohio.	Radio Air Service Corporation	1KW	Unlimited.
KLRA	Little Rock, Ark.	Arkansas Broadcasting Co.	1KW	Shares with KUOA.
KUOA	Fayetteville, Ark.	University of Arkansas	1KW	Shares with KLRA.
KOY	Phoenix, Ariz.	Nielsen Radio & Sporting Goods Co.	500W	Unlimited.

1400 KILOCYCLES

WCGU	Brooklyn, N. Y.	United States Broadcasting Corporation	500W	Shares with WFOX, WLTH and WBBC.
WFOX	Brooklyn, N. Y.	Paramount Broadcasting Corporation.	500W	Shares with WCGU, WLTH, and WBBC.
WLTH	Brooklyn, N. Y.	Voice of Brooklyn (Inc.)	500W	Shares with WSCH-WSDA, WCGU, and WBBC.
WBBC	Brooklyn, N. Y.	Brooklyn Broadcasting Corporation	1KW	Shares with WFOX, WLTH, and WCGU.
KOCW	Chickasha, Okla.	Oklahoma College for Women	250W / 500W-LS	Unlimited.
WCMA	Culver, Inc.	General Broadcasting Corporation	500W	Shares with WBAA and WKBF.
WKBF	Indianapolis, Ind. T—Clermont, Ind.	Indianapolis Broadcasting (Inc.)	500W	Shares with WBAA and WCMA.
WBAA	West Lafayette, Ind.	Purdue University	500W / 1KW-LS	Shares with WCMA and WKBF.
KLO	Ogden, Utah	Peery Building Co.	500W	Unlimited.

1410 KILOCYCLES

WLEX	Lexington, Mass.	Bay State Broadcasting Corporation	500W	Shares with WMAF and WSSH.
WMAF	South Dartmouth, Mass.	Round Hills Radio Corporation	500W	Shares with WLEX and WSSH.
WSSH	Boston, Mass.	Tremont Temple Baptist Church	500W	Shares with WLEX and WMAF.
WRBX	Roanoke, Va.	Richmond Development Corporation	250W	One-half time.
WBCM	Bay City, Mich. T—Hampton township, Mich.	James E. Davidson	500W	Unlimited.
KGRS	Amarillo, Tex.	E. B. Gish (Gish Radio Service)	1KW	Shares with WDAG.
WDAG	Amarillo, Tex.	National Radio Broadcasting Corporation	250W[31]	Shares with KGRS.
WODX	Mobile, Ala. T—Springhill, Ala.	Mobile Broadcasting Corporation	500W	Shares with WSFA.
WSFA	Montgomery, Ala.	Montgomery Broadcasting Co. (Inc.)	500W	Shares with WODX.
KFLV	Rockford, Ill.	Rockford Broadcasters (Inc.)	500W	Shares with WHBL.
WHBL	Sheboygan, Wis.	Press Publishing Co.	500W	Shares with KFLV.

1420 KILOCYCLES

KGVO	Missoula, Mich.	Mosby's (Inc.)	100w	Daytime.
WHDL	Tupper Lake, N. Y.	Tupper Lake Broadcasting Co. (Inc.)	10W[32]	Daytime.
WTBO	Cumberland, Md.	Associated Broadcasting Corporation	100W / 210W-LS	Unlimited.
WILM	Wilmington, Del. T—Edge Moor, Del.	Delaware Broadcasting Co. (Inc.)	100W	Do.
WPAD	Paducah, Ky.	Pierce E. Lackey and S. Houston McNutt, doing business as Paducah Broadcasting Co.	100W	Do.
WEDH	Erie, Pa.	Erie Dispatch-Herald Broadcasting Corporation	100W	Do.
WMBC	Detroit, Mich.	Michigan Broadcasting Co.	100W / 210W-LS	Do.
WELL	Battle Creek, Mich.	Enquirer-News Co.	100W[33]	Unlimited.
WHIS	Bluefield, W. Va.	Daily Telegraph Printing Co.	100W[34]	Do.
WIBR	Steubenville, Ohio.	George W. Robinson	50W	One-half time.
WFDW	Talladega, Ala.	Raymond C. Hammett	100W	Unlimited.
WJBO	New Orleans, La.	Valdemar Jensen	100W	Do.
KGFF	Alva, Okla.[35]	D. R. Wallace (owner KGFF Broadcasting Co.)	100W	Do.
KTAP	San Antonio, Tex.	Alamo Broadcasting Co. (Inc.)	100W	Do.
KXYZ	Houston, Tex.	Harris County Broadcast Co.	100W	Do.
KFYO	Abilene, Tex.	T. E. Kirksey, trading as Kirksey Brothers	100W / 250W-LS	Do.
WSPA	Spartanburg, S. C.	Virgil V. Evans, trading as The Voice of South Carolina.	100W / 250W-LS	Do.
KICK	Red Oak, Iowa	Red Oak Radio Corporation	100W	Do.
WIAS	Ottumwa, Iowa	Iowa Broadcasting Co.	100W	Do.
WLBF	Kansas City, Kans.	The WLBF Broadcasting Co.	100W	Do.
WMBH	Joplin, Mo.	Edwin Dudley Aber	100W / 250W-LS	Do.
KLPM	Minot, N. Dak.	John B. Cooley	100W	Do.
WEHS	Evanston, Ill.	WEHS (Inc.)	100W	Shares with WKBI and WHFC.
WHFC	Cicero, Ill.	Triangle Broadcasters	100W	Shares with WKBI and WEHS.
WKBI	Chicago, Ill.	Fred L. Schoenwolf	100W	Shares with WHFC and WEHS.
KFIZ	Fond du Lac, Wis.	The Reporter Printing Co.	100W	Unlimited.
KFXY	Flagstaff, Ariz.	Mary M. Costigan	100W	Do.
KGIX	Los Vegas, Nev.	J. M. Heaton	100W	Do.

[31]C. P. to increase power to 1 KW.
[32]C. P. to increase power to 100 watts.
[33]Licensed to increase power to 100 watts.
[34]C. P. to increase power to 250 watts, to change frequency to 1410 kilocycles, to operate one-half time.
[35]C. P. to move studio and transmitter to Shawnee, Okla.
[35a]Synchronize on 1430 kc.
[36]C. P. to move transmitter and studio to Albany, N. Y.
[37]C. P. to increase power to 100 watts.
[38]C. P. to increase power to 100 watts.
[39]C. P. to increase power to 100 watts.

BROADCASTING STATIONS BY FREQUENCIES—*Continued*

1420 KILOCYCLES—(Cont.)

KFQU	Holy City, Calif.	W. E. Riker	100W	Shares with KGGC.
KFXD	Nampa, Idaho	Frank E. Hurt, trading as Service Radio Co	50W	Unlimited.
KGIW	Trinidad, Colo.	Leonard E. Wilson	100W	Do.
KGKX	Sandpoint, Idaho.	C. E. Twiss and F. H. McCann	100W	Do.
KGGC	San Francisco, Calif.	The Golden Gate Broadcasting Co.	100W	Shares with KFQU.
KGVO	Missoula, Mont.	Mosby's (Inc.)	100W	10 a. m. to 6 p. m. (C. P. only).
KXL	Portland, Oreg.	KXL Broadcasters	100W	Shares with KBPS.
KBPS	Portland, Oreg.	Benson Polytechnic School	100W	Shares with KXL.
KORE	Eugene, Oreg.	Frank L. Hill and C. G. Phillips, doing business as Eugene Broadcast Station.	100W	Unlimited.
KFQW	Seattle, Wash.	KFQW (Inc.)	100W	Do.

1430 KILOCYCLES

WHP	Harrisburg, Pa. T—Lemoyne, Pa.	WHP (Inc.)	500W 1KW-LS	Shares with WBAK and WCAH.[35a]
WBAK	Harrisburg, Pa.	Pennsylvania State Police, Commonwealth of Pennsylvania.	500W 1KW-LS	Shares with WHP.
WCAH	Columbus, Ohio.	Commercial Radio Service Co.	500W	Shares with WHP and WBAK.[35a]
WGBC	Memphis, Tenn.	Memphis Broadcasting Co.	500W	Shares with WNBR.
WNBR	Memphis, Tenn.	Memphis Broadcasting Co.	500W	Shares with WGBC.
KGNF	North Platte, Nebr.	Herbert Logan Spencer	500W	Daytime.
KECA	Los Angeles, Calif.	Pacific Development Radio Co.	1KW	Unlimited.

1440 KILOCYCLES

WHEC-WABO	Rochester, N. Y.	Hickson Electric & Radio Corporation	500W	Shares with WOKO.[35a]
WOKO	Poughkepsie, N. Y. T—Mount Beacon, N. Y.[30]	WOKO (Inc.)	500W	Shares with WHEC-WABQ.[35a]
WCBA	Allentown, Pa.	B. Bryan Musselman	250W	Shares with WSAN.
WSAN	Allentown, Pa.	Allentown Call Publishing Co. (Inc.)	250W	Shares with WCBA.
WBIB	Greensboro, N. C.	North Carolina Broadcasting Co. (Inc.)	500W	Unlimited.
WTAD	Quincy Ill,	Illinois Stock Medicine Broadcasting Corporation.	500W	Shares with WMBD.
WMBD	Peoria Heights, Ill.	E. M. Kahler (owner Peoria Heights Radio Laboratory.	500W 1KW-LS	Shares with WTAD.
KLS	Oakland, Calif.	E. N. and S. W. Warner, doing business as Warner Bros.	250W	Daytime.

1450 KILOCYCLES

WBMS	Hackensack, N. J.	WBMS Broadcasting Corporation	250W	Shares with WNJ, WHOM, and WKBO.
WNJ	Newark, N. J.	Radio Investment Co. (Inc.)	250W	Shares with WBMS, WHOM, anud WKBO.
WHOM	Jersey City, N. J.	New Jersey Broadcasting Corporation	250W	Shares with WNJ, WBMS, and WKBO.
WKBO	Jersey City, N. J.	Camith Corporation	250W	Shares with WNJ, WHOM, and WBMS.
WSAR	Fall River, Mass.	Doughty & Welch Electric Co. (Inc.)	250W	Unlimited.
WGAR	Cleveland, Ohio	WGAR Broadcasting Co.	500W	Do.
WTFI	Toccoa, Ga.	Toccoa Falls Institute	500W	Do.
KTBS	Shreveport, La.	Tri State Broadcasting System (Inc.)	1KW	Do.
WJSV	Alexandria, Va. T—Mt. Vernon Hills, Va.	Independent Publishing Co.	10KW	Do.
KSTP	St. Paul, Minn. T—Westcott, Minn.	National Battery Broadcasting Co.	10KW	Do.

1470 KILOCYCLES

WLAC	Nashville, Tenn.	Life and Casualty Insurance Co.	5KW	Unlimited.
KGA	Spokane, Wash.	Northwest Broadcasting System (Inc.)	5KW	Do.

1480 KILOCYCLES

WKBW	Buffalo, N. Y. T—Amherst, N.Y.	WKBW (Inc.)	5KW	Unlimited.
KFJF	Oklahoma City, Okla.	National Radio Manufacturing Co.	5KW	Do.

1490 KILOCYCLES

WCKY	Covington, Ky. T—Crescent Springs, Ky.	L. B. Wilson (Inc)	5KW	Shares with WJAZ and WCHI.
WJAZ	Mt. Prospect, Ill.	Zenith Radio Corporation	5KW	Shares with WCKY and WCHI.
WCHI	Chicago Ill. T—Batavia, Ill.	Peoples Pulpit Association	5KW	Shares with WJAZ and WCKY.

1500 KILOCYCLES

WMBA	Newport, R. I.	LeRoy Joseph Beebe	100W	Unlimited.
WLOE	Boston, Mass. T—Chelsea, Mass.	Boston Broadcasting Co.	100W 250W-LS	One-half time.
WNBF	Binghamton, N. Y.	Howitt-Wood Radio Co. (Inc.)	100W	Unlimited.
WMBQ	Brooklyn, N. Y.	Paul J. Gollhofer	100W	Shares with WLBX, WCLB, and WWRL.
WCLB	Brooklyn, N. Y.	Arthur Faske	100W	Shares with WLBX, WMBQ, and WWRL (C. P. only).
WLBX	Long Island City, N. Y.	John N. Brahy	100W	Shares with WMBQ, WCLB, and WWRL.
WWRL	Woodside, N. Y.	Long Island Broadcasting Corporation	100W	Shares with WMBQ, WLBX, and WCLB.
WSYB	Rutland, Vt.	H. E. Seward, jr., and Philip Weiss, doing business as Seward & Weiss Music Co.	100W	Unlimited.
WKBZ	Ludington, Mich.	Karl L. Ashbacker	50W	Do.
WMPC	Lapeer, Mich.	First Methodist Protestena Church of Lapeer	100W	Do.
WPEN	Philadelphia, Pa.	Wm. Penn Broadcasting Co.	100W 250W-LS	Do
WWSW	Pittsburgh, Pa.	William S. Walker	100W	Unlimited (C. P. only).
WOPI	Bristol, Tenn.	Radiophone Broadcasting Station WOPI (Inc.)	100W	Unlimited.
WDDIX	Tupelo, Miss.	North Mississippi Broadcasting Corporation	100W	Do.
WRDW	Augusta, Ga.	Musicove (Inc.)	100W	Do.
KGFI	Corpus Christi, Tex.	Eagle Broadcasting Co (Inc.)	100W 250W-LS	Unlimited.
KUT	Austin, Tex.	Rice Hotel	100W	Do.
KGKB	Brownwood, Tex.	E. M., C. T., and E. E. Wilson, doing business as Eagle Publishing Co.	100W	Do.
KGIZ	Grant City, Mo.	Grant City Park Corporation	50W[37]	Do.
KGKY	Scottsbluff, Nebr.	Hilliard Co. (Inc.)	100W	Do.
WKBV	Connersville, Ind.	William O. Knox, trading as Knox Battery & Electric Co.	100W 150W-LS	Do.
KGFK	Moorehead, Minn.	Red River Broadcasting Co. (Inc.)	50W	Do.
KPJM	Prescott, Ariz.	A. P. Miller and George R. Klahn, doing business as Miller & Klahn.	100W	Do.
KXO	El Centro, Calif.	E. R. Irey and F. M. Bowles	100W	Do.
KDB	Santa Barbara, Calif.	Dwight Faulding	100W	Do.
KREG	Santa Ana, Calif.	Pacific-Western Broadcasting Federation (Ltd.)	100W	Do.
KPQ	Wenatchee, Wash.	Wescoast Broadcasting Co. Ct	50W	Do.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912,

Of Radio World published weekly at New York, N. Y. for April 1, 1931.

State of New York }
County of New York } ss.

Before me, a Notary Public in and for the State and county aforesaid, personally appeared Roland Burke Hennessy, who, having been duly sworn according to law, deposes and says that he is the Editor of the Radio World, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 411, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor and business managers are: Publisher Hennessy Radio Publications Corp., 145 West 45th St., N. Y. C. Editor Roland Burke Hennessy, 145 West 45th St., N. Y. C. Managing Editor Herman Bernard, 145 West 45th St., N. Y. C. Business Manager, Herman Bernard, 145 West 45th St., N. Y. C.

2. That the owner is: (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of the stockholders owning or holding one per cent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a firm, company, or other unincorporated concern, its name and address, as well as those of each individual member, must be given.) Hennesy Radio Publications Corp., 145 West 45th St., N. Y. C. Roland Burke Hennessy, 145 West 45th St., N. Y. C. Mrs. Mary J. McArthur, Edgewater Manor, 9828 Lake Avenue, Cleveland, O.

3 That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent, or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state.) None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

5. That the average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers, during the six months preceding the date shown above is ..... weekly. (This information is required from daily publications only.)

ROLAND BURKE HENNESSY.
(Signature of Editor.)

Sworn to and subscribed before me this 30th day of March, 1931.

[Seal.] HARRY GERSTEN.

Notary Public, Kings Co. Clks. No. 121, Reg. No. 2133, N. Y. Co. Clks. No. 214,, Reg. No. 2-G-153. My commission expires March 30, 1932.

Note.—This statement must be made in duplicate and both copies delivered by the publisher to the postmaster, who shall send one copy to the Third Assistant Postmaster General (Division of Classification). Washington, D. C., and retain the other in the files of the post office. The publisher must publish a copy of this statement in the second issue printed next after its filing.

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SHORT WAVE STATIONS BY FREQUENCIES —with schedule of hours on the air given for the five time zones. This valuable information appeared in Radio World dated March 28, 1931; mailed on receipt of 15c in stamps or coin. Or send your subscription starting with this issue. Radio World, 145 W. 45th St., N. Y. City.

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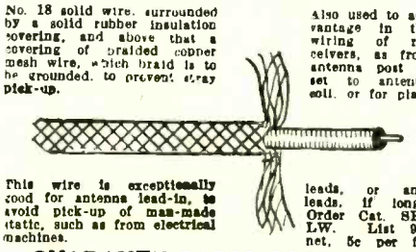

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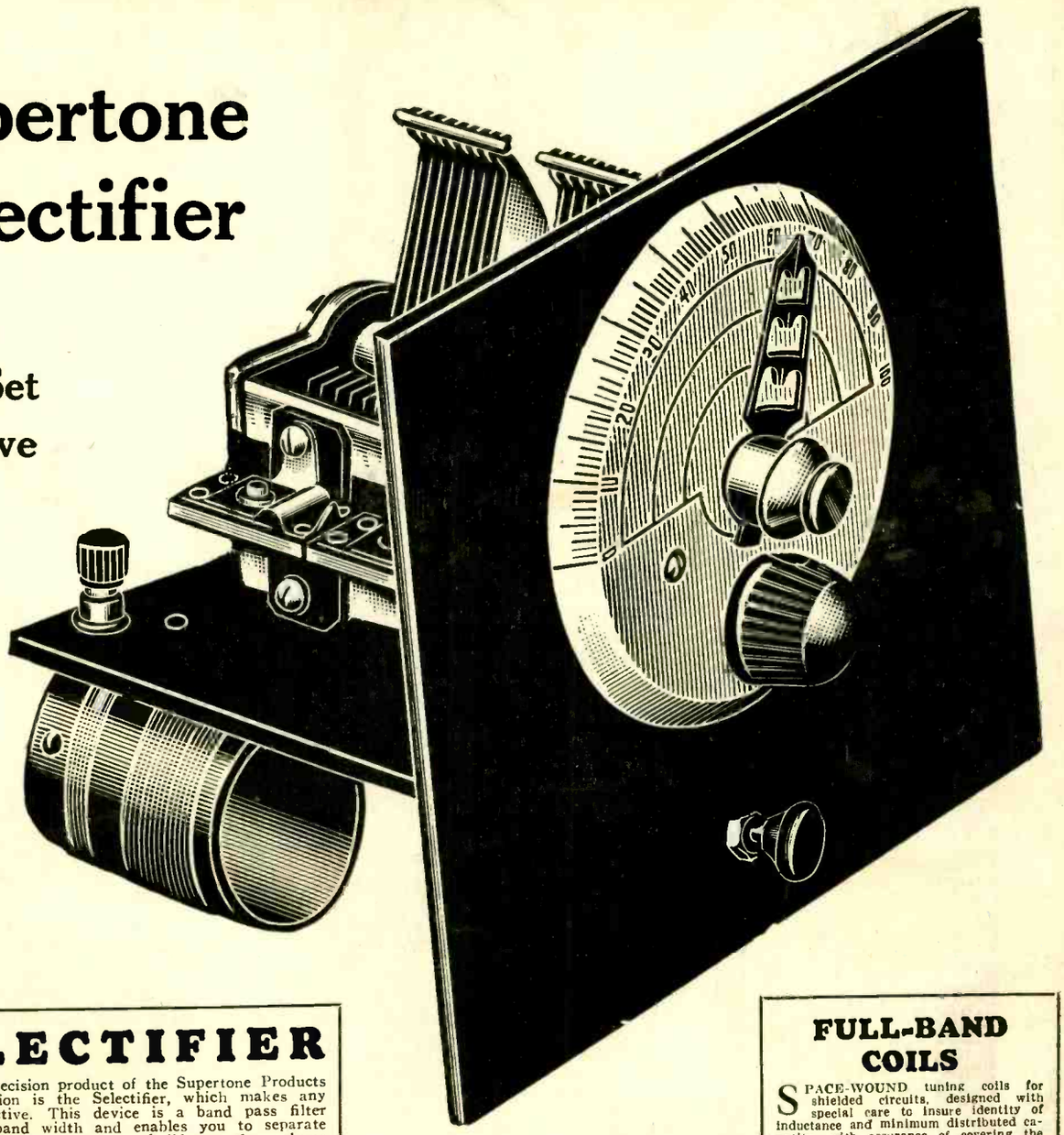

SELECTIFIER

A NEW precision product of the Supertone Products Corporation is the Selectifier, which makes any set selective. This device is a band pass filter with 10 kc. band width and enables you to separate any station from any other, build up the volume of weak stations, subdue powerful locals so they are no longer troublesome, and bring in far greater distance, and more of it, than you ever thought possible with your set.

Many persons own sets excellent in every respect, except for insufficient selectivity. Why not capitalize on the heavy investment already made, by installing a Selectifier, and rid yourself forever of interference from other stations, due either to cross-talk or crossmodulation?

By tuning the Selectifier to the same frequency as that of an interfering station, that interference is totally eliminated. By tuning the Selectifier to the frequency of a desired station, the volume of that station is approximately doubled.

Not only is the Selectifier an interference eliminator and volume booster, but it is also an accurate frequency meter for broadcast frequencies, since the tuning curve is obtainable. A conversion table, also furnished, makes the Selectifier a wave meter, so you can tell either wavelength or frequency.

So, even if your set is not calibrated in kilocycles or meters, you can tune the Selectifier to the desired frequency or wavelength, and then turn the dial of your set without looking at that dial, to bring in the desired station.

There are only three connections to make: (1) Remove the aerial from the antenna post of your receiver and connect it instead to the antenna wire of the Selectifier; (2) Connect a wire from the ground of your set, leaving ground connected there, to the ground wire of the Selectifier; (3) Connect the output wire of the Selectifier with a wire to the vacated antenna post of your set.

The Selectifier, a band pass filter pretuner, has two ganged tuned circuits. No tubes are used in it.

Get one of these new Selectifiers right away! Enjoy real selectivity without sideband-cutting. Modernize your set by endowing it with a band pass filter.

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A DOUBLY tuned fixed-frequency transformer, 1 to 1 ratio, tuned to 175 kilocycles, is another of Supertone's new precision products. Two loosely coupled duolateral-wound high-inductance choke coils constitute primary and secondary. Suitable for all uses where 175 kilocycle frequency is desired, and affording high selectivity, without sideband cutting. The transformer may be mounted on the side of a chassis, in horizontal position, or upright either above or below the chassis top.

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These coils are wound on 1¾ inch diameter natural Spaulding bakelite, threaded for space-wound secondaries, while primaries are wound in a slot. Space winding is essential, where ganged tuning condensers are used, for perfect matching. Colored wire outleads, 6 inches long, are soldered at the factory to the coil terminal rivets, shielded wire being used, however, for control grid connections. Code and instructions are contained in each coil box.

With each coil is supplied a drawn aluminum finished shield, 3 inch diameter, 3¾ inches high.

ANTENNA COIL for all circuits, also interstage coil where the primary is in the plate circuit of a general purpose tube; shield, hardware. Order Cat. 15-85, net price.....$2.50

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OSCILLATOR COIL, consisting of secondary, fixed tickler and small pickup coil winding, each winding wholly independent of the others; shield, hardware. Order Cat. 8-30-85, net price.$2.75

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