OCT. 19TH 1929

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RADIO WORLD

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The First and Only National Radio Weekly

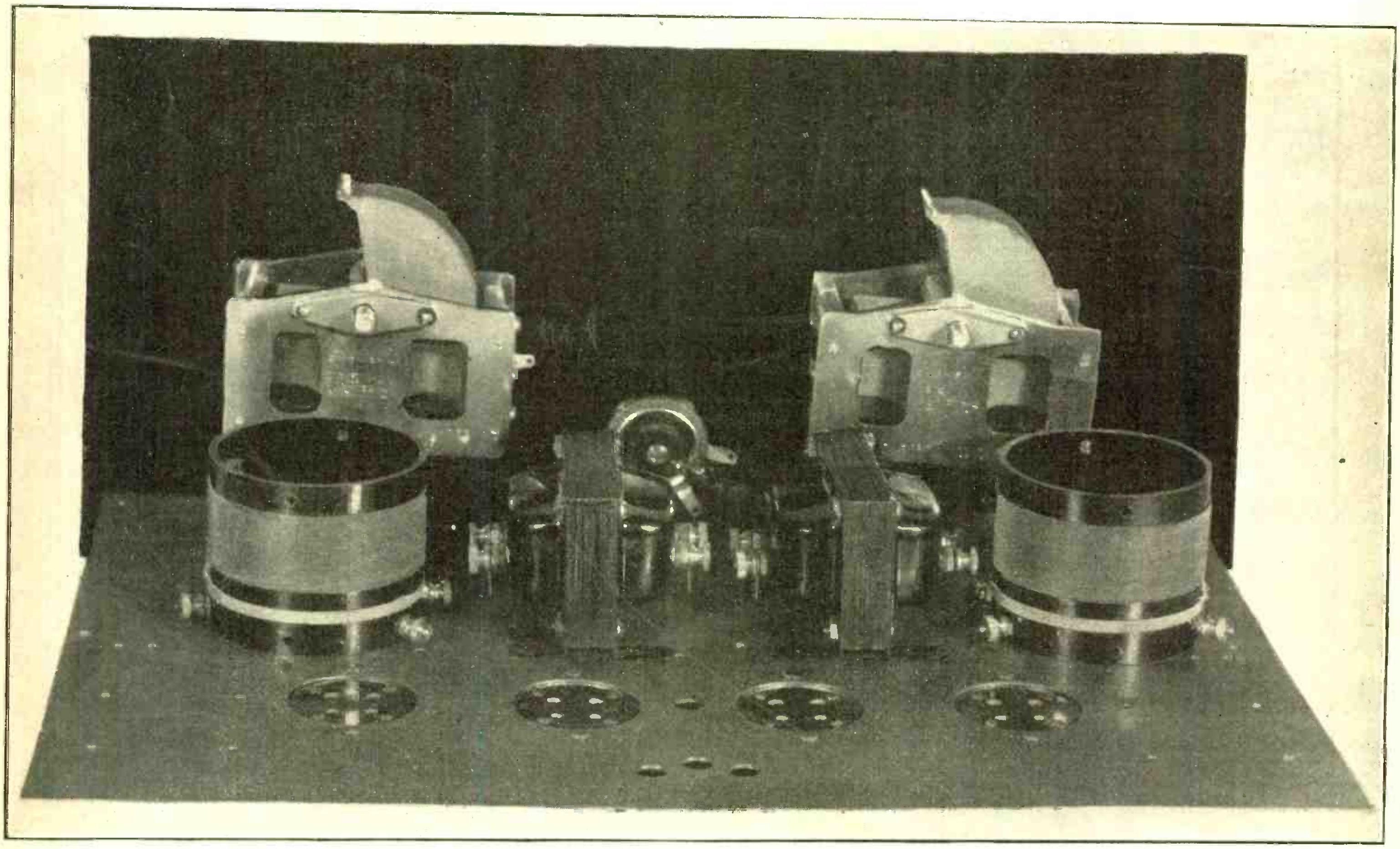
395th Consecutive Issue—EIGHTH YEAR

PRINCIPLE OF TUBE VOLTMETER

MIXING CIRCUITS FOR SUPERHETERODYNE

PUSH-PULL BATTERY DIAMOND

FOUR TUBE CIRCUIT PARTS COST $11.72



This Power Tube Circuit Is a Good Performer, Despite Very Low Cost to Construct. It is an attractive loudspeaker receiver for Schoolboys. See p. 3.

How to Get Detection by Bias Method	This Year's Audio-Frequency Amplification	Board Queries Big Stations on Wave Use	Ten Questions for You to Answer

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

Rider Lifts a **BIG** *Load Off the Service Man's Chest!*

In New Book Noted Radio Engineer Devotes 240 Pages to Trouble Shooting in All Receivers and Gives the Wiring Diagrams of Factory-Made Sets in 200 Illustrations—You Can Carry This Book Around With You—No More Torture Tracing Out Circuits.

JOHN F. RIDER
Member, Institute of Radio Engineers

"Trouble Shooter's Manual" *By John F. Rider*

JUST OUT!

The first comprehensive volume devoted exclusively to the topic uppermost in every service man's mind is "Trouble Shooter's Manual," just published. It is not only a treatise for service men, telling them how to overcome their most serious problems, and fully diagramming the solutions, but it is a course in how to become a service man. It gives all the details of servicing as they have never been given before. Finding the right mode of attack, applying the remedy promptly and obtaining the actual factory-drawn diagrams of receivers always have been a load on the service man's chest. But no more. Rider, expert on trouble shooting, has produced the outstanding volume on servicing, and has taken the load off the service man's chest!

This book is worth hundreds of dollars to any one who shoots trouble in receivers—whether they be factory-made, custom-built or home-made receivers. The home experimenter, the radio engineer, the custom set-builder, the teacher, the student,—all will find this new book immensely informative and absolutely authoritative.

Wiring Diagrams of *All* These Receivers!

Besides 22 chapters covering thoroughly the field of trouble shooting, this volume contains the wiring diagrams of models, as obtained direct from the factory, a wealth of hitherto confidential wiring information released for the first time in the interest of producing better results from receivers. You will find these diagrams alone well worth the price of the book. The wiring diagrams are of new and old models, of receivers and accessories, and as to some of the set manufacturers, all the models they ever produced are shown in wiring diagrams! Here is the list of receivers, etc., diagrams of which are published in this most important and valuable book:

R. C. A.
60, 62, 20, 64, 30, 105, 51, 16, 32, 50, 25 A.C., 28 A.C., 41, Receptor S.P.U., 17, 18, 33.

FEDERAL
Type F series filament, type E series filament, type D series filament, Model K, Model H.

ATWATER-KENT
10B, 12, 20, 30, 35, 48, 32, 33, 49, 38, 36, 37, 40 42, 52, 50, 44, 43, 41 power units for 37, 38, 44, 43, 41.

CROSLEY
XJ, Trirdyn 3R3, 601, 401, 401A, 608, 704, B and C supply for 704, 704A, 704B, 705, 706.

ZENITH
39, 39A, 392, 392A, 40A, 35PX, 35APX, 352PX, 352APX, 37A, 35P, 35AP, 352P, 352AP, 34P, 342P, 33, 34, 35, 35A, 342, 352, 352A, 362, 31, 32, 333, 353A, power supply ZE17, power supply ZE12.

MAJESTIC
70, 70B, 180, power pack 7BP3, 7P6, 7P3 (old wiring) 8P3, 8P6, 7BP6.

FRESHMAN
Masterpiece, equaphase, G, G-60-S power supply, L and LS, Q15, K, K-60-S power supply.

FADA
50/80A receivers, 460A Fada 10, 11, 30, 31, 10Z, 11Z, 30Z, 31Z, 16, 17, 32, 16Z, 32Z, 18, special, 192A-192S and 192BS units, R80A, 480A, and SF 50/80A receivers, 460A receiver and R60 unit, 7 A.C. receiver, 475 UA or CA and SF45-75 UA or CA, 50, 70, 71, 72, C electric unit for special and 7 A.C. receivers, ABC 6 volt tube supply, 86V and 82W, E180Z power plant and E 420 power plant.

FREED-EISEMANN
NR5, FE18, NR70, 470, N R 5 7, 457, NR11, NR80 DC.

STEWART-WARNER
300, 305, 310, 315, 320, 325, 500, 520, 525, 700, 705, 710, 715, 720, 530, 535, 750, 801, 802, 806.

GREBE
MU1, MU2, synchrophase 5, synchrophase A C 6, synchrophase AC7, Deluxe 428.

PHILCO
Philco-electric, 82, 86.

KOLSTER
4-tube chassis used in 6 tube sets, tuning chassis for 7 tube sets, power amplifier, 7 tube power pack and amplifier, 6 tube power pack and amplifier, rectifier unit K23.

STROMBERG-CARLSON
1A, 2B, 501, 502, 523, 524, 635, 636, 403AA power plant, 404 RA power plant.

ALL-AMERICAN
6 tube electric, 8 tube 80, 83, 84, 85, 86, 88, 6 tube 60, 61, 62, 65, 66, 6 and 8 tube A.C. power pack.

DAY FAN
OEM7, 4 tube, 5-5 tube 1925 model, Day Fan 8 A.C., power supply for 6 tube A.C., B power supply 5524 and 5525, motor generator and filter, 6 tube motor generator set, 6 tube 110 volt D.C. set, 6 tube 32 volt D.C. set.

COLONIAL
26, 31 A.C., 31 D.C.

WORKRITE
8 tube chassis, 6 tube chassis.

AMRAD
70, 7100, 7191 power unit.

SPARTON
A.C. 89.

MISCELLANEOUS
DeForest F5, D10, D17, Super Zenith Magnavox dial, Thermyodyne, Grimes 4DL inverse duplex, Garod neutrodyne, Garod EA, Ware 7 tube, Ware type T, Federal 102 special, Federal 59, Kennedy 220, Operadio portable, Sleeper RX1, Armad inductrol.

Here are the 22 chapter headings:

SERVICE PROCEDURE
PRACTICAL APPLICATION OF ANALYSIS
VACUUM TUBES
OPERATING SYSTEMS
AERIAL SYSTEMS
"A" BATTERY ELIMINATORS
TROUBLES IN "A" ELIMINATORS
TROUBLE SHOOTING IN "A" ELIMINATORS
"B" BATTERY ELIMINATORS
TROUBLES IN "B" BATTERY ELIMINATORS
TROUBLE SHOOTING IN "B" BATTERY ELIMINATORS
SPEAKERS AND TYPES
AUDIO AMPLIFIERS
TROUBLE SHOOTING IN AUDIO AMPLIFIERS
TROUBLES IN DETECTOR SYSTEMS
RADIO FREQUENCY AMPLIFIERS
TROUBLE SHOOTING IN RF AMPLIFIERS
SERIES FILAMENT RECEIVERS
TESTING, AND TESTING DEVICES
TROUBLES IN DC SETS
TROUBLES IN AC SETS

Some of the Questions Settled in Book:

Securing information from the receiver owner, list of questions, practical chart system of repairs, circuits and operating conditions.

Repairs in the home, method of operation, spare tubes, the process of elimination, recognizing symptoms, examples of practical application, tracing distortion, tracing electrical disturbances; vacuum tube tests; neutralizing systems, filament circuits, grid circuits, methods of securing grid bias, plate circuits; long aerials, short aerials, selectivity, imperfect contact, directional qualities, grounds; "A" battery eliminator types, design, operating limitations, requirements for perfect operation, AC eliminators, DC eliminators; "A" elminator hum, reasons, voltage, reasons, noise; full wave, half wave, B battery eliminators, filament rectifiers, gaseous rectifier, dry disc rectifier, wiring, parts used, design, voltage regulation, operating limitations, requirements for perfect operation, combination filament and plate voltage eliminators, AC and DC types; B battery eliminator output current and voltage, excessive hum, dead eliminator, poor design, reasons for defects, motorboating, punctured condensers, shorted chokes, voltage regulator tubes, function of filter system, C bias voltages, voltage divider systems, filter condensers, by-pass condensers, voltages in the system; determining voltages in B eliminators, AC, DC, voltage drop, effect of shorted filter system, defective rectifiers, defective transformer, defective chokes, defective by-pass condenser, design of filter system, defective voltage divider network, relation between hum and output voltage, isolation of troubles, external filters, noise filters; cone, dynamic, exponential speakers, troubles, dead, weak output, distorted output, rattle, continuity testing, windings, magnets, frequency filters, testing, chokes, condensers, hum elimination;! audio amplifier types, transformer, resistance, impedance, auto-transformer, combinations, requirements for perfect operation, operating limitations, tubes, forms of coupling, plate voltage, grid voltage, filament voltage, isolating condensers, voltage reducing resistances, noises, analysis of trouble, plate current, grid current.

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(Just East of Broadway)

Enclosed please find:

☐ $3.50 for which please send me postpaid "Trouble Shooter's Manual," by John F. Rider, being Part II of "Service Man's Manual." 240 pages, 8½x11", more than 200 illustrations, including wiring diagrams of commercial receivers as advertised; imitation leather cover, gold lettering.

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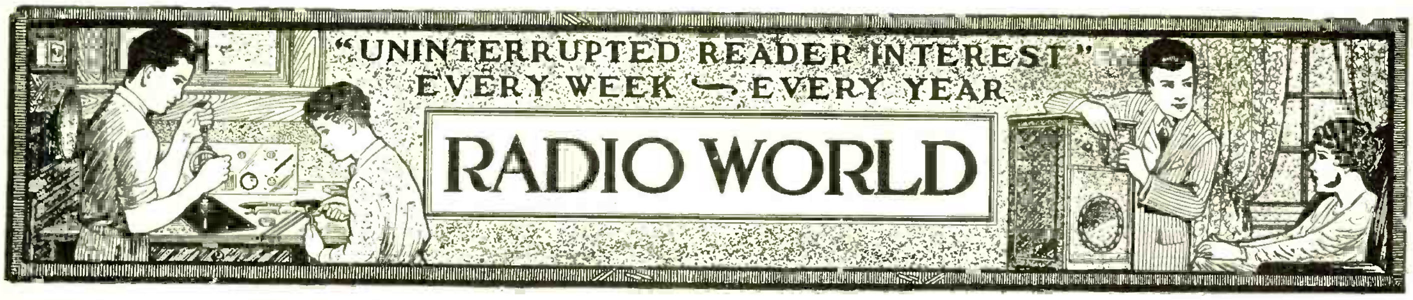
"The Mathematics of Radio"

John F. Rider wrote two companion books grouped under the title "Service Man's Manual." The first was "Mathematics of Radio," the second "Trouble Shooter's Manual." The value of one of these books is more than doubled by the possession of the other.

"The Mathematics of Radio," 128 pages, 8½x11", 119 illustrations, bridges the gap between the novice and the college professor. It gives a theoretical background so necessary for a proper understanding of radio and audio circuits and their servicing.



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Latest Circuits and News

EIGHTH YEAR

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Schoolboy's Economy 4

Good Performance Assured, Using 201A and 112A Tubes

By Jack Tully

SATISFACTORY performance indeed may be obtained from a four-tube circuit consisting of two circuits tuned at radio frequencies and two circuits coupled by iron-core transformers at audio frequencies. The first tube is the radio frequency amplifier. The second tube is the detector, using a grid leak and grid condenser. The third tube is the first audio tube. The fourth and last tube is a semi-power tube, the 112A. The three other tubes are 201A, so that not only is the cost of the parts extremely low ($11.72) but the tubes are the lowest-priced ones you can obtain, for amplifying and detecting purposes, while the semi-power tube is as low in price as any other in the output group of tubes. A maximum of 135 volts is required, furnished by B batteries or a B eliminator, while a six volt storage battery heats the tube filaments.

That is the summarized picture of the circuit and its components. For tuning purposes two .00035 mfd. condensers are used, each actuated by a separate dial. Both of these coils have the same type of windings. The primary is the small winding and consists of 14 turns. The secondary is the large winding and consists of 60 turns. There is 1/4" separation between the two windings. The diameter is 2 1/2" and the wire is No. 24 silk insulated.

Compact Assembly

The receiver is compact. A 7 x 14" front panel is large enough. The baseboard should be 13 1/2" x 8 1/2". The tuning condenser holes are 7/16" in diameter, 7 1/2" apart and 4" up, so that that these holes are 3¾" from a line drawn down the middle of the front panel. The locknut that holds the adjustment of the condenser rotor plates is used for single hole mounting, but it is necessary that the front panel be no thicker than ⅛", to insure the nut biting the thread on the shank.

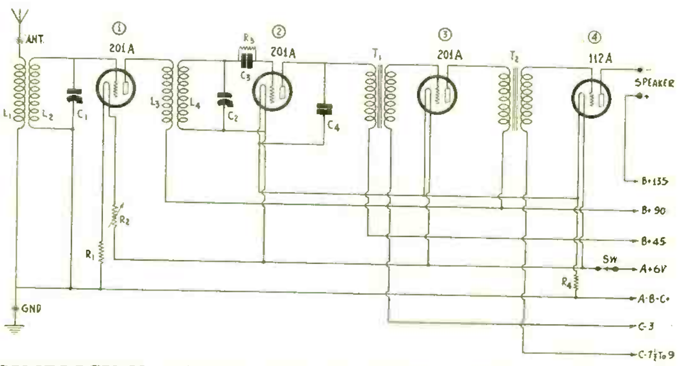
The volume control is a 30 ohm. rheostat, in which a switch is built, for turning the set on and off. The hole for the rheostat-switch is 1½" up on the middle line, and the size is 7/16" also.

At left and right behind the subpanel, but attached to the baseboard, are the two tuning coils. These are electrically connected as shown in the schematic diagram. The two audio transformers, each 3-to-1 ratio, are placed between the coils, and a neat appearance results, especially as the sockets are in line at rear. The antenna and ground binding posts are the lugs on the antenna winding, while the speaker posts are at center rear.

Speaker Set for Schoolboys

This circuit is a good one, and will not only provide satisfaction but delight. Schoolboys will find it just the type of loudspeaker-operating receiver they have been looking for, particularly as the cost is within their means, and when they have finished the wiring and tuned in some stations they will know that they have a real, honest-to-goodness receiver.

Now, as to what can be received. No great expectations should be encouraged of reception of distant stations. A great many who build this receiver will tune in plenty of distance, enough to boast of the DX, but it is a certainty that all the locals will come in fine under any conditions, and steady reception on the speaker over a rage of 100 to 150 miles may be expected. Of course 1,000 miles will be reached by many, but as that will not be the rule, it can not be promised. Whatever is received will come in plenty loud enough, for the sensitivity in the radio level is good, while the gain at audio frequencies is sufficient.



SIMPLICITY MARKS THE ECONOMY FOUR, WHICH IS NOT ONLY COMPACT BUT INEXPENSIVE. THE PARTS FOR THIS RECEIVER COST ONLY $11.72. SATISFACTORY LOUDSPEAKER OPERATION IS ASSURED.

Separately Tuned Circuits

Two separately tuned circuits should be used, as prescribed, instead of single control, because a little extra sensitivity results, and it is needed to keep the performance of the circuit at a reasonably high level. Also the detector must be of the leak-condenser type. That is the easiest one to hook up for the immediate production of loud signals. Other types of detection, while they have excellent

LIST OF PARTS

L1L2, L3L4—Two RF3 radio frequency transformers.
C1, C2—Two .00035 mfd. tuning condensers.
C3—One .00025 mfd. mica grid condenser with clips.
C4—One .00025 mfd. mica condenser.
R1—One 4 ohm filament resistor.
R2, SW—One switched rheostat, 30 ohms.
R3—One 5 meg. grid leak.
R4—One 1.3 ohm filament resistor.
T1, T2—Two audio frequency transformers.
(1), (2), (3), (4)—Four UX 4-prong sockets.
Sp. (—), Sp.(+)—Two binding posts.
Nine wires for cable.
Two dials
One 7x14" front panel.
One 8½"x13½" subpanel.
Three 201A tubes and one 112A tube.
One 6-volt storage battery.
Three 45-volt B batteries.
One 7½-volt battery, tapped at 3 volts.

Where Bypass Helps Much

Detector Condenser Placed from Plate to Filament Minus

(Continued from preceding page)

purposes in other receivers, are not suitable for this one. The sensitivity of the leak-condenser detector is well known. Power detection requires much radio frequency amplification and is not to be considered in connection with the present circuit.

The baseboard you can obtain from any woodworking shop or cabinet maker. The front panel is standard and you can drill the three main holes as previously directed. Also two or three equidistant small holes should be drilled along the bottom of the front panel to permit insertion of wood screws, so the front panel may be affixed to the baseboard.

Next mount the coils, sockets, audio transformers and the two fixed filament resistors. Put the two binding posts in place.

The binding post mounting may be accomplished by drilling a hole for each post through the baseboard, and countersinking at the bottom of the baseboard, to afford room to attach the nut that will hold the binding post in place.

The coils are examined before being wired, so that you can see where the respective terminals come out to lugs. The beginning of one winding adjoins the end of the other. Then there are two extreme points. Connect the first coil, L1L2, so that the adjoining terminals of the windings go to ground. Connect the other coil, L3L4, so that the adjoining terminals go to B plus and A plus, respectively. Thus in both instances the grids are connected to outer terminals of the windings, and so are antenna and plate.

Filament Resistors

Notice that the first tube, the radio frequency amplifier, has two resistors in its filament circuit. One is a fixed resistor, R1, of 4 ohms, and is in the negative leg. The other is the rheostat and is in the positive leg. This rheostat is the volume control, wholly adequate for this purpose.

The third filament resistor cuts down the voltage of the storage battery (six volts) to about the required five volts of the filaments of three tubes. The voltage need not be precisely 5 volts, as tolerance is permissible. Use of the specified resistors will give good results.

Use of the bypass condenser, C4, which is .00025 mfd., mica dielectric, improves the detecting efficiency by sidetracking radio frequencies while not impeding audio frequencies. This bypass condenser is not necessary with all types of tubes, and with tubes of very high amplification, such as the 222 and the 240, it is better omitted, but in the present circuit, with a 201A detector, it must be included. The circuit will work without it, but not as well.

The audio transformers have their windings marked, P and B representing the primary, connected in the plate circuit, P to plate and B to B plus, and G and F representing the necondary, with G to grid and F to C minus. As both audio transformers are the same, either one may be used in the first stage and the other in the second stage. The negative biases are different for the two stages. Notice this in the diagram.

No interaction will be suffered by the placement of the audio transformers as shown on the front cover, as it was tried out and proved highly successful. The gain is high enough, but not so high as to make one audio transformer back-couple to the other.

There are few special precautions to be taken. The rotors of the tuning condensers go to the "cold" side, that is, to A minus and A plus respectively, and these connections are represented by a condenser lug at which a pigtail terminates. The purpose of the pigtail is to insure perfect connection and conductivity between moving plates and frame, and not rely on friction affording this. The nut holding the pigtail lug may have to be removed and inserted backward, the excess snipped off, so that the condenser can be more securely mounted to the front panel.

This Side Is Hot

The "hot" side is represented by the grid, or G post of socket, in each instances. A lug at the side of the condenser is used for establishing this connection.

All leads should be soldered. The way to solder is to wipe a proposed joint clean, using alcohol on cotton batting or on a small rag, and if any muck is present which refuses to yield to this treatment, scrape off with a knife, or file it off. The proposed joint is then heated with the soldering iron, a tiny bit of soldering flux is placed on the joint, and then the solder is placed on the iron while the iron is against the joint. This is better practice than melting solder on the iron and carrying it over to the joint. Also the separate flux, with strip solder of 50-50 composition, serves excellently for radio purposes, and is handier in the long run than self-fluxing solder, which causes the iron to become greasy, and makes solder form beads and roll off.

Everything is so constituted that the placement of parts and the wiring are simplified and excellent results are bound to follow the exercise of reasonable care. Do your very best, make wires run neatly, instead of being scrambled in appearance, and solder carefully. Test each joint with a tug to be sure it's right. You will then be sure of a good receiver, one that will fill you with satisfaction and pride.

Right or Wrong?

[*Here are ten more questions. They are based on material published in last week's issue of* RADIO WORLD. *If you read that issue carefully you should be able to answer the questions. Verify your efforts by consulting the answers herewith. Next week's questions will be based on material published in this week's article.—Editor.*]

(1)—A push pull stage can be added advantageously to the screen grid Diamond of the Air, battery model.

(2)—Beats can occur only between tones of different frequencies.

(3)—The production of beat tones and heterodyne currents can take place only if the disturbances occur in a medium in which the amplitude of the disturbance is not proportional to the force causing it.

(4)—A radio frequency wave modulated by a single low frequency is physically composed of three different frequencies, the carrier and the two side frequencies, and no more.

(5)—When a circuit is tuned to the carrier frequency of a station it is also tuned to the side frequencies regardless of the values of these frequencies.

(6)—A characteristic curve is a graphical representation of the relation between two quantities which vary together according to some law.

(7)—A curve showing the relationship between dial settings and frequencies of broadcast stations is a characteristic curve of the tuner.

(8)—An audio frequency oscillator can be constructed by taking advantage of the beat between two radio frequencies.

(9)—A screen grid tube can be used as a detector by employing the screen grid tube as the control grid.

(10)—A stroboscope is an optical device for slowing down the apparent motion of any device that has a regular periodicity too fast for the eye to follow.

ANSWERS

(1)—Right. A push-pull stage can be added to any receiver, and if the circuit remains properly designed there will be a gain both in quality and volume.

(2)—Wrong. Beats can occur between any regular periodic disturbances such as waves on water, tones on air, alternating currents, two pendulums and many others. The difference between spring tides and neap tides is due to beats between the tides of the sun and the moon.

(3)—Right. This is essentially correct. This does not, however, mean that beats cannot occur.

(4)—This is the usual conception because mathematically or analytically a modulated wave is equivalent to the carrier and the two side frequencies provided certain factors are neglected. Actually there are many more components.

(5)—Wrong. This is only true approximately when the side frequencies differ but slightly, relatively, from the carrier. If the side frequencies differ much they are tuned out by the tuner just as effectively as if they had no relation to the carrier.

(6)—Right. If any two quantities I and E are related so that when E is given certain values, I assumes certain other values depending only the value of E in each instance, then a graph representing the relation is a characteristic curve, that is, it is characteristic of the device having the specified relation.

(7)—Right. In this case definite values are assigned to the frequency and certain dial settings follow because of the nature of the tuning condenser and the dial attached to it.

(8)—Right. A very satisfactory oscillator can be constructed in this manner for measurement purpose where a high order of constancy of frequency is not essential.

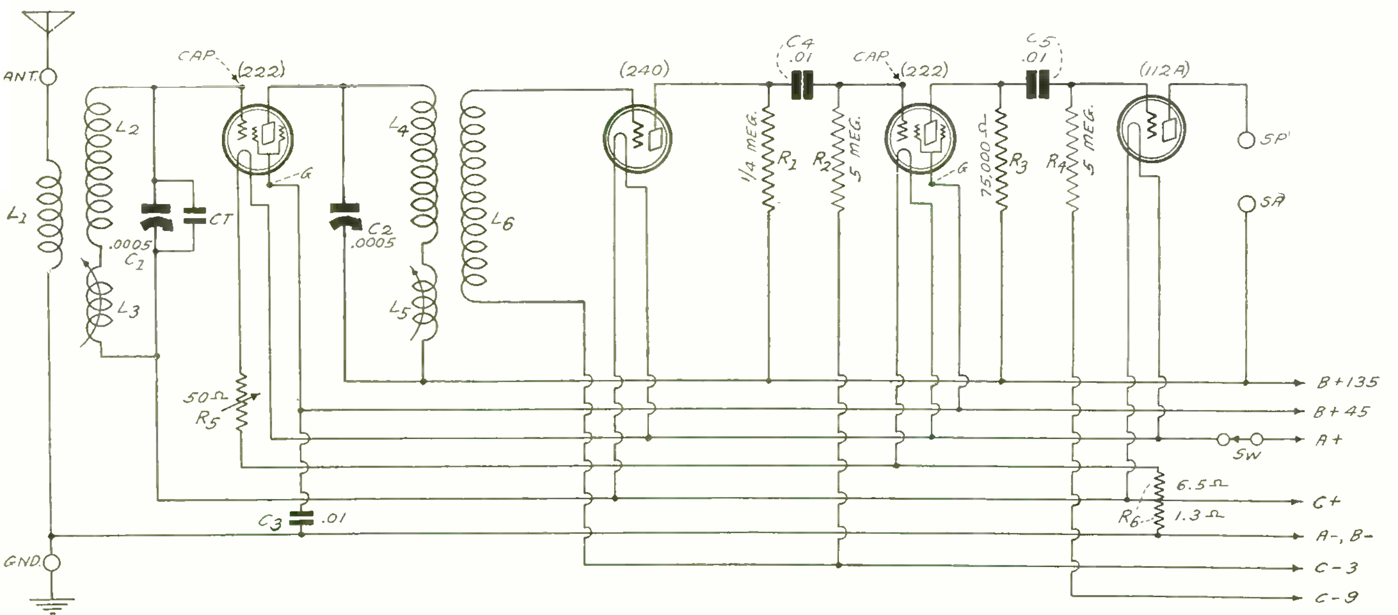
(9)—Right. This forms the space charge detector, which is a very good form of detector.

(10)—Right. A stroboscope is a device for bringing out optical beats between two visual periodic motions. Any such motion, such as the cogs in a gear spinning at a high speed, can be made to appear to move very slowly or even to stand still. This fact is often utilized in observing a piston running at high speed.

Leak-Condenser Detection

mines the Type of Carrier-Eliminator to Use

V. O'Rourke



THIS IS THE BATTERY MODEL HB COMPACT, USING SEMI-POWER DETECTION. IF C-3 DOES NOT DO THE TRICK, RETURN THE DETECTOR GRID TO DETECTOR NEGATIVE FILAMENT OR TO A GROUNDED .01 MFD. CONDENSER.

sturdy detector would be sorely overloaded, for this circuit is one of the most sensitive tuned radio frequency receivers ever developed.

Careful to Be Wrong

One man who built the MB29, despite the specification of 135 to 180 volts on the detector plate, severed this B plus lead from the others so he could carefully apply the wrong voltage of 45. Sensitivity and quality were of a low order. So would they be if the tubes were connected backward, as with plate inputs and grid outputs, or, alas, if the speaker were connected to antenna and ground, and the antenna and ground to power tube plate and B plus! There are many ways of doing things wrong. Often there are numerous ways of doing them right. But in this instance you can not gain anything by adventuring in the realms of forbidden voltages. The geometry of the tube is the imperial law of the circuit. The plate voltages must be high for power detection. That must be understood above all else.

Semi-Power Detection

As to semi-power detection, it is encouraging indeed to find so many experimenters interested in this, but not discouraging to find so many having trouble with, because the ground is unfamiliar to them.

When the low voltage type of negative grid bias detection is used, the negative bias becomes critical, if for no other reason than small differences in grid bias are hard to obtain from batteries.

If AC operation is used, then this critical aspect can be overcome in practice by use of an adjustable biasing resistor, or by providing means of applying different plate voltages. Large differences in plate voltages are more readily obtained than small differences in grid voltages, even in AC circuits, because of taps on the voltage divider, not because of greater ease of turning the knob of an adjustable resistor when it is in one circuit, as compared with the physical task when it is in another!

If detection difficulty is experienced in an AC circuit it is well to take the bias directly off the voltage divider, or if a separate biasing resistor is used, to introduce bleeder current, as was done in the MB29, an idea of Prof. Browning. Also, with battery-operated circuits the difficulty may be overcome by altering the bias specified or attempted. This may be done by connecting the grid return of the detector, instead of to a C battery voltage, to A minus itself, affording a bias equal to the voltage drop in the filament resistor, usually 1 volt (for 5-volt filament tubes served from a 6-volt storage battery). If a high mu tube is used with resistive load, it will be found a readier bias detector than a 201A tube. If difficulty is experienced with the 240, try these remedies:

(1) Reduce the plate voltage without changing the bias.

(2) Restore the plate voltage to what it was, and connect the grid return to negative filament of the detector tube.

(3) Let the grid return be unconnected to anything.

(4) Under the free grid and negative filament return experiments, vary the plate voltage, particularly downward from 135.

Good Detection With Free Grid

Good detection always can be obtained from a 240 tube with 135 volts on the plate, with a resistive load, and a grid returned to negative filament, or not conductively returned anywhere. There is actually a small negative bias, due to the grid's tendency to accumulate electrons.

In modest circuits, even where negative grid bias (semi-power) detection is specified, and assuming you can not obtain satisfactory results, do not condemn the system. Sometimes tubes have different characteristics, and bias voltages must be arranged accordingly. It would be possible to plot the curve of a tube, showing grid voltage compared with plate voltage, and predict the point at which any given tube will be best as a negative bias detector, but there is no need for that. The foregoing suggestions will simplify matters.

Somewhat better quality is afforded by negative bias detection on loud signals because the detector will stand higher signal amplitudes, as compared with a leak-and-condenser detector which overloads at lesser values of signal voltage. Those having circuits using two or three stages of general purpose tubes in RF amplifiers, or two stages or less of screen grid tubes, still may use leak-and-condenser without danger, so if you are stuck at the detecting end, where negative bias (semi-power) detection was specified, you can insert the leak and condenser and make the grid return positive.

Load, Not to Win Sensitivity Honors

Six Different Mixer Cir

Oscillator and Modulator Combinat

By Knollys

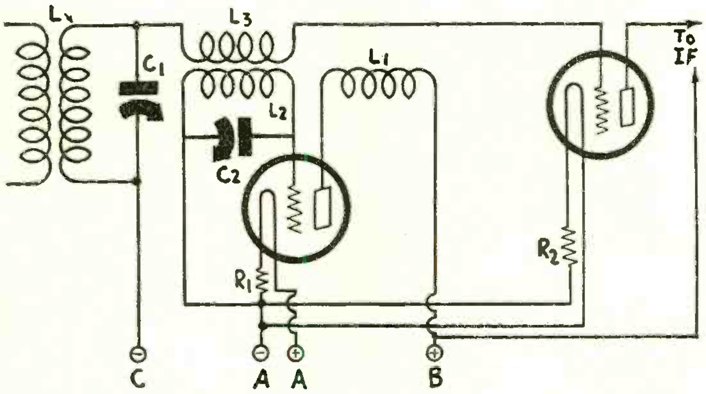


FIG. 3
THE MOST COMMON METHOD OF COUPLING THE OSCILLATOR TO THE MODULATOR IN A SUPERHETERODYNE. L_3 IS LOOSELY COUPLED TO THE RESONAND CIRCUIT

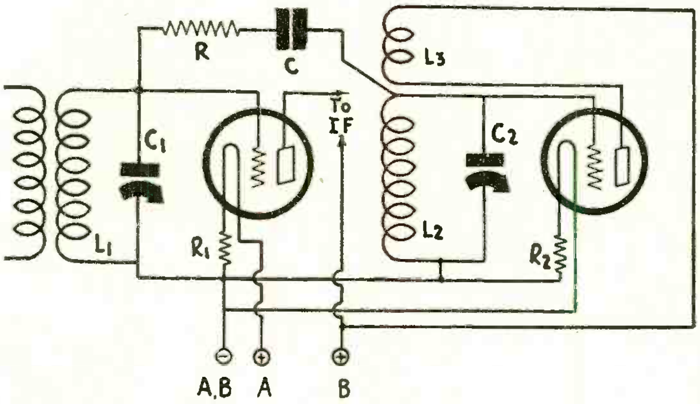


FIG. 4
A MODULATOR CIRCUIT IN WHICH THE OSCILLATOR IS COUPLED TO THE MODULATOR BY MEANS OF A HIGH RESISTANCE AND A SMALL CAPACITY.

[*This is the second of a series of articles on the Superheterodyne. Next week another.*]

For the purpose of explaining the operation of the Superheterodyne it will be convenient to assume for the time being that the signal to be received is unmodulated, or that it consists of the carrier frequency alone. Let this frequency be F_1 and let the frequency of the local oscillator be F_2. Voltages having these two frequencies are impressed simultaneously on the modulator tube in the receiver. The product of this modulation contains the frequencies F_1-F_2 and F_1+_2, the two side frequencies. The first of these is a difference between two radio frequencies, and is, therefore, a beat or heterodyne frequency. The second is a sum of two radio frequencies, and is, therefore, itself a radio frequency.

In practice these two frequencies are so widely different that they cannot be selected by the same tuning system. Receivers employing either of these frequencies can be built, and many have been constructed of both types. Every superheterodyne employs the beat frequency F_1-F_2. However, F_2, the local frequency, does not have to be the fundamental of the local oscillator frequency. One commercial superheterodyne made use of the second harmonic. How this can be done will be clear after the discussion of the effects of harmonics on the behavior of a superheterodyne.

The difference frequency F_1-F_2 will be referred to as the intermediate frequency, or simply IF, unless there is some reason for retaining the terms beat or heterodyne. Let the intermediate frequency be designated by f so that $f=F_1-F_2$.

The intermediate frequency filter or tuner is simply a selective arrangement which is tuned to the intermediate frequency f. It may consist of transformers with tuned secondaries, or with tuned primaries, or again it may consist of filters having both tuned primaries and secondaries. Again, it may consist of more complex filter systems which respond to a definite band of frequencies rather than a single frequency. Some of these filters are only variations or refinements of the simple tuned transformer system which in no way alter the principle of operation of the Superheterodyne.

The selectivity of the Superheterodyne depends primarily on the properties of the intermediate frequency filter. If this is selective, the receiver is selective; if it is broad, the receiver is broad. The lower the intermediate frequency, as a rule, the greater is the selectivity. However, high selectivity in the intermediate frequency amplifier is not at all a guaranty against interference from stations not desired. There are several reasons why the intermediate frequency. This is erroneous, for it has nothing to do with what lack of selectivity, why the frequency should not be very high. The choice of intermediate frequency for any Superheterodyne is always a compromise among several conflicting factors, and the exact value chosen in any case depends on the relative importance the designer attaches to these various factors.

Many think that the oscillator determines the intermediate frequency. This is erroneous because it has nothing to do with what the intermediate frequency is to be. It is merely one of the factors which jointly produce the frequency that is acceptable to the tuned filter system.

Yet the oscillator condenser is the main device for bringing in desired signals. When this condenser is turned the radio frequency generated by the oscillator changes continuously. Beats between this frequency and any other frequency that may be impressed on the modulator also change. Whenever the beat frequency between any signal frequency and the oscillator frequency happens to be that which is acceptable to the filter, the signal comes through and is amplified. Beats of all other frequencies are rejected.

The oscillator is the heart of the superheterodyne, and as long as it beats the receiver is alive. The sensitivity of the receiver depends to a large extent on how vigorously the oscillator works and how much energy it pumps into the modulator. The signal received is directly proportional to the product of the voltages impressed on the modulator by the carrier frequency of the signal and the oscillator. If either is reduced, the signal received is reduced also; and conversely, if either is increased, the output of the receiver is increased.

The intensity of either of these voltages depends on the degree of coupling between the source and the modulator. If the oscillator, for example, is closely coupled to the modulator the output of the receiver is strong for a given signal strength. If the coupling is loose, the output is weak. Indeed, if the coupling between the oscillator and the modulator is zero, the receiver is dead just as if the oscillator were not functioning and as if no carrier were present. The method of coupling the two frequencies with the modulator constitutes a major problem in design.

Countless coupling arrangements have been used, but only a few of the more typical can be presented. Six such arrangements are shown in Figs. 2 to 7. The points for and against each of these will be discussed.

Fig. 2 represents the autodyne, which is characterized by the fact that the oscillator tube is also the modulator. The coupling between oscillator and modulator is, therefore, unity, or just as high as it can be. In this particular arrangement the signal is impressed on the grid circuit of the oscillator by means of a choke coil Ch, and therefore the signal is also coupled very closely to the modulator.

There is no frequency discrimination in this case, and all signal carriers present are impressed on the modulator with practically the same intensity, provided they reach the antenna with the same intensity.

Usually a modulator of this type is extremely sensitive. Loudspeaker volume can be obtained when only one stage of IF, a detector and one stage of audio are used. Yet the circuit is practically useless because it cannot eliminate interference. For example, with a circuit of this type a low power local broadcasting station was brought in at 32 different points on the oscillator dial, and besides these definite points where the signal could be recognized without difficulty, there were many other points where the station could be recognized by the rhythm of the music emanating from it. Moreover, the circuit growled all over the dial.

The reason for the many "repeat points" and the growling was that the two beating frequencies were coupled too closely to the modulator. Beats of sufficient intensity to produce audible tones and noises were produced between harmonics of the oscillator and the signal carrier frequencies. If the multiplicity of repeat points and the growling are to be avoided, it is essential that harmonics be

cuits for Superheterodyne

ionsAre Analyzed and Compared

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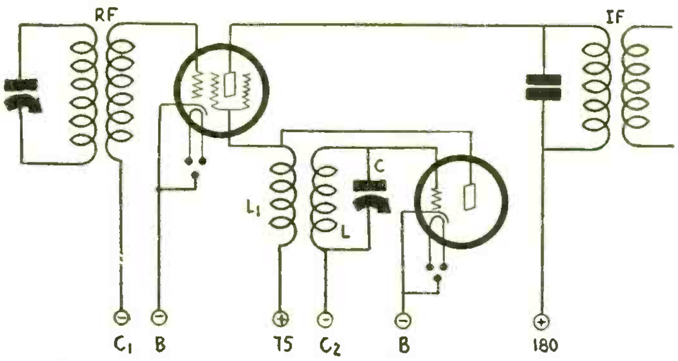


FIG. 5

A SCREEN GRID MODULATOR CIRCUIT IN WHICH THE OSCILLATOR IS COUPLED TO THE MODULATOR BY MEANS OF THE SCREEN GRID.

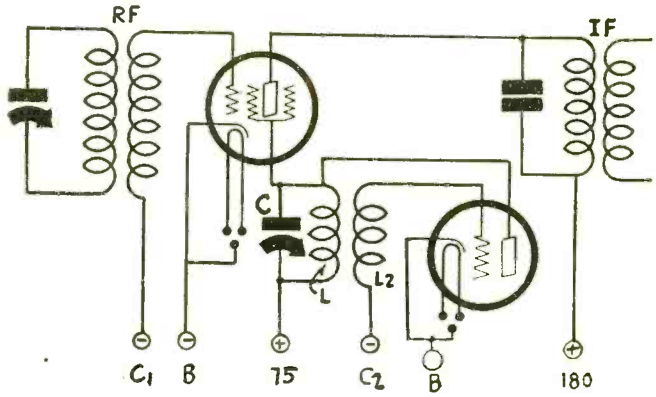


FIG. 6

AN IMPROVEMENT OVER THE CIRCUIT IN FIG 5 IN WHICH THE OSCILLATOR RESONANT CIRCUIT IS PLACED IN THE SCREEN GRID LEAD.

eliminated from the modulator as much as possible. This requires loose, selective coupling between the oscillator and the modulator, or it requires an oscillator which does not produce harmonics of appreciable intensity. Moreover, it is necessary to prevent generation of harmonics of the signal carrier frequency, which can be done by tuning and by adjusting the RF amplifier so that there is the least amount of detection in the circuit. The production of "repeats" will be discussed at some length in a subsequent section.

The circuit shown in Fig. 3 might be called the standard modulator, because it has been used more than any other, either as it is shown or in some of its many variations. The oscillator is a separate tube and the frequency generated is determined by L_2C_2. The signal carrier is selected by means of the tuned circuit LC_1 and is then impressed on the grid of the modulator, which is the second tube shown. The oscillator frequency is introduced into the grid circuit of the modulator by means of the pick-up coil L_3 connected in the grid lead. This coil could also be connected in series with the grid return lead below the tuned circuit without changing the type of the modulator.

Since the signal carrier and the oscillator frequency are introduced into the modulator grid circuit through selective circuits, only the fundamentals of the two frequencies are impressed in appreciable intensity. This is especially true if L_3 is coupled loosely to L_2 and still more loosely to L_1. Even so harmonics will be generated in the modulator since this operates under detection conditions. The only way to prevent the harmonics would be to use a linear detector.

In most superheterodynes in the past the coil L has been a loop. In more recent receivers, L has been the secondary of an ordinary radio frequency transformer of which the primary is connected in the plate circuit of an amplifier tube, this tube being preceded by another tuner. This tuner may be of the same type as shown in Fig. 3, in which the primary is in the antenna circuit, or it may be a loop with a tuning condenser across it. In some instances the coupling between the antenna and the first RF amplifier is non-selective. being either a choke coil or a resistance.

The first IF transformer is to be connected across the terminals marked "to IF." If the secondary of this transformer is tuned to the intermediate frequency there should be a by-pass condenser of suitable capacity to let the two radio frequency currents by, but if the primary is tuned the tuning condenser serves this purpose.

When the intermediate frequency is low and the tuned circuits of the oscillator and the signal selector are coupled closely, the frequency of oscillator is not completely determined by the oscillator tuned circuit, but is partly determined by the constants of the signal selector. Under certain conditions the two selective circuits act as one, when they are said "to pull together." Reception is not possible when this occurs. The looser the coupling between the two resonant circuits, the less the likelihood of this occurring, and also the higher the intermediate frequency, the less the tendency for the two circuits "to pull together."

Loose coupling between the two resonant circuits is not necessarily the same as loose coupling with the modulator. There are arrangements in which the coupling between the resonant circuits is very loose and yet the coupling with either of these circuits and the modulator is close.

One arrangement for securing loose coupling between the two resonant circuits and still fairly close coupling with the modulator is shown in Fig. 4. The grids of the modulator and the oscillator are connected by a high resistance R and a small condenser C. The smaller the condenser and the higher the resistance, the looser is the coupling. A resistance of two megohms and a condenser of .0001 mfd., or smaller, have been used successfully when the intermediate frequency is as low as 45 kilocycles. This method of coupling has the advantage that it practically eliminates the tendency for the two resonant circuits to act as one. Yet it has not been used much.

When a screen grid tube is used as modulator several additional methods of coupling are available, and there is no doubt that these will be used extensively in the future. One of these is shown in Fig. 5. The signal carrier is impressed in the usual manner on the control grid of the modulator, which is operating on the grid bias principle. The oscillator is coupled to the screen grid so that the voltage on the screen grid and the plate of the oscillator is the same. The tickler coil L_1 is simply placed in the screen grid circuit.

The screen grid voltage, therefore, is varied according to the frequency generated by the oscillator, and this results in modulation. The disadvantage of this arrangement is that all the harmonics generated by the oscillator are impressed on the modulator, because the plate current of the oscillator is very rich in harmonics.

Fig. 6 shows a modification of this method, the tuning condenser being placed in the plate circuit instead of in the grid circuit of the oscillator. This is an improvement with respect to purity of the voltage impressed on the modulator because the fundamental voltage across the tuned circuit is relatively much higher than the harmonic voltages. However, the tuned circuit is shunted with the resistance of the screen grid circuit, and this will lower the selectivity of the oscillator, which in turn will make the frequency generated unsteady and more easily influenced by other tuned circuits in the vicinity. Moreover, the oscillator will not work as readily as if no resistance were shunted across the tuned circuit.

A preferred arrangement is that shown in Fig. 7. A small pick-up coil L_2, placed in the screen grid circuit, is coupled to the tuned grid circuit of the oscillator. Since the oscillation current in the tuned circuit is free from harmonics, only fundamental frequency voltage will be induced in L_2, and only the fundamental will be introduced into the modulator. It is true that L_1 is also coupled to L_2 and that this contains harmonics, but the coupling between L_1 and L_2 can be made so loose that harmonics introduced by this route are negligible. The tickler coil, for example, can be placed at one end of the tuned coil and the pick-up coil at the other. Of the three arrangements, Fig. 7 is by far the best.

The intentional coupling in any Superheterodyne between the oscillator and the modulator is not necessarily the only coupling. The two tubes will be served by the same batteries or voltage supplies. These will have resistance which will act as a coupling medium. In order to minimize this coupling by-pass condensers should be used liberally across the supply leads. No condenser is

The Problem of Re

Why Oscillator Brings in Same

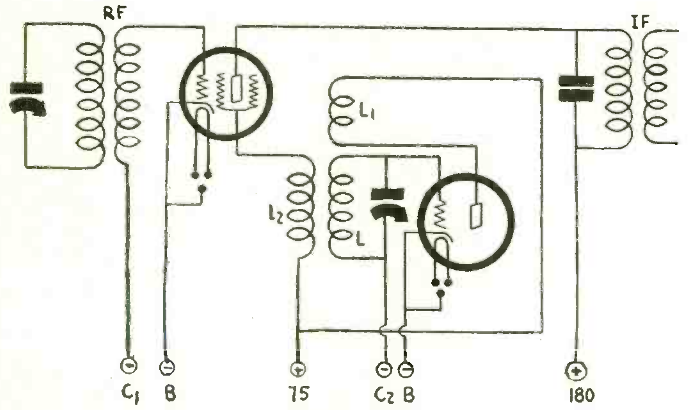


FIG. 7
THE PREFERRED WAY OF COUPLING THE OSCILLATOR TO THE SCREEN GRID MODULATOR IS BY MEANS OF A SMALL PICK-UP COIL IN THE SCREEN GRID CIRCUIT.

(Continued from preceding page)

shown in any of the modulator arrangements because the only purpose of the circuits is to show some of the possible methods of modulation. Stray coupling must be kept down to the lowest possible minimum if the receiver is to work properly.

Types of Oscillators

In the preceding paragraphs only two types of oscillators have been shown, tuned grid and tuned plate. There are many other types which can be employed in a Superheterodyne, and the particular type used does not make much difference. The main condition is that there is present an oscillator the frequency of which can be varied over the required range. Some oscillators, however, have certain disadvantages, and in designing a Superheterodyne it is just as well to avoid them. In Figs. 8 to 13 are shown six different oscillators, any one of which can be used.

Fig. 8 shows the tuned grid oscillator. It has the advantage that one side of the tuned circuit can be grounded, which is an important consideration. If the side of the circuit to which the control knob is connected is not grounded, body capacity effects will make tuning difficult, unless special precautions are taken to shield the resonant circuit from the hand.

Fig. 9 is of the tuned plate type. Neither side of the resonant circuit can be grounded directly in this oscillator, but it can be grounded through a large condenser. If the capacity of this condenser is large, the grounding is as good as if the rotor of the tuning condenser were grounded directly. Hence this oscillator is satisfactory as far as body capacity is concerned. The size of the by-pass condenser need not be larger than .25 mfd., and since a condenser of this capacity should be used anyway, no extra equipment is needed.

Fig. 10 shows an oscillator of the Hartley type. A single coil is used and this serves both as grid and plate inductance, since the plate battery lead is connected to a point near the center of the coil. The tuning condenser is connected across the entire coil. The condenser C serves to isolate the grid from the plate voltage and resistance R serves as a leak. For broadcast reception the condenser may have a value of .001 mfd. and the leak about 50,000 ohms. This circuit is a good oscillator and is very simple in construction, but it has the disadvantage that neither side of the tuning condenser can be grounded. Hence when this is used special precautions must be taken against body capacity.

Fig. 11 is an oscillator which has been used in many popular Superheterodynes. Two coils wound on the same form are used, one being connected in the plate circuit and the other in the grid circuit. The tuning condenser is connected across both these windings, and the resonant circuit is completed by a large condenser C, for which a capacity of .01 mfd. is sufficient. It will be observed that this condenser is also a by-pass across the grid and plate batteries. If there are other condensers across these, and if they are placed so that the oscillating circuit is confined, condenser C is not necessary, for its only function would be to by-pass the leads from the coils to the batteries. But whether or not the by-pass condensers are used, it is of some advantage to use C.

This circuit is a very good oscillator and is even simpler in construction than that in Fig. 10. But like that circuit it is subject to body capacity, and special precautions must be taken against it when it is employed.

Fig. 12 is a modification of the circuit in Fig. 9, and is of the tuned plate type. It is not especially suitable for a Superheterodyne but is very useful for the production of a pure alternating

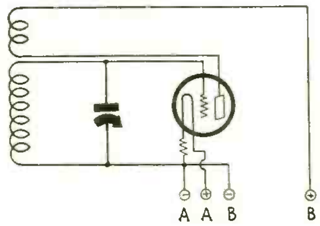


FIG. 8
THE TUNED GRID OSCILLATOR.

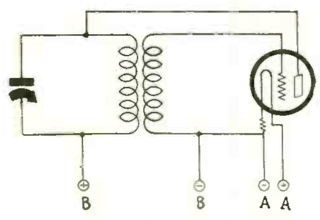


FIG. 9
THE TUNED PLATE OSCILLATOR.

current of a steady frequency. The purity of the wave generated and the constancy of the frequency are greater the higher the value of the resistance R. This resistance determines the amount of feedback, and if it is too large the circuit will not oscillate. The intensity of oscillation also decreases as the value of the feedback resistance increases, and it is because the amplitude of oscillation is small that the generated wave is pure.

Fig. 13 is an oscillator of the Colpitts type, which is characterized by the fact that regeneration is obtained by capacity feed back. Two condensers C_1 and C_2 are connected in series and are then connected across the tuning inductance. The junction between the two series condensers is connected to the filament circuit, and one extreme of the tuned circuit is connected to the grid and the other to the plate. Condensers C_1 and C_2 should be small compared with the tuning condenser. This circuit is subject to body capacity since neither side of the tuned circuit can be grounded. It is rarely used in Superheterodynes but is frequently employed in transmitters.

Whichever of these oscillators is used for supplying the local radio frequency, the most satisfactory coupling is that which employs a small pick-up coil in inductive relation with the tuned circuit, as illustrated in Figs 3 and 7.

While all these oscillators are shown for battery type tubes, they can be used equally well with alternating current tubes, especially of the heater type. Likewise, any of the modulators shown above can be used with DC or AC tubes.

Double Modulation

We assumed previously for the purpose of explaining the production of the intermediate frequency that the signal was unmodulated, or that it consisted of the carrier alone. But a broadcast wave is modulated with audio frequencies whenever it brings in an audible signal, and these audio frequencies may lie, as we found, anywhere in the band between about 16 and 10,000 cycles per second. For simplicity let us assume that the carrier is modulated by a single audio frequency. We have found that the modulated wave can be regarded as composed of three different radio frequencies, namely, the carrier itself and two side frequencies.

When a locally generated frequency is mixed with this complex wave, the local wave becomes modulated by it, or what amounts to the same thing, by the three components of it. Of the products of the local modulation we are interested only in the inferior side frequency, since the intermediate frequency filter accepts this only. The local frequency is subtracted from each of the three components of the complex signal wave, or each of the three components is subtracted from the local frequency, depending on whether the locally generated frequency is lower or higher than the signal component frequencies. The result is an intermediate frequency which is modulated by the original audio frequency, and this intermediate frequency wave can be regarded as composed of three intermediate frequencies, one equal to the difference betwen the carrier frequency and the local frequency, and the other two being greater and less this difference by the amount of the audio frequency.

Let us summarize this in symbols. Suppose the carrier frequency is F_1 and the local oscillator frequency is F_2. Let the audio frequency be f. Then the complex signal is composed of F_1, F_1-f, and F_1+f, all of which are radio frequencies. When these are mixed with F_2 and the difference frequencies only are taken, we have F_1-F_2, F_1-F_2-f, and F_1-F_2+f, if the local oscillator frequency is less than the carrier frequency, and F_2-F_1, $F_2-(F_1-f)$, and $F_2-(F_1+f)$, if the oscillator frequency is greater than the carrier. All of these are intermediate frequencies.

In each of these two groups there are three frequencies, the intermediate carrier and the two side frequencies. In the two groups the value of F_2 is not the same for any particular value of F_1 and f. In fact, F_2 in one group differs by $2f$ from the F_2 in the other group, and the two values of F_2 represent the two points on the oscillator at which any given signal comes in on a Superheterodyne, or more exactly the two principal points.

The value of f in the above formulas may be any from 16 to 10,000 cycles per second, and it may have one or more values at the same time; depending on the complexity of the sound that is

peat Tuning Points

Station At Different Settings

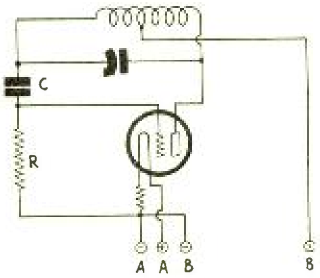


FIG. 10
TYPE OF OSCILLATOR FREQUENTLY USED IN SUPERHETERODYNES.

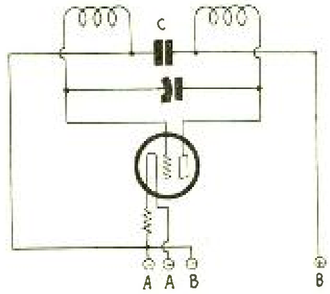


FIG. 11
THIS OSCILLATOR HAS BEEN FAVORED BY MANY DESIGNERS.

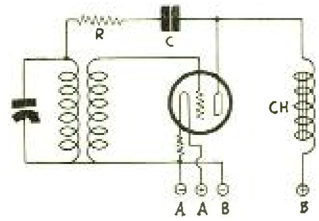


FIG 12
A TUNED PLATE OSCILLATOR ARRANGED TO GIVE A CONSTANT FREQUENCY AND PURE FORM OF THE GENERATED WAVE.

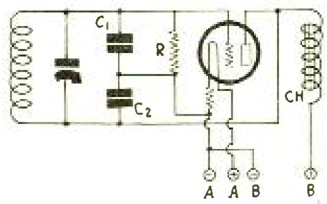


FIG. 13
A MODIFIED COLPITTS OSCILLATOR. REGENERATION IS OBTAINED BY CAPACITY FEEDBACK. THE CIRCUIT IS SUBJECT TO BODY CAPACITY.

being transmitted. In fact, it may have as many different values as there are different frequencies in the sound of orchestral music. No matter how complex the sound may be, each component frequency can be treated separately as f was treated above.

The value of the difference F_2—F_1, or F_1—F_2, is determined by the tuning of the intermediate frequency filter, and the value accepted by the filter is determined by varying F_2. This is done by turning the oscillator dial. In order to save writing out the difference let it be designated by IF. Thus the intermediate frequency signal can be expressed by the three components IF, $IF—f$, and $IF+f$. These expressions include both groups given previously.

When a circuit is tuned to a carrier, as has been stated, it is also tuned approximately to the side frequencies provided that the frequencies do not differ much relatively. Suppose, for example, that the carrier frequency is 1,000,000 cycles and that the highest audio frequency impressed on it is 10,000 cycles. The side frequencies are 900,000 and 1,100,000 cycles, and the ratio of the lower side frequency to the carrier is .9. This is so nearly equal to unity that when the circuit is tuned to the carrier it is almost as well tuned to the side frequencies. But suppose the carrier is 30,000 cycles, as it is in certain superheterodynes. The side frequencies corresponding to a 10,000 cycle tone are now 20,000 and 40,000 cycles. The ratio of the lower side frequency to the carrier is now 2/3. This differs so much from unity that when the circuit is tuned sharply to the carrier the side frequencies are practically tuned out. Not only are the upper side frequencies tuned out, but frequencies corresponding to tones as low as 1,000 cycles are greatly suppressed.

Avoid Low IF

This is one of the reasons why a low intermediate frequency should not be used in a superheterodyne. Excessive selectivity must be avoided if the quality of broadcast signals is to be good.

When superheterodynes were first popularized the intermediate frequency was made low in order to get a high order of amplification with stability of the circuit. The development of new tubes and the invention of stabilizing devices have now made it possible to use a high intermediate frequency without any loss in amplification or stability.

It should be remembered that the intermediate frequency amplifier and filter accepts the intermediate frequency to which it has been tuned regardless of the source of the intermediate frequency. A signal having the proper frequency will pass through if it comes directly from a station operated on this frequency just as well as if it comes from the interaction of two higher frequencies. It will come through also if it is produced by the beating of any two frequencies, for example, the harmonics of the carrier frequency and the oscillator frequency, or by the beating of the fundamental of one and any harmonic of the other. There is an infinite number of ways in which the proper intermediate frequency can be produced.

The number of possible combinations which will yield the intermediate frequency can be illustrated effectively by the aid of symbols. Let S be the frequency of the carrier and let m be a whole number expressing any of its harmonics. Likewise let H be the oscillator frequency and n the number of any of its harmonics. Either m or n may have any value from unity to infinity, just so it is a whole number. Then mS will be the frequency of the mth harmonic of S and nH will be that of the nth harmonic of H. If these harmonics beat in a modulator, and if they are so related that $ms—nH=f$, or so that $nH—mS=f$, we have the proper condition for producing the intermediate frequency acceptable to the filter. Here f is used for the intermediate frequency for simplicity and H and S are used for the radio frequencies for the same reason.

Now m and n can have any values whatsoever as long as they are integral, and therefore it is clear that there is an infinite number of possibilities. When $m=n=1$ we have the two fundamentals beating to produce the intermediate frequency. This is the normal case in most superheterodynes, and it is clear that there are two possible adjustments of the oscillator when m and n are equal to unity. Every superheterodyne, whether it is called "one-spot" or not, has these two adjustments of the oscillator at which a given signal can come in. Theoretically, a true "one-spot" superheterodyne is not possible; practically it can be approached. The meaning that can be attached to the term "one-spot" will be discussed later.

Since m and n in the above formulas can be assigned any integral values whatsoever, it is clear that for any signal, or value of S, there is an infinite number of points on the oscillator dial at which that signal will come in, at least theoretically. Practically the number may be quite limited.

Suppose the oscillator dial has been calibrated in frequency so that H not only represents the oscillator frequency but also the dial setting. Let us rewrite the equations given above as the conditions for the production of the intermediate frequency in he forms $H=(mS—f)/n$ and $H=(mS+f)/n$. Assume that S is fixed, or that we are considering a single carrier frequency. Also assume that f is fixed by the tuning of the filter. Both m and n can vary in any manner just so they remain whole numbers.

Intensity Decreases Rapidly

Under these conditions, the value obtained for H no matter what the values of m and n, is a possible setting of the oscillator that will bring in the signal carried by S. Not all, however, will be within the tuning range of the oscillator condenser, and those that are off will not cause any trouble. Moreover, not all will be of sufficient intensity to cause appreciable interference. The values obtained for large m and n will be weak.

We saw that when the two harmonic numbers were unity we have the normal two points at which a given signal comes in on the superheterodyne. Suppose $m=n=2$. The two second harmonics are beating, and these give rise to two points on the dial at which the same signal comes in. If we let $m=n=3$, we get two additional points. If we take higher integral values, we get two points at which the same signal comes in for every value. Since there is no limit to the whole numbers there is no limit to the number of points at which the signal comes in.

There is a definite limit, however, to the place on the dial where they can come in. They all lie between the two normal points determined by letting the two harmonic numbers, m and n, equal unity. As the harmonic numbers increase the location of the repeat points converge on the dial where the carrier S would tune in. The distribution of these repeat points is illustrated in Fig. 15. The horizontal line represents the frequency scale and the numbers on this scale are values of H for different values of m and n. When these two numbers are unity the two repeat points are $S—f$ and $S+f$ at the two extremes of the figure. These are the normal points for the ordinary superheterodyne. The middle line SB indicates the point at which the oscillator is in tune with the carrier frequency, since S is the carrier. When the two harmonic numbers are equal to 2, the two points $S—f/2$ and $S+f/2$ are obtained. These lie midway between $S—f$ and S and between S and $S+f$, respectively. As the harmonic numbers are increased, the two corresponding points lie closer and closer to the point S, as well as closer and closer to each other. The highest harmonic number used in the figure is 5.

The dotted curve is an approximate representation of the manner in which the intensity of the signals produced at each point is decreased. If the harmonics are absent from both fundamentals, or either of them, there will be only two points, the two extremes under A and C. If the harmonics are present in both but weak, the dotted line drops rapidly, so that even the intensity of $S—f/2$ and $S+f/2$ is negligible. The object of loose selective coupling between the oscillator and the modulator is to make all the repeats except the two extremes vanish.

Measurement of Respon

Beat Note Tone Generator, Consisting

By J. E. Anderson a

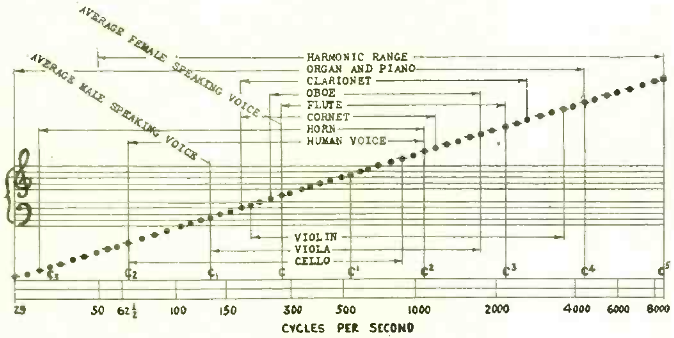


FIG 103.
SCALE SHOWING THE RELATIONSHIP BETWEEN THE FREQUENCIES OF VIBRATION AND NOTES OF THE MUSICAL SCALE.

[Herewith is the final instalment of the serially published book, "Power Amplifiers." The volume in bound form will be released soon.—EDITOR.]

There are oscillator circuits which generate practically pure sinusoidal currents, but the amplitudes of these currents are weak. The use of such oscillators would require additional audio frequency amplification with its attendant complications and chances for frequency and amplitude distortion. Therefore two oscillators which generate currents of large amplitudes have been selected in this instance. The first of these oscillators, the one which feeds into the control grid of the detector tube, is coupled directly and therefore feeds the harmonics of the radio frequency as well as the fundamental into the detector tube. However, due to the fact that the input potentiometer P is connected across the oscillating circuit, across which there is little harmonic voltage, the fundamental input to the detector will be large in comparison with the harmonic voltages.

The pure radio frequency is impressed on the screen grid circuit of the detector. While the second oscillator generates a large proportion of harmonics, practically none is impressed on the detector because the coupling between the pick-up coil L3 and the oscillating coil L4 is loose and only the fundamental circulates in the L4C3C4 circuit. In practice the tickler L5 and the pick-up coil L3 should be placed as far apart as is consistent with satisfactory oscillation and pick-up.

The audio frequency output of the detector tube is proportional to the product of the voltages introduced by the two oscillators. Hence the output can be varied by varying either. The input from the first oscillator is adjusted by means of potentiometer P and the input from the second oscillator is adjusted by varying the coupling between the two coils L3 and L4. If the intensity of the audio frequency output from the power tube cannot be reduced to the desired value by means of these two variables R5 can be made another potentiometer just like P, with the grid of the power tube connected to the slider. It is doubtful that this will ever be necessary if the two oscillators are shielded from each other.

The transformer used in the output of the power tube should have the best possible frequency characteristic. That is to say, this transformer should be one which is capable of the highest quality. If this condition is met, and if the resistance coupler between the detector and the power tube does not distort, the output from the circuit will be substantially the same for all audio frequencies.

The choice of oscillating coils and condensers depends largely on what size of variable condenser is available, as well as on what value of radio frequency is desired. Suppose we select a frequency of 250,000 cycles for the fixed oscillator, and let this oscillator be (1) in Fig. 1. The sum of the capacities of C1 and C2 and the inductance of L1 must then be chosen so that the frequency of the circuit is 250,000 cycles per second. Let C2 be a midget, the capacity of which can be neglected temporarily in comparison with the capacity of C1. Let C1 have a capacity of .0025 mfd. Then L1 must have an inductance of 160 microhenries. This is practically the same as the inductance of a tuning coil in a radio receiving set when the tuning condenser has a value of .0005 mfd. Hence L1 may be the ordinary tuned winding of an RF coil, but L2 should have at least as many turns on approximately the same diameter as L1.

A commercial condenser of a nominal value of .0025 mfd. may differ considerably from this value, say from 5 to 15 per cent. This is one reason for using the variable condenser C2 in parallel with the fixed condenser. C2 is also used for calibration purposes. This will be taken up later.

The frequency of the second oscillator is to be variable between 250,000 cycles per second and about 260,000 cycles per second. This allows for a beat frequency range from zero to 10,000 cycles. This variation in the frequency is effected by varying C3. The sum of the capacities of C3 and C4 and the inductance of L4 must be such that the frequency of the second oscillator is 250,000 cycles per second when C3 is fully meshed. Suppose that L4 has an inductance of 160 microhenries. Then, as we found for the first oscillator, the total capacity of C3 and C4 should be .0025 mfd. It remains to determine how these two condensers should be proportioned so that as C3 is varied from maximum to minimum the frequency change is 10,000 cycles. This is done by substituting in the usual formula for frequency, first using 260,000 cycles and C4 alone and then by using 250,000 cycles and both C3 and C4. In both cases the inductance is 160 microhenries. The calculation gives .00234 mfd. for C4 and .00253 mfd. for C3 and C4. Thus the capacity of C3 should be .00019 mfd.

There is no commercial variable condenser of this value. But one of this value can be made out of a .000250 mfd. variable condenser by cutting down the number of plates and reducing the size of one or more plates. Another possibility is to use a commercial variable condenser of .000250 mfd. and then increase the number of turns on L4 and adjusting the value of C4. The exact adjustment in any case must be made experimentally. The adjustment should be such that when all the capacity is used in the second oscillator the beat frequency with the first oscillator should be zero. Then as C3 is opened up the frequency should increase up to 10,000 cycles. As much as possible of the range of C3 should be used in effecting this frequency change.

The oscillator can be calibrated against any known set of frequencies, or a single known frequency and its harmonics. The output of the beat frequency oscillator is impressed on a loudspeaker and the known frequency is sounded simultaneously. The setting of C3 is adjusted until the sound from the speaker is in unison with the known tone. This setting is recorded against the known frequency.

Then another known tone is sounded and C3 again adjusted until the two tones are in unison. This process is repeated for all the known tones available. To get settings for the higher frequencies from the speaker. for which known tones may not be available, the harmonics of the known tones may be used.

One set of known tones which is nearly always available is that of an accurately tuned piano. Usually the A above middle C on a piano has a frequency of 435 cycles. The A one octave higher has a frequency of 870 cycles and one octave below a frequency of 217.5 cycles. For any given note and its octave the ratio is one to two. Instead of calibrating in terms of frequency, it is often as useful to calibrate in terms of octaves.

The piano does not go as high as the oscillator. Harmonics must be used to locate the higher frequencies or octaves on the oscillator.

In Fig. 103 is shown a scale giving the relationship between the frequencies of vibration and notes on the musical scale. It will be noted that the piano extends only up to about 4,000 cycles, whereas the oscillator should go up to at least 10,000 cycles. The first harmonic of the highest note on a piano, when A above middle C is 435, lies between 9,000 and 10,000 cycles per second.

The beat note oscillator will not stay accurately calibrated. It will change with temperature, with voltages applied to the tubes, and with changes in the tubes. These changes can be compensated for by adjusting C2 just before using the oscillator. For this purpose a low frequency tone is used as guide, such as the 60-cycle note obtained from a 60-cycle power line when this is coupled to a loudspeaker. A small voltage from the line is introduced into the beat oscillator by means of a step-down transformer or it may be introduced in the same manner directly into the loudspeaker while the beat oscillator is also feeding energy into it. Then the condenser of the second radio frequency oscillator is set on the point corresponding to 60 cycles, as obtained during the calibration. Then the setting of C2 is adjusted until the tone generated by the beat oscillator is in unison with the tone from the power line. C2 is then locked. This so-called zero setting adjustment corrects the calibration throughout the range of the oscillator.

se Of Audio Amplifiers

Of Four Vacuum Tubes, Is Used

nd Herman Bernard

The settings of P and L3 also affect the calibration. The effect of the potentiometer can be corrected by the zero setting adjustment just explained, for each setting of the potentiometer. The setting of L3 will have a very small effect on the frequency because it is loosely coupled to the oscillating circuit.

It is well to shield the two oscillators from each other and from external electrical disturbances by means of grounded metallic boxes.

List of Parts

C0—One .01 mfd. condenser.
C1—One .0025 mfd. fixed, mica condenser.
C2—One 80 mmfd. midget variable condenser.
C3—One .00234 mfd. condenser (assembled from smaller units).
C4—One .00025 mfd. variable condenser, preferably cut down to .00019 mfd.
C5—One 1 mfd. fixed by-pass condenser.
C6, C7—Two .0005 mfd. condensers.
C8—One .25 mfd. condenser.
C9—One 2 mfd. by-pass condenser.
L1, L2—One radio frequency transformer. Primary L1 40 turns of No. 22 DCC wire on 3 inch tubing. Secondary L2 the same number of turns of fine wire or a larger number.
L3—A small coil mounted at one end of L4 so that it can be turned.
L4—A tuning coil of 40 turns of No. 22 D. C. C. wire on 3 inch tubing.
L5—A fixed tickler of 30 turns of fine wire on L4 tubing far from L3.
L6—One 65 millihenry RF choke.
Ch—One 85 millihenry RF choke coil, or larger inductance.
T—One high quality audio frequency output transformer.
R1, R3, R6—Three 4-ohm resistors or 1A amperites.
R2—One 20-ohm ballast resistor or 222 amperite.
R4—One 100,000-ohm resistor with mounting.
R5—One 2 megohm grid leak with mounting.
Sw—One filament switch.
Four X-type sockets (four prong).
Two 201A type tubes, or 112A type.
One 222 type screen grid tube.
One 171A type power tube.
Six binding posts.
Filament, plate and grid batteries.

Frequencies other than those at which the beat note oscillator has been calibrated may at times be required. For example, calibration points may have been taken at C and C1 on the musical scale and the tone A may be required. This note, or any other within the range of the calibration, may be obtained if a calibration curve is made of the data obtained. Frequencies are plotted against settings on the dial of oscillator condenser C3, Fig. 102, and a smooth curve is drawn through all the points. From this curve the setting required for any desired frequency can be obtained. While the frequency thus obtained may not be close enough to be in unison with the frequency desired, it will be accurate enough for taking output characteristics of transformers, amplifiers, and loudspeakers.

The output of the modulator in the beat frequency oscillator is practically constant for all frequencies because it is proportional to the product of the intensities of the two radio frequencies impressed on the modulator tube, and one of these remains constant and the other varies by a negligible amount. The amplifier, however, will introduce some frequency distortion since there are condensers and transformers in the circuit. For some purposes it is required to have the output constant as the frequency varies, or to know just how the output varies with frequency. To determine this variation a curve showing the relationship should be taken after the oscillator has been calibrated.

The method of taking this curve depends somewhat on the manner in which the output is to be used. Let us assume the tone generated will be impressed on the grid circuit of an amplifier, and that we are interested only in the effective value of the alternating voltage. If we know the alternating current flowing in the secondary of the transformer T, Fig. 102, and in a resistance of known value connected across the output terminals, we know the voltage, for it is simply the product of the current in amperes and the resistance in ohms. To obtain the current, an AC milliammeter is inserted in series with the secondary of the output transformer and with the resistance R, as shown in Fig. 104. An output curve can be obtained by setting the oscillator, which has been calibrated as to frequency, at several selected points throughout the scale and noting the current output at each point. The output voltage is obtained by multiplying the current at each setting by the resistance R. Then

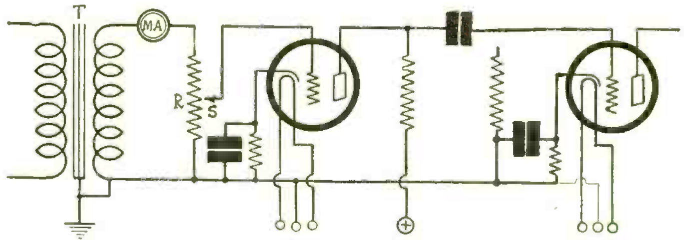


FIG. 104
THIS ILLUSTRATES HOW THE OUTPUT OF A BEAT NOTE OSCILLATOR, SUCH AS THAT IN FIG. 102, CAN BE IMPRESSED ON AN AMPLIFIER UNDER TEST AND HOW TO DETERMINE THE EFFECTIVE VALUE OF THE VOLTAGE. M.A. IS AN AC MILLIAMMETER AND R KNOWN RESISTANCE.

the data obtained are plotted on suitable cross-section paper. The curve can be used regardless of the absolute value of the output voltage for the percentage deviation from constancy will be the same for all intensities. For example, if the output voltage is less by 5 per cent. at 10,000 cycles per second as compared with the voltage at 400 cycles, it will be the same whether the absolute voltage is 1 volt or 100 volts.

If the entire output voltage across resistance R is not required for some measurement, a lower voltage can be obtained by tapping the resistance at a suitable point so as to include only a fraction of the resistance in the input circuit to the amplifier under test. The input voltage will be the product of the current and the resistance actually in the grid circuit. By choosing the proper ratio of the total resistance to the resistance of the fraction used, any desired small voltage can be obtained. For example, suppose the ratio is 1,000/1 and that the total voltage is 10 volts. The voltage across the small fraction is then .01 volt.

If the resistance of R be taken as 1,000 ohms, the total voltage across the resistance is numerically equal to the reading on the milliammeter. If the small fraction of R is one volt the voltage across this resistance will be as many millivolts as the meter indicates milliamperes.

When measuring voltage amplification it is convenient to adjust the input voltage so that it is just one volt, for then the amplification will be given directly by measurement without any computation. For example, if the measured voltage across the grid leak of the last stage in the amplifier is 50 volts, the amplification is also 50. In many instances, of course, the amplification is much greater than this. In such cases the input voltage can be adjusted to values of .1, .01, or .001 volt, as the case may require, and the measured

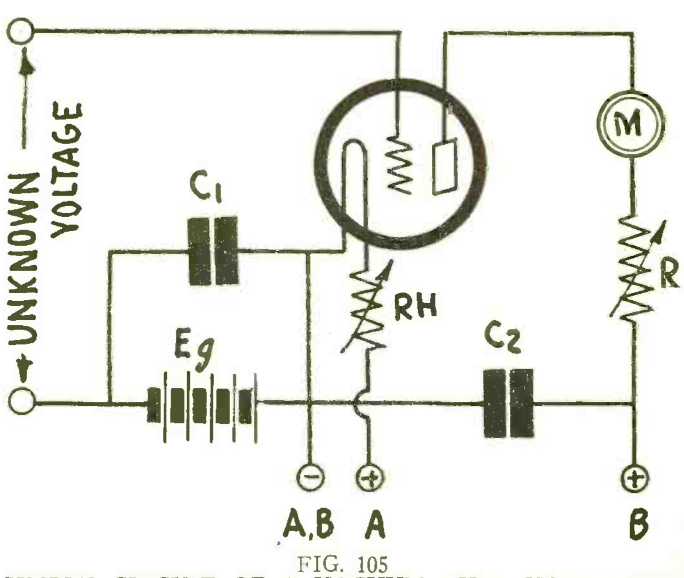


FIG. 105
SIMPLE CIRCUIT OF A VACUUM TUBE VOLTMETER FOR MEASURING ALTERNATING VOLTAGES. IT IS APPLICABLE TO BOTH RADIO AND AUDIO FREQUENCIES.

Wave's Route to First Tuned Circuit

By Thomas Pierce

WHEN a radio wave leaves the broadcast station antenna it is composed of a high frequency carrier having the wavelength of the station. On this is superimposed the modulated wave (the audio wave).

We say that a certain station has a wavelength of so many meters of a frequency of so many kilocycles. By wavelength we mean the distance between the crests of the wave. If the distance is 300 meters the wavelength is 300 mters.

It is very evident from this, that the more crests that appear the shorter will be the distance between the two crests. Hence, the shorter the wavelength the higher the frequency.

Since radio waves travel at the same speed as light or 186,000 miles a second, they also travel at a rate of 300,000 meters a second. If a station sends out a wave which has a frequency of 550,000 a second, 550,000 complete repetitions of the wave will be transmitted each second. There will, therefore, be 550,000 waves traveling at 300,000 meters a second. We see, therefore, that each of the 550,000 waves must be equal in length to the distance divided by the number of waves, which in this case means that each wave would be 545,550 meters long.

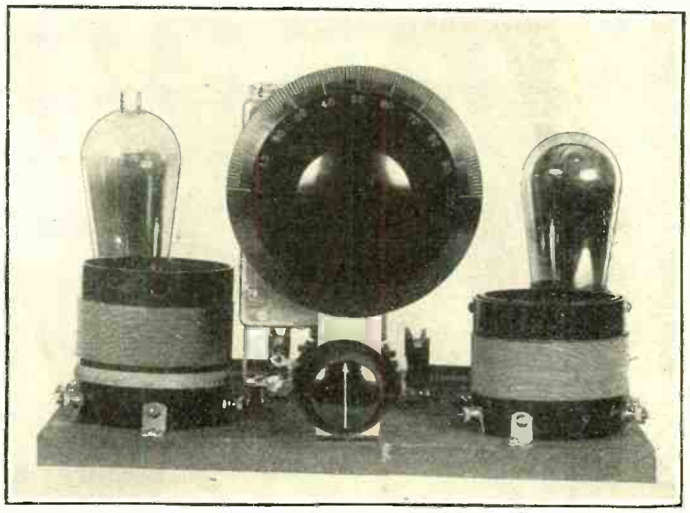
These 550,000 waves are in reality electrical impulses which alternate in polarity 550,000 times a second. That is, they flow in one direction 550,000 times and in the other direction 550,000 times, so that 1,100,000 complete changes or alternations of current are produced.

Between the antenna and the ground of the receiver, what is known as a condenser effect exists. That is, the antenna may be termed as one plate and the ground as the other, and the air between can be charged with electrical energy.

Now when the waves from the transmitting station reach a receiver's antenna-ground condenser, they pass through the condenser dielectric, air in this case, setting up a charge. This charge flows through the primary or the fixed small winding known as the antenna winding.

We are all familiar with the action of an iron nail and magnet. That is, the iron nail is drawn to the magnet. This is known as magetnism, and consists of magnetic lines of force. Because it is easier for the lines of force to travel through iron than through air, the nail goes to the magnet.

When an electric current passes through a coil, there is the same result. That is, the lines of force exist about the coil. It is these lines of force that we call electromagnetic lines of force, while the effect is known as electromagnetism.



THE FIRST TUNED CIRCUIT IS AT LEFT

Since a current flowing through a coil will produce a magnetic field about the coil and since a magnetic field will reproduce an electric current set up in the coil, a second coil can be brought close to the field of the first one and have an electric current induced in it. This second coil may be called the secondary.

The impulses through a condenser effect in the antenna and ground, and by induction have reached as far as the secondary winding. But these impulses are of a variety of frequencies and were so far transferred from circuit to circuit as such. Something must now be done to separate them.

For that purpose we have the condenser, which is also needed to complete the circuit. That is, we must have capacity (condenser) to tune the secondary.

Vacuum Tube Voltmeter Calibration

(*Continued from preceding page*)

voltage multiplied by the proper multiple of 10 in order to get the amplification.

Alternating voltages such as occur across secondaries of transformers and across grid leaks can best be measured with a vacuum tube voltmeter. There are many forms of such meters but one of the simplest and most satisfactory is shown in Fig. 105. In this circuit Eg represents a grid bias battery the voltage of which is so high that the plate current in the tube is nearly zero. M is a microammeter or a sensitive milliammeter, and R is a variable resistance which can be adjusted to obtain suitable deflections on the microammeter. C1 and C2 should be condensers of 2 mfd. or more. The tube used should preferably be a 171A type, and the filament voltage impressed on it be about 4.5 volts. This is adjusted with the rheostat Rh, which can have a value of 10 ohms, provided a 6 volt storage battery is used. The plate voltage should be about 10 volts and supplied by a battery.

The principle of operation of the meter is that of grid bias detection. When the two terminals marked "unknown voltage" are short-circuited the current in the plate circuit will be determined by the emission, or by the filament terminal voltage, by the grid bias Eg, by the resistance R and by the plate voltage applied. For given values of the other factors, R should be adjusted so that the microammeter reads about one tenth of the meter scale. This reading is the zero for the instrument and it should be carefully noted. Whenever this reading is obtained it means that there is no voltage across the input terminals.

When any voltage is impressed across the input terminals, the reading on the microammeter will be higher, and the higher the voltage impressed the higher is the reading on the meter. The highest alternating voltage that can be impressed on the voltmeter in any particular case is determined by the upper limit of the microammeter.

Before this vacuum tube voltmeter can be used it must be calibrated, and this is a simple process if the equipment represented in Figs. 102 and 104 is available. The input terminals of the voltmeter are connected across R in Fig. 104, or across a portion of it as has been explained in place of the amplifier used in this circuit. The transformer T in Fig. 104 is the output transformer in the beat note oscillator in Fig. 102. Hence we have a source of pure alternating current and voltage and a method for measuring the current before it is impressed on the vacuum tube voltmeter. The frequency of the current used should be comparatively low, or somewhere between 60 and 400 cycles per second.

The first reading is taken with zero input in order to determine the zero reading on the microammeter. Then readings are taken at various voltage inputs until the microammeter reads full scale. A curve is then plotted between voltage input and microammeter readings. The resulting calibration curve can be used for measuring any unknown alternating voltage impressed across the input terminals of the vacuum tube voltmeter.

Since the AC milliammeter used in calibrating the instrument reads effective values of current, the voltage drops across the resistance R will also be effective values. Therefore the vacuum tube voltmeter is calibrated in terms of effective values and not in terms of peak values. To get the peak value of any voltage measured multiply the reading by the square root of 2, or 1.414. Peak values are useful when the grid bias to be used in any given instance is to be determined. This factor for obtaining the peak values from effective values applies strictly only when the voltage measured is free from harmonics, but if the harmonic content is small the error will be very small also. There should be no DC component in the unknown voltage impressed on the voltmeter. A vacuum tube voltmeter for measuring steady voltage has been described already.

The accuracy is very high indeed.

RADIO UNIVERSITY

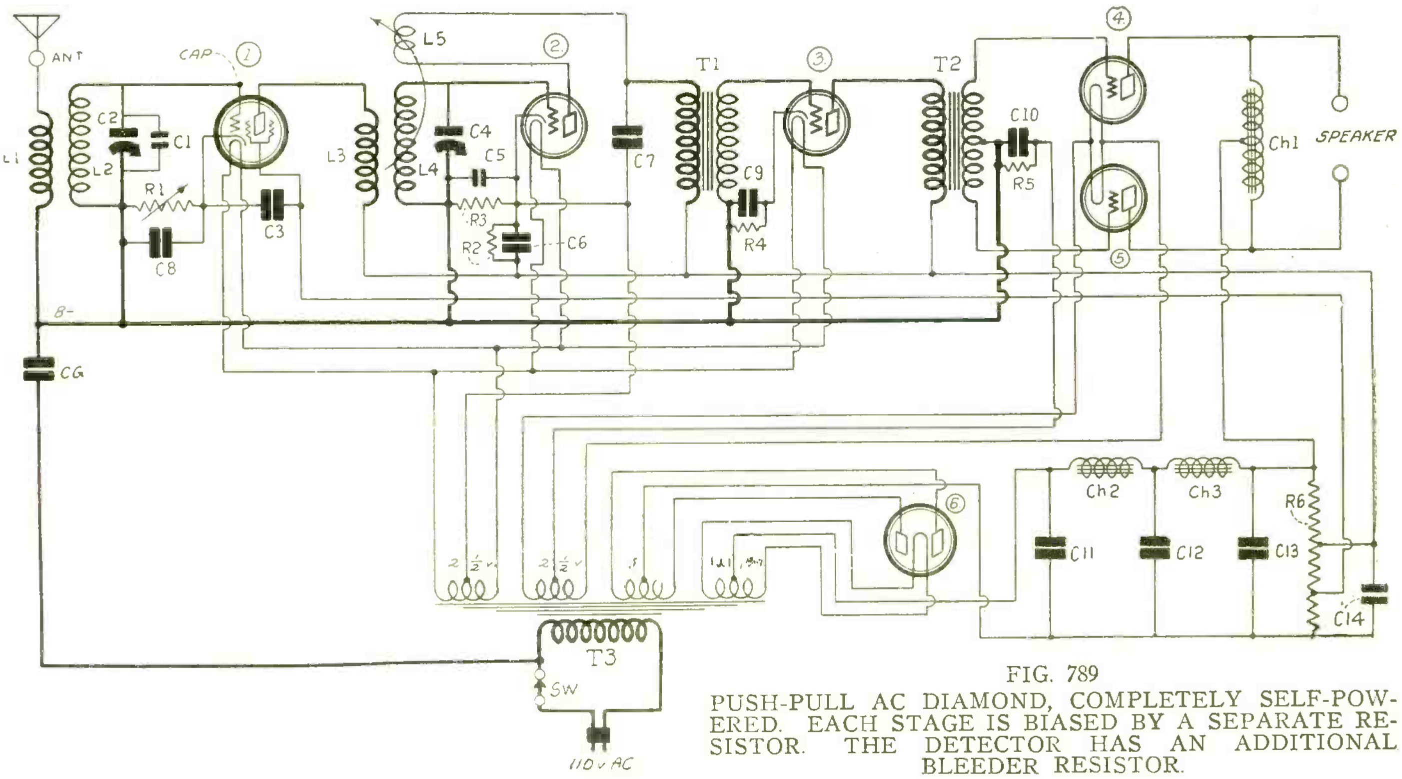


FIG. 789

PUSH-PULL AC DIAMOND, COMPLETELY SELF-POWERED. EACH STAGE IS BIASED BY A SEPARATE RESISTOR. THE DETECTOR HAS AN ADDITIONAL BLEEDER RESISTOR.

IS THERE any way I can avoid insulating the condenser brackets that are affixed to the subpanel in the HB Compact, battery model?—F. W.

Yes. You can fasten the brackets to the two condensers and to the subpanel without insulation. The rheostat must be insulated from the front of the metal cabinet. A small bakelite or fibre washer will do this. If unable to obtain such a washer, write to Technical Editor, RADIO WORLD, 145 West 45th Street, New York City, and enclose stamped, addressed envelope. Connect the grid return of the first coil to the juncture of the two filament resistors, as diagrammed originally, but do not connect this coil to the tuning condenser rotor. Do connect the other terminal to condenser stator. The coil in the grid circuit of the 222 radio frequency amplifier is meant. Now, in the next stage, connect the plate return of the tuned winding to B plus, but do not connect this coil to the tuning condenser rotor. Connect the plate terminal of this coil to plate and to stator of the tuning condenser, of course. Put a fixed condenser of .01 mfd. capacity or higher from the plate return of the second tuned winding to the subpanel. Thus in the first instance the tuned circuit was completed through the filament resistor and in the second instance through the bypass condenser.

* * *

IT WAS always my understanding that the larger the filter capacities used in a B supply, the better the filtration, the less the hum. But I read something in RADIO WORLD recently that seemed to argue in the opposite direction. The question came up in Anderson's and Bernard's book, "Power Amplifiers," which you are publishing serially.—S. E. F.

The larger the capacity, the better the filtration, up to the point where filtration saturation is reached, a condition reflected in the audio amplifier. If hum is due to inadequate capacity in the filter and bypass sections, then additional capacity will reduce the hum. If the filtration has been done adequately, hence the capacities are sufficiently large, then hum may be due to the characteristic of the audio amplifier. The excellent audio amplifiers hum more than the poor ones, because fine audio channels amplify low notes much better, and poor ones usually cut off around 200 cycles. Hence the principal hum frequency, 120 cycles, and the 60-cycle fundamental itself, while present, are not amplied much, hardly at all, in poor audio channels. The elimination of hum is sometimes touted as a scientific feat, when all that has been done is to render a poor audio amplifier worse, by filtering out the low frequency response entirely. Hum that is heard when no program is being reproduced, but is inaudible when the program is on, cannot be fairly called objectionable. Indeed, if the audio amplier is a good one there is bound to be some hum. The increase of filtration and bypass capacities beyond the bare requirements of hum reduction in the B supply tends to increase hum in the speaker, because the low notes are more adequately served by large filter capacity, especially the capacity across the line at the output.

* * *

PLEASE show how an AC receiver has its stages separately biased by means of individual resistors, and explain the theory of operation of this biasing.—H. W. T.

Fig. 789 shows the AC Push-Pull Diamond of the Air, which embodies this feature. The plate current of the tube that is to be biased is sent through the biasing resistor and this resistor is by-passed. For radio frequencies a small capacity is sufficient, say, .006 mfd. up, while for audio frequencies a higher capacity is needed, especially the last stage, where 4 mfd. is the minimum. R1 is a 0-5,000 ohm adjustable resistor. If it proves critical place another resistor of about 2,000 ohms in parallel with it. R3 is the separate resistor for biasing the detector stage, while R4 is the resistor that sends bleeder (additional) current through this biasing resistor, so the biaser may be of smaller resistance, due to the increased current, hence of lower relative impedance, making the bypass condenser more effective. In practice the two, R2 and R3, may be a 20,000 or 25,000 ohm resistor with an adjustable tap on it, like Electrad type B. A ratio of about 10 to 1 is used, that is, ten times as much resistance for the bleeder resistor R2. The first audio stage is biased like the radio stage, only the resistor is fixed. The biasing resistor of these three tubes is connected from cathode to B minus. The last stage has directly heated tubes, and the biasing resistor is connected from midtap of the filament winding to B minus. In all instances the grid return (B minus) is negative in respect to the cathode or filament center, hence the bias is negative. The rectifier in this circuit is a 280.

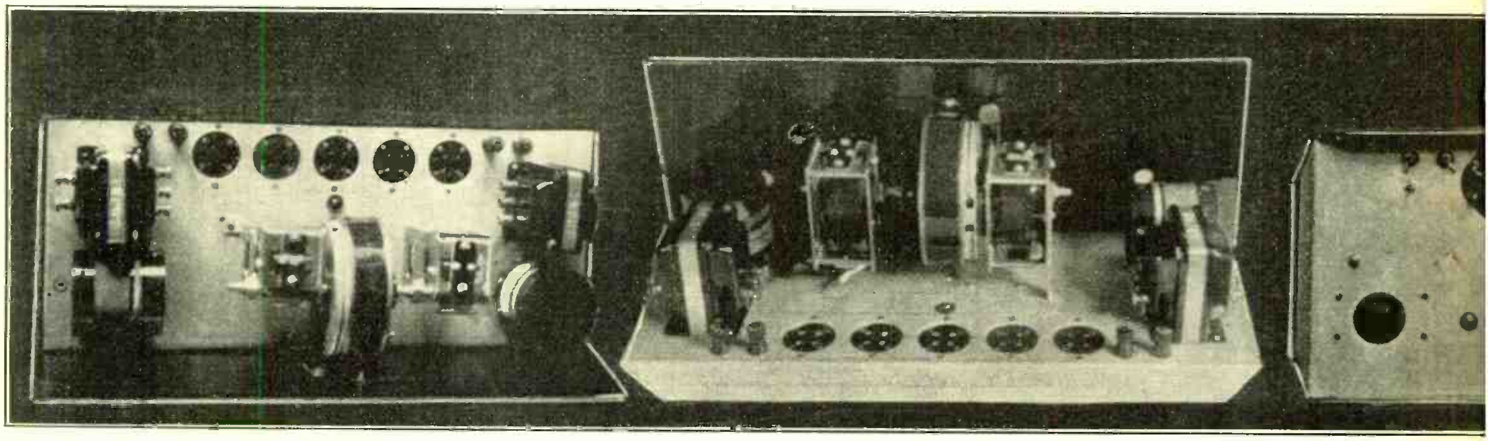
* * *

IN THE HB Compact, battery model, negative grid bias detection is used on a 240 high mu tube. Please give me particulars on how to get best detection. Also, the first audio tube is a 222 screen grid. Please let me know the value of the resistor in the plate circuit of this tube.—F. D.

You can try 135 volts applied to the resistor in the plate circuit of the 240 tube, grid return to negative filament. You will find that low order of bias affords better detection. If the detection is not as sensitive as you would expect, decrease the plate voltage. The resistor is .075 meg. (75,000 ohms) or try .05 meg.

Construction of the Push-Pull Ba

Symmetry Maintained n Front and Back Layout and M



Views of the receiver, showing rear, top and bottom observations. The two tuning condensers are att the medium of a piece of insulated rod, aided by a flexible coupler. The bottom view shows how

[In last week's issue, dated October 12th, was published the first instalment of a series of articles on the Push-Pull Battery Model Diamond of the Air. The radio frequency amplifier is a screen grid tube, 222, the detector is a high mu tube, 240, the first audio tube and the push-pull pair are 112As. Next week another instalment will be published, but enough has been printed, with this week's article, to enable anybody to build the receiver.—EDITOR.]

A SPECIALLY prepared steel subpanel, cadmium plated, is used for the Push-Pull Diamond of the Air, battery model. It has a right-angle flange all around, which provides a self-bracketing feature. The subpanel will not dip when you insert tubes, even though no additional supporting brackets are used. Indeed, no such brackets are specified, as the rigidity leaves nothing to be desired.

The five four-prong (UX) sockets are built into this subpanel. They are in a row at rear. At left rear, assuming you have the front panel before you, is the push-pull input transformer, and at right the push-pull output impedance-transformer.

The queer name for the output is derived from the following facts: the device is a transformer, but it has a large primary, center-tapped, that renders it useful as an output impedance, as shown in last week's diagram. This week the diagram shows the same output with the alternative of using a transformer to couple the speaker and the push-pull pair of tubes.

Symmetry Is Keynote

The object of presenting the choice is to permit constructors to use that type of output that works better with the particular speaker they are using, without buying two devices.

In general the speaker cords for the magnetic or inductor type may be connected to the secondary of the output transformer. For dynamic speakers it is usually, but not always, better to connect the speaker tips to the plates of the respective tubes, with the center-tapped impedance in circuit. The better way is a marked improvement, so you will have no difficulty in reaching a decisive determination.

The usual insulated openings are provided for antenna, ground and two speaker binding posts. A simple way of grounding the subpanel is to omit the flat insulating washer underneath the subpanel, and tighten a nut directly on the ground binding post screw. A lead may be soldered between lugs from the ground post to the nearest mounting screw of the input transformer for double assurance of grounding.

There is a symmetrical keynote in the entire layout. Take the parts at rear. The sockets are symmetrically arranged. The two push-pull couplers and the coils that adjoin them are in symmetrical positions. So are the respective pairs of binding posts. There is only one deviation, and that is, one of the tuning condensers is spaced from the National drum so that about 2" intervenes, when coupling is effected by a small extra bakelite rod and a flexible coupler, although the other tuning condenser is close to the drum.

Valuable Constructional Information

The reason is that the second tuning condenser, the one in the detector grid circuit, has grid return of its coil made to A plus, while the other has grid return of its coil made to grounded A minus (the subpanel). To keep the two insulated it is not only necessary to use insulated coupling, but the condenser supporting bracket for the second capacity must be insulated from the subpanel. This is done in the factory, the insulator being built into the subpanel at the proper place.

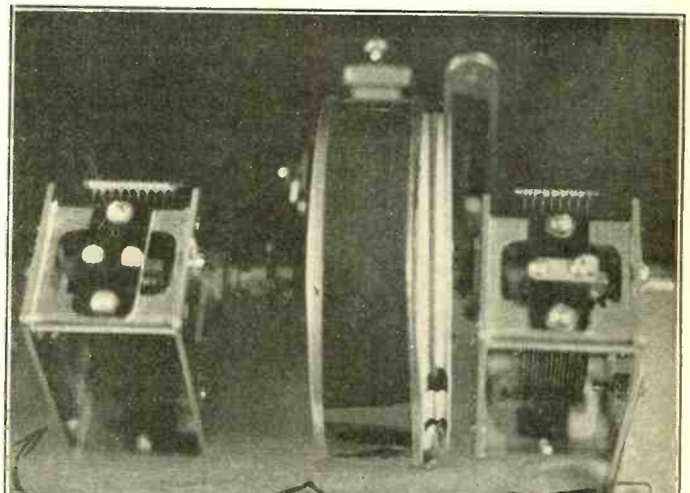
Both condensers are supported on one side by the drum and on the other side by independent single brackets. These are special brackets and are furnished with the subpanels.

Not On Its Head

The diameter of the bakelite rod is 1/4", so that the drum bushing will receive it, and only about 3/8" is permitted to protrude. The flexible link will grip this extension. It is not necessary that the flexible coupler be insulated, since the bakelite rod separates the condenser electrically from grounded A minus, while uniting it mechanically with the tuning mechanism. However, if the flexible link is insulated no harm is done. A brass bushing, with two set screws about 1/2" apart, will serve as a uniting element.

Front panel symmetry and other aesthetic advantages are gained by having the knob that turns the drum located a little higher up than the knobs that actuate the tickler and the switch-rheostat. This carries out the impression of a pyramid standing on its base, rather than on its head.

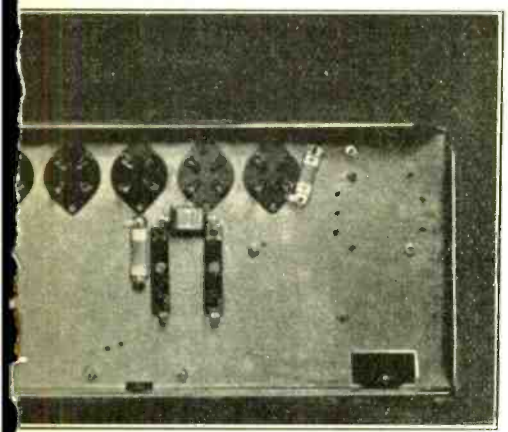
The subpanel is cut away at left to afford clearance for the rheostat, and at the other end is cut away in a circle 3 1/4" in diameter, to permit a clearance of the entire three-circuit coil diameter. The coil lugs should be bent inward, to avoid all danger



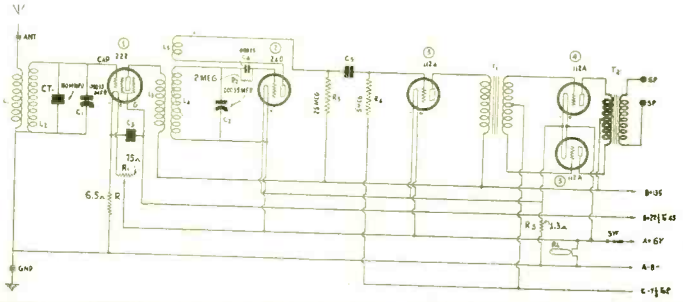
ARROWS POINT TO WHERE THE CONDENSER BRACKETS ARE PLACED. THE ONE AT RIGHT IS IN FULL VIEW. THE ONE AT LEFT, HIDDEN, MUST BE INSULATED FROM THE SUBPANEL.

ttery Model Diamond of the Air

ost Wires Are Dropped Out of Sight Through Subpanel



ched to the drum, one through
some of the parts are placed



CIRCUIT DIAGRAM, WITH PUSH - PULL OUTPUT TRANSFORMER. THIS DEVICE MAY BE USED AS SHOWN, OR THE PRIMARY ALONE MAY BE USED, AS TOLD IN TEXT.

LIST OF PARTS

L1L2—Antenna coil RF3.
L3L4L5—Three circuit SG Coil, SGT3.
T2—Push-pull output device.
T1—Push-pull input transformer.
CE—Equalizing condenser 80 mmfd.
C3—One .01 mfd. condenser.
R—One 6.5 ohm filament resistor.
R1SW—75 ohm switched rheostat.
R2—One 0.25 meg. Lynch resistor.
R3—One 5.0 meg. Lynch resistor.
C1, C2—Two .00035 mfd.
R4—One 1.3 ohm filament resistor.
Ant., Gnd., Sp (+), Sp. (—)—Four posts.
One 7x18" drilled front panel.
One self-bracketing subpanel 7x17½", sockets affixed; already drilled, cut out in two places.
Two resistor mountings.
One National type H modernistic dial with color wheel, pilotbracket, lamp, hardware.
Two matched knobs.
Flexible link, insulating shaft.
Five vari-colored cable leads.

of contact with the subpanel, and upward inside to avoid all possibility of being struck by the rotating tickler.

Properly placed holes in the subpanel receive the National Type drum dial, which is the new model, with modernistic escutcheon and the now-famous rainbow feature, that causes changing colors to flood the illuminated screen on which the dial numbers are read.

How to Mount the Dial

Just below the tuning knob on the National dial is a mounting screw with diamond-like engraving on it. This screw must not be driven in as far as human strength permits, but should be gently handled, and turned until it comes to a natural stop. Use no extra pressure, or you may bend the beautiful modernistic escutcheon.

You should get some willing pair of hands to give you a moment's assistance when you attach the tuning knob to the National dial, as someone should hold the pulley which the knob shaft drives, otherwise this pulley may be spaced from the vertical plate of the drum dial. The object is to have the pulley close to the plate, so suppose you hold it close, meanwhile pressing the knob at front against the apex of the special washer provided with each dial. The pair of helping hands will simply tighten the setscrew for you. Or, if you're acrobatic, you may use a long, thin screw driver and tighten the screw with that. The problem seems to be, with which hand? The answer is, just teeth!

Mounting feet and a footrest bracket are on the specified tuning condensers, but these appurtenances are not needed in this hookup, so remove them. A pair of pliers will take off the mounting feet with ease. A little extra pressure is needed to remove the footrest bracket. When these extras are off, clean the holes. An easy way is to drill through them, thus removing all remains of the eyelets that held the fixtures in place. If you hear loud squeaks, and the last vestige of eyelet seems impossible to dislodge, use a larger size drill, as you are simply turning the eyelet around in the groove, without drilling.

The first condenser bracket uses the footrest bracket holes for mounting purposes. The other condenser bracket is mounted by removing two small screws from the condenser adjoining the shaft, and restoring them after the bracket is placed. These screws have lock-washers on them. Do not lose these washers.

Adjustable Tension

The condenser tension is adjustable. Very easy rotation is advisable. Loosen the locknut, and turn the adjusting bushing a fraction of a turn. Do not loosen the adjustment to that point where the independence of the moving plates is lost, and they touch the stator plates or wabble. When the desired adjustment is attained, fasten the locknut.

The three-circuit coil is mounted with tickler at bottom, so-called upside down fashion, the only way it can be mounted in this receiver, so you will make no mistake.

The antenna coil is secured to the subpanel as follows:

Examine the coil, hold it in the illustrated position, with binding posts pointing toward the first tuning condenser. Examine the coil for connections. The pair of binding posts that connects to the antenna winding should face the rear of the front panel. Now you will find holes in the coil that permit mounting it on insulating washers already provided in the subpanel. These washers are not directly for purposes of insulation, but to keep the coil elevated from the subpanel. Now with awl or jackknife enlarge the smaller mounting hole on the coil just a trifle, so it will easily pass a 6/32 machine screw. Put such a screw, of ¾" length, through a flat insulating washer, and through the hole in the coil, from the inside. Let the screw pass through the collar washer on the subpanel, and tighten a nut against the subpanel from the under side. True up the coil and fasten with extreme tightness now.

Extra insulating washers are provided with the subpanels, also screws and nuts.

Parts On Subpanel Bottom

Below the subpanel are placed the two resistor mountings and the two fixed filament resistors. The one that connects to the F minus post of the screen grid tube (6.5 ohms) is attached to a condenser bracket screw, is bent up at an angle, and wired to the F minus socket post, which is about ⅜" away. Use flexible wire, connect physically as securely as you can, by threading through the hole in the socket lug, and then solder. This resistor must not be mounted in wobbly fashion but must be rigid.

The other fixed filament resistor (1.3 ohms) is underneath, also, but in the central line of the subpanel, attached by a screw at one end with insulation (already provided in the subpanel), and uninsulated at the other end. Thus the uninsulated end, nearer the front panel, picks up A minus directly from the subpanel.

Between these two resistors are the resistor coupler mountings. Put three flat insulators between each of these two mountings and subpanel, to prevent the lugs on the mountings from touching the subpanel. You will find that the lugs of these mountings can be pivoted, so cut down the sides of the .01 condenser lugs until these lugs will pass into the mounting lugs nearer the sockets.

Thus the resistor mountings are close to the sockets they serve.

The reason why this accessibility prevails in several places is that (apart from the fact it was so intended) the sockets are in an unusual order. Left to right, front panel toward you, the sockets are: first audio, RF, detector and push-pull pair.

WABC GRANTED 50,000 WATTS AS EXPERIMENT

Washington.

Authority to use the maximum broadcasting power of 50,000 watts has been granted to WABC, key station of the Columbia broadcasting system, in New York, the Federal Radio Commission announced.

The station, which previously used 5,000 watts, will be removed to a location outside the city limits of New York, pursuant to engineering regulations of the Commission which require that high-powered transmitters be remote from thickly populated areas because of the "blanketing" of the signals of lower-powered stations transmitting in the sections.

Robinson Opposes

In its application for increased power, the Columbia System stated that the new site had not yet been determined.

Chairman Ira E. Robinson voted against the grant of increased power. Commissioners Sykes, Lafount, and Starbuck voted in favor.

Sam Pickard, vice-president of the Columbia System, former member of the Commission, presented the application. He said that WABC, with its low power, was unable adequately to cover the metropolitan area of New York. He explained that the National Broadcasting Company has two key stations in New York—WEAF, using 50,000 watts, and WJZ, 30,000 watts.

KNX Got 50 KW

Under Commission regulations, says "The United States Daily," the maximum power actually allocated broadcasting stations is 25,000 watts, with 25,000 watts additional awarded on an experimental basis. There are now six stations throughout the country using this maximum power, while construction permits to build such stations are held by six other stations.

KNX, Los Angeles, Calif., previously obtained authority to use 50,000 watts.

Bill Bans Lottery in Air Advertising

Washington.

A bill to prohibit lottery advertising over the radio was recently introduced in Congress by Representative Burton L. French, of Moscow, Idaho.

According to Mr. French, this type of advertising constitutes as much a violation as that if it were advertising in newspapers, which has long been prohibited.

Kolster-Earl Merger Is Put Into Effect

The Kolster Radio Corporation recently acquired the Earl Radio Company, by an exchange of three shares of Earl stock for one of Kolster.

The present chairman of the board of Kolster, Rudolph Spreckels, will remain as chairman of the Kolster board. Clarence A. Earl, president of the Earl company, will become president of the new company. Ellery Stone, now president of the Kolster Company, will become chairman of the executive committee.

Ether Music Maker To be Sold by RCA

The patents covering Prof. Leo Theremin's "ether music" device have been acquired by the Radio Corporation of America. The instrument, played by merely waving the hands, one controlling the volume and the other the tone, will be made by the General Electric Company and the Westinghouse Electric and Manufacturing Company, and merchandised by RCA. It will sell for $175.

The first public demonstration of this device was given by Prof. Theremin, in the Metropolitan Opera House on January 31st of this year. He had arrived from Russia only a month before. It met with instantaneous success.

The sounds emanate through a loudspeaker, and are of approximately the same frequencies as those of a 'cello. Beat note oscillation produces the sounds.

WORLD CONTROL IS PROPOSED

Berlin.

Control of radio broadcasting through a world organization under the jurisdiction of the League of Nations was recommended by the International Parliamentary Economic Congress which recently met in Berlin.

A proposal that an international statute shall govern world radio activities was made, this statute to provide among other things the elimination of transmission conflicts between various competing stations and also guarantee more equitable distribution of short wave allocations. The fact that radio is of an international structure, which makes it a valuable agency for the promotion of peace, was pointed out. While its functions are akin to those of the press, the stage and literature, it commands an unique position in relation to problems which affect human endeavor, it was further stated.

Recommendations for the erection of an international broadcasting station at Geneva were also made.

Phones to Australia, 15,000 Miles Away

In a recent test, the new round-the-world radiophone circuit of the American Telephone and Telepgraph Company was put into action, when Dr. Frank Jewett spoke from his office at 195 Broadway, New York City, over a standard desk phone to a person in Australia. The voice traveled a distance of 15,000 miles. The transmissions are made on short waves. Different frequencies are used, according to the weather conditions.

The service will be placed into commercial operation shortly.

Spearman Promoted

Washington.

The Federal Radio Commission has appointed Paul D. P. Spearman, of Jackson, Miss., assistant general counsel to the commission. For the past six months, Mr. Spearman has been on the Commission's legal staff. He now becomes one of the two assistant general counsel.

SOON FOREIGN STATIONS WILL RING IN EARS

One of the big attractions to be expected the coming winter is trans-oceanic programs.

According to arrangements independently completed between the two largest chain station operators, the National Broadcasting Company and the Columbia Broadcasting System, and stations in Europe, the broadcasts will begin during December, and will take place nearly every week, during the late afternoon.

The recent tests conducted by these companies whereby programs originating in studios of stations throughout Europe were rebroadcast on regular broadcast waves after being picked up on short waves, were highly successful. The signals received were with great volume and with extreme clarity.

So highly successful has been the special experimental work on international broadcasts covering distances twice and three times as great as heretofore, that station owners predict that next year we will be able to listen to programs emanating from stations located in the farthest points of the earth, by the rebroadcast method.

Hoover, Jr., Obtains 35 Trade Licenses

Washington.

The Federal Radio Commission recently approved thirty-five applications for aeronautical station licenses and for modification of licenses for communication between plane and ground, and point to point, made by the Western Air Express. The applications were filed by Herbert Hoover, Jr., who is the technical adviser to the president of the company. These applications were filed before the revised set up by aeronautical radio communication.

Automatic Beacons Used in Canal Zone

Washington.

A notice recently made by the lighthouse service of the Department of Commerce says that an automatic radio beacon is now in operation on each side of the Panama Canal, one at Cristabol at the Atlantic entrance and one at Capa Malta in the Pacific approach. This means that ships 100 to 200 miles distant from this zone will be able to take accurate bearings each half hour to guide them to the canal entrances.

These beacons are the first in the western hemisphere, south of the United States coasts.

TELEVISION LICENSE RENEWED

Washington.

The general experimental and experimental television licenses of Radio Pictures, Inc., of New York City was recently renewed by the Federal Radio Commission.

A THOUGHT FOR THE WEEK

RADIO assuredly is now in the Big Business class. Proof: mergers accomplished, mergers in the offing and talk of mergers all over the place. Looks as if Wall Street had become radio-minded—and the band has only just started to play.

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

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

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

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

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

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

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

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

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

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

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

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

650 KC, 461.3 METERS
WSM-Nashville, Tenn.

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

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

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

****690 KC, 434.5 METERS**

700 KC, 428.3 METERS
WLW-Mason, Ohio

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

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

****730 KC, 413 METERS**

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

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

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

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

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

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

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

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

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

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

****840 KC, 356.9 METERS**

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

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

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

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

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

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

****910 KC, 329.5 METERS**

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

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

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

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

****960 KC, 312.3 METERS**

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

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

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

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

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

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

****1030 KC, 291.2 METERS**

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

LANGMUIR TUBE PATENTS FOUND RIGHTLY VOIDED

Washington.

Three patents issued to Dr. Irving Langmuir covering vacuum tubes, used principally in radio receiving apparatus, have been held to be invalid by the Circuit Court of Appeals for the Third Circuit.

The three patents are No. 1558436, known as the high vacuum tube patent; No. 1244216, covering the use of thoriated tungsten filament in a high vacuum tube, and No. 1529597, known as the magnesium flash patent covering the use of a magnesium vaporizable agent.

G. E. Sued De Forest

Langmuir patent No. 1244217 relating to electrical devices having a thoriated cathode was held to be valid by the court.

The assignee of these patents, the General Electric Company, brought suit for infringement against the DeForest Radio Company in the District Court for the District of Maryland, and the defendant alleged invalidity of the patents.

The District Court held that the first patent mentioned was invalid in view of the prior art developed on part by Dr. Lee DeForest. The second patent was held not to involve invention, while the third patent was held to be invalid in view of one of Dr. Langmuir's prior patents. The fourth patent was held to be valid.

Court's Brief Opinion

The Appellate Court, Judge Buffington dissenting, affirmed the decrees of the lower court in a per curiam opinion which follows in full text:

"The issues raised on these appeals were fully discussed in the opinion of the learned district judge and we agree with his conclusions. The decrees are, accordingly, affirmed on his opinion."

Producer Objects To Broadcast Review

London.

A critic has no right to express his views freely on current productions over the radio, according to Bertie Meyers, theatrical producer, who has protested to the British Broadcasting Corporation against the review of his production "The Flying Fool", criticized by James Agate, the dramatic critic of the BBC, who is also the dramatic critic of the "Sunday Times".

Mr. Meyers said that the criticisms carried remarks which were injurious to the success of the production.

Licensed to Transmit From Falling Parachute

Washington.

Authority to operate a broadcasting transmitter, using only one watt of power, from a parachute when it is descending, was granted by the Federal Radio Commission to Roosevelt Field, Inc., of New York.

It was explained at the Commission that the transmitter will be used in instructing classes in parachute jumping. The instructor, it was said, after he has jumped from the plane, will broadcast to the class on the ground the proper methods of parachute jumping. The license granted is for experimental work on the frequency of 2,368 kilocycles.

Forum

A Word for a Few Million

IN the October 5th issue of the RADIO WORLD in the Forum column I find several interesting things that I would like to comment upon.

With due regards to Mr. Braddock, of Tampa, Florida, I would like to ask him where he received his information about the people interested in battery-operated receivers being such a meagre minority.

Perhaps it would interest Mr. Braddock to learn that there are people living west of the Mississippi River, and that perhaps three-fourths of these depend entirely upon battery outfits to operate these receivers. It might interest him to know that some of these people haul these same batteries as far as fifteen miles to get them charged.

Perhaps Mr. Braddock's radio is much more important to him than radio is to these few million people.

Enough of this, though. Let me suggest that Mr. Work, of Bangor, Me., subscribe for "Radio-Craft". It and RADIO WORLD ought to go hand in hand. RADIO WORLD tells how to make them and "Radio-Craft" tells how to fix them when they won't work.

Here is an idea of my own. Maybe there is such a place as this but I never heard of it. Why doesn't somebody start a school for radio service men, where they take regular sets and throw them out of adjustment; then let the students fix them; or take sets that won't work and let the students fix them? Of course, it would be desirable to give a thorough course in theory, too.

I think RADIO WORLD is the best.

Everett James, St. Charles, Iowa.

* * *

At It Five Years; Still Going

I READ with amusement the letters from certain peevish individuals and I want to say, in all fairness, that after five years of buying RADIO WORLD I have nothing but praise for it. As for one gentleman's remark about "all electric" sets, it seemed rather pointless to me. Doesn't he know that any set served by A and B eliminators is an electric set, even though it be a table model? And doesn't he know that such a set can be made to perform better than an "all electric" console set with its boxed-in, boomy speaker? But perhaps he was speaking in terms of "furniture". This seems to be the most important feature of sets today. Few realize that we have, musically speaking, quite some distance to travel yet. The thing to worry over is the loudspeaker and honest-to-goodness, no-kidding, realism.

Let's forget the "all electric" mumbo-jumbo and concentrate on something important. If RADIO WORLD were to ignore eliminator-served sets it would lose half its patrons.

Frank Keats, Elizabeth, N. J.

Congress to Resume Monopoly Inquiry

Washington.

Immediately upon the passage of the tariff bill, the investigations by Congress into the fields of radio, telephone, telegraph and cable communication, suspended last Spring, will be resumed.

The radio monopoly question will be one of the topics discussed.

BIG STATIONS QUIZZED ABOUT USE OF WAVES

Washington.

A survey of the actual amount of communications maintained by licensees over radio channels assigned for their use, which will embrace the entire range of the radio frequencies, will be undertaken by the Federal Radio Commission.

"Plans already have been completed for the canvass of radio license holders," said W. J. Clearman, investigator for the Commission. The survey, he explained, is being undertaken at the direction of Harold A. Lafount, Radio Commissioner in charge of investigations.

When this information is obtained, Mr. Clearman said, the files of the Commission will show the actual amount of communication carried on over every channel; prgoress being made in experiments conducted on frequencies reserved for such purposes; hours of operation over each frequency, and similar information.

Duplication to be Noted

On the broadcasting frequencies ranging from 550 to 1,500 kilocycles the survey will provide information as to the extent of duplication of programs by stations on cleared channels which subscribe to chains, and the number of hours each station devotes to particular types of programs, such as educational, musical, mechanical reproductions, and the like.

It will require several months, according to Mr. Clearman, to complete the survey of point-to-point licensees. After it is concluded, the plan is to canvass licensees assigned to the frequencies reserved for television and visual broadcasting experiments. When that is completed, another separate group of licensees will be canvassed, he explained, until the entire spectrum will have been covered.

23,000 kc Present Limit

Mr. Clearman pointed out to "The United States Daily" that the radio art has advanced to the stage where it is possible to use frequencies up to 23,000 kilocycles.

Beyond this point, he said, lies the "great unknown" of radio, but experimenters, with the permission of the Commission, are now endeavoring to utilize channels ranging from 23,000 to 35,000 kilocycles, and the survey will show how far these experiments have progressed.

Loudspeaker Heard Thirty Miles Away

London.

At the recent National Radio Exhibition, held in Olympia, a giant loudspeaker and audio amplifier having a reputed amplification factor of 3,000, enabled speech to be heard over a thirty-mile area.

LITERATURE WANTED

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Harvey B. Paul, L. Box 582, Port Carbon, Pa.

Anton Adasiewicz, care Central Garage, Stambaugh, Mich.

Joseph Freund, 1430 E. Lake Road, Erie, Pa.

Alphabetical List of Stations by Call Letters; Location and Frequency

Station Location Frequency
WAAF—Chicago, Ill., 920
WAAM—Newark, N. J., 1250
WAAT—Jersey City, N.J., 1070
WAAW—Omaha, Nebr., 660
WABC-WBOQ—N.Y. City, 860
WABI—Bangor, Me., 1200
WABZ—New Orleans, La., 1200
WADC—Akron, O., 1320
WAGM—Royal Oak, Mich., 1310
WAIU—Columbus, O., 640
WAPI—Birmingham, Ala., 1140
WASH—Gd. Rapids, Mich., 1270
WBAK—Harrisburg, Pa., 1430
WBAL—Baltimore, Md., 1060
WBAP—Fort Worth, Tex., 800
WBAW—Nashville, Tenn., 1490
WBAX—Wilkes-Barre, Pa., 1210
WBBC—Brooklyn, N. Y., 1400
WBBL—Richmond, Va., 1370
WBBM-WJBT—Chicago, Ill., 770
WBBR—Rossville, N. Y., 1300
WBBY—Charleston, S. C., 1200
WBBZ—Ponca City, Okla., 1200
WBCM—Bay City, Mich., 1410
WBIS—See WNAC
WBMS—Fort, Lee., N. J., 1450
WBNY—New York, N. Y., 1350
WBOQ—See WABC
WBOW—Terre Haute, Ind., 1310
WBRC—Birmingham, Ala., 930
WBRE—Wilkes-Barre, Pa., 1310
WBRL—Tilton, N. H., 1430
WBSO—Wellesley H., Mass., 780
WBT—Charlotte, N. C., 1080
WBZ—Springfield, Mass., 990
WBZA—Boston, Mass., 990
WCAC—Storrs, Conn., 600
WCAD—Canton, N. Y., 1220
WCAE—Pittsburgh, Pa., 1220
WCAH—Columbus, Ohio, 1430
WCAJ—Lincoln, Nebr., 590
WCAL—Northfield, Minn., 1250
WCAM—Camden, N. J., 1280
WCAO—Baltimore, Md., 600
WCAP—Asbury Pk., N. J., 1280
WCAT—Rapid City, N.D., 1200
WCAU—Philadelphia, Pa., 1170
WCAZ—Carthage, Ill., 1070
WCBA—Allentown, Pa., 1440
WCBD—Zion, Ill., 1080
WCBM—Baltimore, Md., 1370
WCBS—Springfield, Ill., 1210
WCCO—Minneapolis, Minn., 810
WCDA—Cliffside, Pk., N.J., 1350
WCFL—Chicago, Ill., 970
WCGU—Coney Island, N.Y.,1400
WCKY—Covington, Ky., 1480
WCLB—Lg. Beach, N.Y., 1500
WCLO—Kenosha, Wis., 1200
WCLS—Joliet, Ill., 1310
WCMA—Culver, Ind., 1400
WCOA—Pensacola, Fla., 1120
WCOC—Columbus, Miss., 880
WCOH—Yonkers, N.Y., 1210
WCRW—Chicago, Ill., 1210
WCSH—Portland, Maine, 940
WCSO—Springfield, O., 1380
WDAE—Tampa, Fla., 620
WDAF—Kansas City, Mo., 610
WDAG—Amarillo, Tex., 1410
WDAH—El Paso, Tex., 1310
WDAY—W. Fargo, N. D., 1280
WDBJ—Roanoke, Va., 930
WDBO—Orlando, Fla., 620
WDEL—Wilmington, Ind., 1120
WDGY—Minneapolis, Minn., 1180
WDOD—Chattanooga, Tenn., 1280
WDRC—New Haven, Conn.,1330
WDSU—New Orleans, La., 1270
WDWF-WLSI—Cr'nst'n,R.I.1210
WDZ—Tuscola, Ill., 1070
WEAF—New York, N.Y., 660
WEAI—Ithaca, N. Y., 1270
WEAN—Providence, R.I., 780
WEAO—Columbus, O., 550
WEAR—Cleveland, O., 1070
WEBC—Duluth, Minn., 1280
WEBE—Cambridge, O., 1210
WEBQ—Harrisburg, Ill., 1210
WEBR—Buffalo, N. Y., 1310
WEBW—Beloit, Wis., 600
WEDC—Chicago, Ill., 1210
WEDH—Erie, Pa., 1420
WEEI—Weymouth, Mass., 590
WEHS—Evanston, Ill., 1310
WELK—Phila, Pa., 1370
WEMC—Berrien Spgs., Mch. 590
WENR-WBCN—Chicago, Ill., 870
WEPS—Gloucester, Mass., 1200
WEVD—New York, N. Y., 1300
WEW—St. Louis, Mo., 760
WFAA—Dallas, Texas, 800
WFAN—Philadelphia, Pa., 610
WFBC—Knoxville, Tenn., 1200
WFBG—Altoona, Pa., 1310
WFBJ—Collegeville, Minn., 1370
WFBL—Syracuse, N. Y., 900
WFBM—Indianapolis, Ind., 1230
WFBR—Baltimore, Md., 1270
WFDF—Flint, Mich., 1310
WFI—Philadelphia, Pa., 560
WFIW—Hopkinsville, Ky., 940
WFJC—Akron, O., 1450
WFKD—Philadelphia, Pa., 1310
WFLA-WSUN—Clrw'tr Fla, 900
WGAL—Lancaster, Pa., 1310
WGBB—Freeport, N. Y., 1210
WGBC—Memphis, Tenn., 1430
WGBF—Evansville, Ind., 630
WGBI—Scranton, Pa., 880
WGBS—New York City, 1180
WGCM—Gulfport, Miss., 1210
WGCP—Newark, N. J., 1250
WGES—Chicago, Ill., 1360
WGH—Newport News, Va., 1310
WGHP—Detroit, Mich., 1240
WGL—Ft. Wayne, Ind., 1370
WGMS—See WLB-WGMS
WGN-WLIB—Elgin, Ill., 720
WGR—Buffalo, N. Y., 550
WGST—Atlanta, Ga., 890
WGY—Schenectady, N. Y., 790
WHA—Madison, Wis., 940
WHAD—Milwaukee, Wis., 1120
WHAM—Rochester, N. Y., 1150
WHAP—N. Y. City, 1300
WHAS—Louisville, Ky., 820
WHAZ—Troy, N. Y., 1300
WHB—Kansas City, Mo., 950
WHBC—Canton, Ohio, 1200
WHBD—Bellefontaine, O., 1370
WHBF—Rock Island, Ill., 1210
WHBL—Sheboygan, Wis., 1410
WHBP—Johnstown, Pa., 1310
WHBQ—Memphis, Tenn., 1370
WHBU—Anderson, Ind., 1210
WHBW—Philadelphia, Pa., 1500
WHBY—W. De Pere, Wis., 1200
WHDF—Calumet, Mich., 1370
WHDH—Gloucester, Mass., 830
WHDI—Minneapolis, Minn. 1180
WHDL—Tupper Lake, N.Y.,1420
WHEC-WABO-Roch'st'r,NY.1440
WHFC—Cicero, Ill., 1310
WHIS—Bluefield, W. Va., 1420
WHK—Cleveland, Ohio, 1390
WHN—New York, N.Y., 1010
WHO—Des Moines, Ia., 1000
WHP—Harrisburg, Pa., 1430
WIAS—Ottumwa, Iowa, 1420
WIBA—Madison, Wis., 1210
WIBG—Elkins, Park, Pa., 930
WIBM—Jackson, Mich., 1370
WIBO—Chicago, Ill., 570
WIBR—Steubenville, O., 1420
WIBS—Elizabeth, N. J., 1450
WIBU—Poynette, Wis., 1310
WIBW—Topeka, Kan., 1300
WIBX—Utica, N. Y., 1200
WICC—Bridgeport, Conn., 1190
WIL—St. Louis, Mo., 1200
WILL—Urbana, Ill., 890
WILM—Wilmington, Del., 1420
WINR—Bay Shore, N. Y., 1210
WIOD—Miami Beach, Fla., 560
WIP—Philadelphia, Pa., 610
WISN—Milwaukee, Wis., 1120
WJAD—Waco, Texas, 1240
WJAG—Norfolk, Nebr., 1060
WJAK—Kokomo, Ind., 1310
WJAR—Providence, R.I., 890
WJAS—Pittsburgh, Pa., 1290
WJAX—Jacksonville, Fla., 1260
WJAY—Cleveland, Ohio, 620
WJAZ—Chicago, Ill., 1480
WJBC—La Salle, Ill., 1200
WJBI—Red Bank, N. J., 1210
WJBK—Ypsilanti, Mich., 1370
WJBL—Decatur, Ill., 1200
WJBO—New Orleans, La., 1370
WJBU—Lewisburg, Pa., 1210
WJBW—New Orleans, La., 1200
WJBY—Gadsden, Ala., 1210.
WJDW—Emory, Va., 1370
WJDX—Jackson, Miss., 1270
WJDZ—W. Salem, N. C., 1310
WJJD—Mooseheart, Ill., 1130
WJKS—Gary, Ind., 1360
WJR—Detroit, Mich., 750
WJSV—Mt.Vernon Hills,Va., 1460
WJW—Mansfield, O., 1210
WJZ—New York, N. Y., 760
WKAQ—San Juan, P. R., 890
WKAR—E. Lansing, Mich., 1040
WKAV—Laconia, N. H., 1310
WKBB—Joliet, Ill., 1310
WKBC—Birmingham, Ala., 1310
WKBF—Indianapolis, Ind., 1400
WKBH—La Crosse, Wis., 1380
WKBI—Chicago, Ill., 1310
WKBN—Youngstown, O., 570
WKBO—Jersey City, N.J., 1450
WKBP—Battle Creek, Mcb.,1420
WKBQ—New York, N. Y., 1350
WKBS—Galesburg, Ill., 1310
WKBV—Brookville, Ind., 1500
WKBW—Buffalo, N. Y., 1470
WKBZ—Ludington, Mich., 1500
WKEN—Buffalo, N. Y., 1040
WKJC—Lancaster, Pa., 1200
WKRC—Cincinnati, O., 550
WKY—Okla. City, Okla., 900
WLAC—Nashville, Tenn., 1490
WLAP—Louisville, Ky., 1200
WLB-WGMS—Minneapolis, 1250
WLBC—Muncie, Ind., 1310
WLBF—Kansas City, Mo., 1420
WLBG—Ettrick, Va., 1200
WLBL—Stevens Pt., Wis., 900
WLBW—Oil City, Pa., 1260
WLBX—L. I. City, N.Y., 1500
WLBZ—Bangor, Maine, 620
WLCI—Ithaca, N. Y., 1210
WLEX—Lexington, Mass., 1360
WLEY—Lexington, Mass., 1420
WLIB-WGN—See WGN-WLIB
WLIT—Philadelphia, Pa., 560
WLOE—Chelsea, Mass., 1500
WLS—Chicago, Ill., 870
WLSI-WDWF—See WDWF
WLTH—Brooklyn, N. Y., 1400
WLW—Mason, Ohio, 700
WLWL—New York, N. Y., 1100
WMAC—Cazenovia, N. Y., 570
WMAF—Dartmouth, Mass., 1360
WMAK—Buffalo, N. Y., 900
WMAL—Washington, D.C., 630
WMAN—Columbus, Ohio, 1210
WMAQ—Chicago, Ill., 670
WMAZ—Macon, Ga., 890
WMBA—Newport, R. I., 1500
WMBC—Detroit, Mich, 1420
WMBD—Peoria Hts., Ill., 1440
WMBG—Richmond, Va., 1210
WMBH—Joplin, Mo., 1420
WMBI—Addison, Ill., 1080
WMBJ—Pittsburgh, Pa., 1500
WMBL—Lakeland, Fla., 1310
WMBO—Auburn, N. Y., 1370
WMBQ—Brooklyn, N. Y., 1500
WMBR—Tampa, Fla., 1210
WMC—Memphis, Tenn., 570
WMCA—New York, N.Y., 570
WMES—Boston, Mass., 1500
WMMN—Fairmont, W. Va., 890
WMPC—Lapeer, Mich., 1500
WMRJ—Jamaica, N. Y., 1420
WMSG—New York, N. Y., 1350
WMT—Waterloo, Iowa, 1200
WNAC-WBIS—Boston, 1230
WNAD—Norman, Okla., 1010
WNAT—Philadelphia, Pa., 1310
WNAX—Yankton, S. D., 570
WNBF—Binghamton, N.Y., 1500
WNBH—N'w Bedf'rd, Mass.,1310
WNBJ—Knoxville, Tenn., 1310
WNBO—Washington, Pa., 1200
WNBR—Memphis, Tenn., 1430
WNBW—Carbondale, Pa., 1200
WNBX—Springfield, Vt., 1200
WNBZ—Saranac Lk., N.Y. 1290
WNJ—Newark, N. J., 1450
WNOX—Knoxville, Tenn., 560
WNRC—Greensboro, N.C., 1440
WNYC—New York, N.Y., 570
WOAI—San Antonio, Tex., 1190
WOAN—Lawrenceburg, Tenn. 600
WOAX—Trenton, N. J., 1280
WOBT—Union City, Tenn., 1310
WOBU—Charlestown, W.Va., 580
WOC—Davenport, Ia., 1000
WOCL—Jamestown, N. Y., 1210
WODA—Paterson, N. J., 1250
WOI—Ames, Iowa, 560
WOK-WMBB—See WMBB
WOKO—Poughkeepsie, NY., 1440
WOL—Washington, D.C., 1310
WOMT—Manitowoc, Wis., 1210
WOOD—Gd. Rapids, Mich., 1270
WOQ—Kansas City, Mo., 610
WOR—Newark, N. J., 710
WORC—Auburn, Mass., 1200
WORD—Chicago, Ill., 1480
WOS—Jefferson City, Mo., 630
WOV—New York, N.Y., 1130
WOW—Omaha, Nebr., 590
WOWO—Ft. Wayne, Ind., 1160
WPAP-WQAO—See WQAO
WPAW—Pawtucket, R.I., 1210
WPCC—Chicago, Ill., 570
WPCH—New York, N.Y., 810
WPEN—Philadelphia, 1500
WPG—Atlantic City, N.J.,1100
WPOE—Patchogue, N. Y., 1420
WPOR-WTAR—See WTAR
WPRC—Harrisburg, Pa., 1200
WPSC—State College, Pa., 1230
WPTF—Raleigh, N. C., 680
WQAM—Miami, Fla., 1240
WQAN—Scranton, Pa., 880
WQAO-WPAP—N.Y.C., 1010
WQBC—Utica, Miss., 1360
WQBZ—Weirton, W.V., 1420
WRAF—LaPorte, Ind., 1200
WRAK—Erie, Pa., 1370
WRAW—Reading, Pa., 1310
WRAX—Philadelphia, Pa., 1020
WRBC—Valparaiso, Ind., 1240
WRBI—Tifton, Ga., 1310
WRBJ—Hattiesburg, Miss., 1500
WRBL—Columbus, Ga., 1200
WRBQ—Greenville. Miss., 1210
WRBT—Wilmington, N. C., 1370
WRBU—Gastonia, N.C., 1210
WRC—Washington, D. C., 950
WREC—Memphis, Tenn., 600
WREN—Lawrence, Kans., 1220
WRHM—Friedley, Minn., 1250
WRJN—Racine, Wis. 1370
WRK—Hamilton, Ohio, 1310
WRNY—New York, N.Y., 1010
WRR—Dallas, Tex., 1280
WRUF—Gainesville, Fla., 1470
WRVA—Richmond, Va., 1110
WSAI—Cincinnati, O., 1330
WSAJ—Grove City, Pa., 1310
WSAN—Allentown, Pa., 1440
WSAR—Fall River, Mass., 1450
WSAZ—Huntington, W.V., 580
WSB—Atlanta, Ga., 740
WSBC—Chicago, 1210
WSBT—South Bend, Ind., 1230
WSDA-WSGH—See WSGH
WSGH-WSDA—Bklyn.,NY. 1400
WSGP—Savannah, Ga., 1410
WSIX—Springfield, Tenn., 1210
WSM—Nashville, Tenn., 650
WSMB—New Orleans, La., 1320
WSMK—Dayton, Ohio, 570
WSOA—Deerfield, Ill., 1480
WSPD—Toledo, Ohio, 1340
WSSH—Boston, Mass., 1420
WSUI—Iowa City, Ia., 580
WSUN-WFLA—See WFLA
WSVS—Buffalo, N. Y., 1370
WSYR—Syracuse, N. Y., 570
WTAD—Quincy, Ill., 1440
WTAG—Worcester, Mass., 580
WTAM—Cleveland, O., 1070
WTAQ—Eau Claire, Wis., 1330
WTAR-WPOR—Norf'lk, Va., 780
WTAW—College Station, 1120
WTAX—Streator, Ill., 1210
WTBO—Cumberland, Md., 1420
WTFI—Toccoa, Ga., 1450
WTIC—Avon, Ct., 600, 1060
WTMJ—Milwaukee, Wis., 620
WWAE—Hammond, Ind., 1200
WWJ—Detroit, Mich., 920
WWL—New Orleans, La., 850
WWNC—Asheville, N. C., 570
WWRL—Woodside, N.Y., 1500
WWVA—Wheeling, W.Va., 1160
KCRC—Enid, Okla., 1370
KDB—Santa Barbara, Cal.,1500
KDKA—Pittsburgh, Pa., 980
KDLR—Devils Lake, N.D., 1210
KDYL—Salt Lake, Utah, 1290
KEJK—Beverly Hills, Calif., 1170
KELW—Burbank, Calif., 780
KEX—Portland, Ore., 1180
KFAB—Lincoln, Nebr., 770
KFAD—Phoenix, Ariz., 620
KFBB—Great Falls, Mont., 1360
KFBK—Sacramento, Calif., 1310
KFBL—Everett, Wash., 1370
KFDM—Beaumont, Tex., 560
KFDY—Brookings, S.Dak., 550
KFEL—Denver, Colo., 940
KFEQ—St. Joseph, Mo., 560
KFGQ—Boone, Iowa, 1310
KFH—Wichita, Kans., 1300
KFHA—Gunnison, Colo., 1200
KFI—Los Angeles, Calif., 640
KFIF—Portland, Ore., 1420
KFIO—Spokane, Wash., 1230
KFIZ—Fond du Lac, Wis., 1420
KFJB—Marshalltown, Ia., 1200
KFJF—Okla., City., Okla., 1470
KFJI—Astoria, Ore., 1370
KFJM—Gd. Forks., N.D., 1370
KFJR—Portland, Ore., 1300
KFJY—Fort Dodge, Iowa, 1310
KFJZ—Fort Worth, Tex., 1370
KFKA—Greeley, Colo., 880
KFKB—Milford, Kans., 1050
KFKU—Lawrence, Kans., 1220
KFKX-KYW—See KYW
KFKZ—Kirksville, Mo., 1200
KFLV—Rockford, Ill., 1410
KFLX—Galveston, Tex., 1370
KFMX—Northfield, Minn., 1250
KFNF—Shenandoah, Iowa, 890
KFOR—Lincoln, Nebr., 1210
KFOX—Long Beach, Calif, 1250
KFPL—Dublin, Tex., 1310
KFPM—Greenville, Tex., 1310
KFPW—Siloam Spgs., Ark.,1340
KFPY—Spokane, Wash., 1390
KFQA-KMOX—See KMOX
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KFQU—Holy City, Calif., 1420
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KFQZ—Hollywood, Calif., 860
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KFRU—Columbia, Mo., 630
KFSD—San Diego, Calif., 600
KFSG—Los Angeles, Calif., 1120
KFUL—Galveston, Tex., 1290
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KFUP—Denver, Colo., 1310
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KGER—Lg. Beach, Calif., 1370
KGEW—Ft. Morgan, Colo., 1200
KGEZ—Kalispell, Mont., 1310
KGFF—Alva., Okla., 1420
KGFG—Okla. City, Okla., 1370
KGFI—Corpus Christi, Tex.,1500
KGFJ—Los Angeles, Calif., 1420
KGFK—Hallock, Minn., 1200
KGFL—Raton, N. Mex., 1370
KGFW—Ravenna, Nebr., 1420
KGFX—Pierre, S. D., 580
KGGC—San Francisco, Cal.,1420
KGGF—Picher, Okla., 1010
KGGM—Albuquerque, N.M., 1370
KGHF—Pueblo, Colo., 1320
KGHG—McGehee, Ark., 1310
KGHI—Little Rock, Ark., 1500
KGHL—Billings, Mont., 950
KGHX—Richmond, Tex., 1500
KGIQ—Twin Falls, Idaho, 1320
KGIR—Butte, Mont., 1360
KGIW—Trinidad, Colo., 1420
KGIX—Las Vegas, Nev., 1420
KGJF—Little Rock, Ark., 890
KGKB—Brownwood, Tex., 1500
KGKL—San Angelo, Tex., 1370
KGKO—Wichita, Falls, Tex 570
KGKX—San Point, Idaho, 1420
KGO—Oakland, Calif., 790
KGRC—San Antonio, Tex., 1370
KGRS—Amarillo, Tex., 1410
KGU—Honolulu, Hawaii, 940
KGW—Portland, Ore., 620
KGY—Lacey, Wash., 1200
KHJ—Los Angeles, Calif., 900
KHQ—Spokane, Wash., 590
KICK—Red Oak, Iowa, 1420
KID—Idaho Falls, Idaho, 1320
KIDO—Boise, Idaho. 1250
KIT—Yakima, Wash., 1370
KJBS—San Francisco, Cal., 1070
KJR—Seattle, Wash, 970
KLCN—Blytheville, Ark., 1290
KLO—Ogden, Utah, 1370
KLPM—Minot, N.D., 1420
KLRA—Little Rock, Ark., 1390
KLS—Oakland, Calif., 1440
KLX—Oakland, Calif., 880
KLZ—Dupont, Colo., 560
KMA—Shenandoah, Iowa, 930
KMBC—Independence, Mo., 950
KMED—Medford, Ore., 1310
KMIC—Inglewood, Calif., 1120
KMJ—Fresno, Calif., 1200
KMMJ—Clay Center, Nebr., 740
KMO—Tacoma, Wash., 1340
KMOX-KFQA—St. Louis, 1090
KMTR—Hollywood, Calif., 570
KNX—Hollywood, Calif., 1050
KOA—Denver, Colo., 830
KOAC—Corvallis, Ore., 560
KOB—State College, N.M., 1180
KOCW—Chickasha, Okla., 1400
KOH—Reno, Nev., 1370
KOIL—Council Bluffs, Ia., 1260
KOIN—Portland, Ore., 940
KOL—Seattle, Wash., 1270
KOMO—Seattle, Wash, 920
KOOS—Marshfield, Ore., 1370
KORE—Eugene, Ore., 1420
KOY—Phoenix, Ariz., 1390
KPCB—Seattle, Wash., 1210
KPJM—Prescott, Ariz., 1500
KPLA—Los Angeles, Calif., 1000
KPO—San Francisco, Cal, 680
KPOF—Denver, Colo., 880
KPPC—Pasadena, Calif., 1200
KPQ—Seattle, Wash., 1210
KPRC—Houston, Tex., 920
KPSN—Pasedena, Calif., 950
KPWF—Westminster, Calif.1490
KQV—Pittsburgh, Pa., 1380
KQW—San Jose, Calif., 1010
KRE—Berkeley, Calif., 1370
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KRLD—Dallas, Tex., 1040
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KRSC—Seattle, Wash., 1120
KSAC—Manhattan, Kans., 580
KSCJ—Sioux City, Ia., 1330
KSD—St. Louis, Mo., 550
KSEI—Pocatello, Idaho, 900
KSL—Salt Lake City, U., 1130
KSMR—Santa Maria, Calif, 1200
KSO—Clarinda, Iowa, 1380
KSOO—Sioux Falls, S. D., 1110
KSTP—St. Paul, Minn., 1460
KTAB—Oakland, Calif., 550
KTAP—San Antonio, Tex., 1420
KTAT—Ft. Worth, Tex., 1240
KTBI—Los Angeles, Calif., 1300
KTBR—Portland, Ore., 1300
KTBS—Shreveport, La., 1450
KTHS—Hot Springs, Ark., 1040
KTM—Los Angeles, Calif.,780
KTNT—Muscatine, Iowa, 1170
KTSA—San Antonio, Tex., 1290
KTSL—Shreveport, La., 1310
KTSM—El Paso, Tex., 1310
KTUE—Houston, Tex., 1420
KTW—Seattle, Wash., 1270
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KUSD—Vermillion, S.D., 890
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KVEP—Portland, Ore., 1500
KVI—Tacoma, Wash., 760
KVL—Seattle, Wash., 1370
KVOA—Tucson, Ariz., 1260
KVOO—Tulsa, Okla., 1140
KVOS—Bellingham, Wash., 1200
KWCR—Cedar Rapids, Ia., 1310
KWEA—Shreveport, La., 1210
KWG—Stockton, Calif., 1200
KWJJ—Portland, Ore., 1060
KWK—St. Louis Mo., 1350
KWKC—Kansas City, Mo., 1370
KWKH—Kennonwood, La., 850
KWLC—Decorah, Iowa, 1270
KWSC—Pullman, Wash., 1390
KWTC—Santa Ana, Calif., 1500
KWWG—Brownsville, Tex.,1260
KWYO—Laramie, Wyo., 600
KXA—Seattle, Wash., 570
KXL—Portland, Ore., 1250
KXO—El Centre, Calif., 1200
KXRO—Aberdeen, Wash., 1420
KYA—San Francisco, Cal.,1230
KYW-KFKX—Chicago, Ill., 1020
KYWA—Chicago, Ill., 1020
KZM—Hayward, Calif., 1370

New High Mu AC Tube

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

228 Provides Higher Amplification and is an Excellent Power Detector

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

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

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

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

228
$2.50

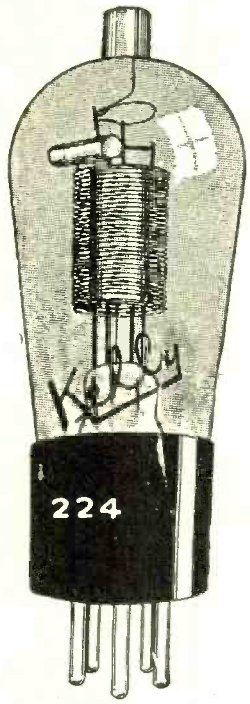
CHARACTERISTICS OF THE 228

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

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

The 228 is not suitable as a radio frequency amplier.

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



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

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

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

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

Battery Type Screen Grid 222 at $3.50

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

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

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

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

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

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

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Types of Tubes and Their Voltages

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

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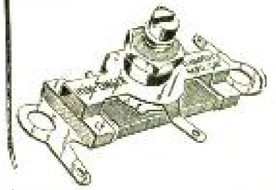

In AC circuits accuracy of the electrical center, particularly with power tubes, is easily obtained through a fixed resistor with adjustable center tap. Then hum due to unbalance in the filament circuit is dispelled. Use the 30-ohm Humdinger, adjustable with knife or screw driver. Connect extreme ends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

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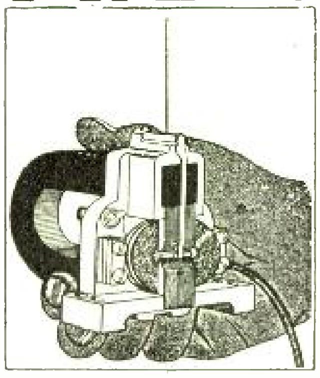

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Radio World's Speedy Medium for Enterprise and Sales

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ARTISTS and Art Students are printing 250 signs or pictures an hour without machinery. Sample and particulars, 10c. Straco, 1014 Mulberry, Springfield. Ohio.

BARBECUE. Broil, Grill all meats, fowl, fish with electric table appliance size chafing dish. Chrome finish $20, nickel, $15. Also bakes waffles and cooks like stove. Cleveland Neaco Products, 2012 West 83rd St., Cleveland, O.

EVERYTHING IN RADIO
At attractive Prices Sets or parts
Orders shipped exactly as ordered. Prompt service. Write for prices. Inquiries invited Send your address.
ALL RADIO CO., 417 North Clark St., Chicago

TYPE 222 NATIONAL screen grid tuning unit, never used, $10.00 post-paid. E. D. Miner, Phillips, Wis.

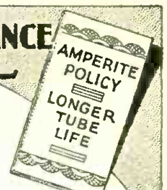
BRAND NEW CROSLEY Tip-Top Musicone, $37.50 list, your price, $3.90. Dandy magnetic speaker on walnut pedestal. P. Cohen, Suite 1214, at 143 West 45th Street, N. Y. City.

A COMPLETE CATALOG containing detailed information on condensers and resistors may be had free on request.

AEROVOX
BUILT BETTER CONDENSERS AND RESISTORS
74½ Washington St., Bklyn., N. Y.

THE RESEARCH WORKER will keep you abreast of developments in radio. It may be had free on request.

RADIO TUBE INSURANCE THAT PAYS—



AMPERITE *automatically* controls voltage fluctuations which cause burn-outs and shorten tube life. *$1.10 with mounting (in U. S. A.) At All Dealers.*

This symbol in a radio diagram means—

AMPERITE Corporation
561 BROADWAY, NEW YORK

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AMPERITE REG. U. S. PAT. OFF.
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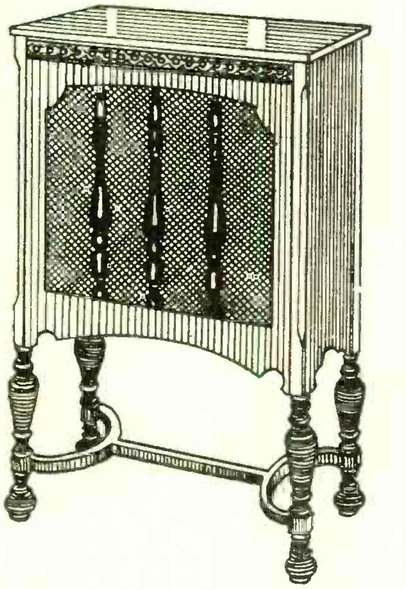
ARISTOCRAT FLOOR SPEAKER

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

$20.00



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

Acoustical Engineering Associates
143 WEST 45th STREET
NEW YORK CITY
(Just East of Broadway)

LYNCH

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

Write for Booklet.
Lynch Mfg. Co., Inc., 1775 Broadway, N. Y.

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Not just the name of a product, but the name of a service dedicated to better radio results. CLAROSTAT stands for variable and fixed resistors, volume controls, automatic line voltage ballasts, socket antennas, etc.

CLAROSTAT MFG. CO.,
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Component Parts for PUSH-PULL BATTERY DIAMOND

[Check off parts you want. Each part is sold separately.]

☐ L1L2—Antenna coil RF3 @	$ 0.80
☐ L3L4L5—3-circuit SG coil SGT3 @	1.30
☐ L6—Push-pull output impedance	2.83
☐ T1—Push-pull input transformer	3.41
☐ CT—80 mfd. equalizer	.35
☐ C1, C2—Two .00035 mfd. ext. shafts @ 98c	1.96
☐ C3—One .01 mfd. mica	.35
☐ R—One 6.5 ohm filament resistor	.25
☐ R1, Sw—One 75 ohm switched rheostat..	.80
☐ R2, C4—2 meg. Lynch leak, grid clip condenser	.51
☐ R3—One .25 meg.	.30
☐ R4—One 5.0 meg.	.30
☐ R5—One 1.3 ohm filament resistor	.20
☐ Ant., Grid, Sp (+) Sp. (—)—Four posts @ .10	.40
☐ One drilled front panel 7x18"	1.85
☐ One socketed, self-bracketing metal sub-panel, all holes drilled	3.50
☐ One National new modernistic drum dial with color wheel, pilot bracket, lamp. hardware, knob	3.13
☐ Two matched knobs for rheo. and tickler @ .18	.36
☐ Five vari-colored cable leads @ .07	.35
☐ Flexible link and insulated shaft	.55
☐ All parts	$23.50

RADIO WORLD. 145 West 45th Street. N. Y. City (Just East of Broadway)

Enclosed please find $............... for which please mail at once the parts for the Push-Pull Battery Model Diamond of the Air as checked off above.

☐ If ordering C.O.D. put check mark here.

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NATIONAL

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

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

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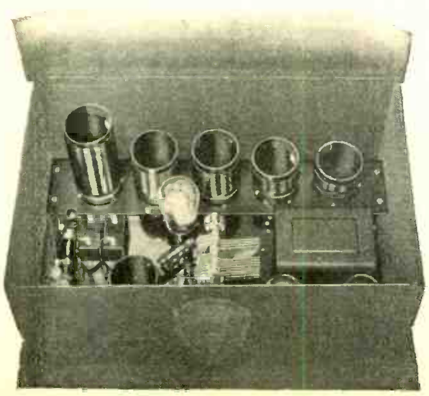
This book tells about newest startling developments. How to take advantage of the new wrinkles in radio, television, short wave, etc. Pictures and descriptions of thousands of new ideas. Shows new A-C Screen Grid tube and other sets, kits, parts, accessories and supplies at wholesale prices. Shows you how to save money on these and many home necessities besides. New edition now ready. Send for it today—NOW BARAWIK CO., 139F Canal St., Chicago, U. S. A.

A Short Wave Set that Works on B-Eliminator



It gets short waves AND Broadcasts All in One

Here's a humless short-wave loudspeaker operation on a B-Power Supply—another NATIONAL achievement. Here's a new NATIONAL THRILL BOX embodying full range reception over both short-wave and broadcast bands. And it operates perfectly from the NATIONAL Velvet-B power supply. You will get a brand new kick out of the fine tone and different performance of this

NATIONAL

4 TUBE THRILL BOX SW-4

All parts, all six coils, cabinet @ more than 40% off list...$33.00 net

GUARANTY RADIO GOODS CO.,
143 West 45th Street, New York, N. Y.
(Just East of Broadway)

Polo 245 Power Supply

Scientifically Engineered, It Insures Superb Performance

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

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

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

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

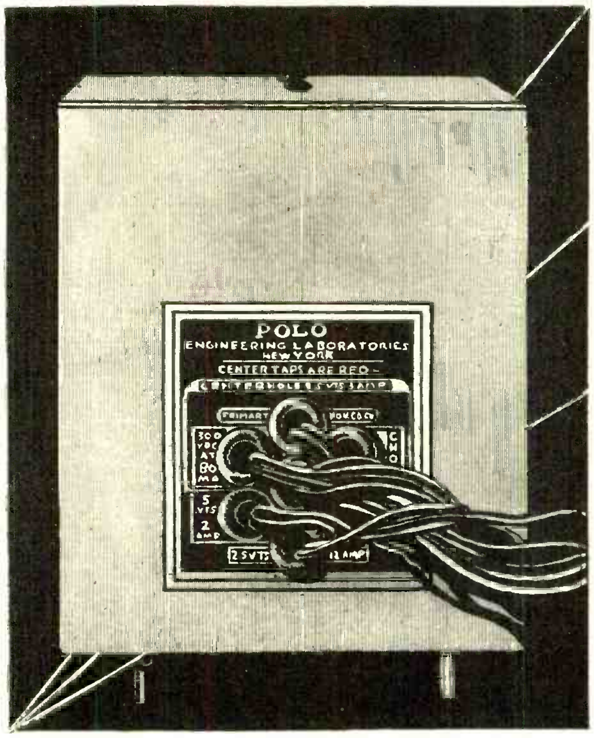
The two chokes are 50 henries each, and each choke is on a saparate core.

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

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

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

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



Polo 245 Power Supply, including two chokes built in, size 4⅝" wide x 5⅛" front to back, 6⅛" high. Cat. No. P245 PS 110 volts, 50-60 cycles (code Cyclops)..................$10.00
Cat. No. P245, S40, for 40 cycles, 110 volts; size 4⅝" wide x 5⅛" front to back, by 8⅛" high (code Cyclone)............$13.50

Chief Engineer's Report on Polo 245 Power Supply

By Walter J. McCord, Chief Engineer

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

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

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

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

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

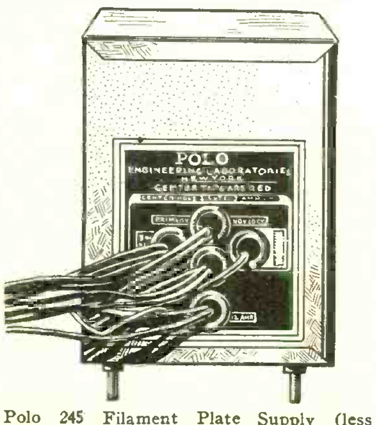
(5)—One transformer core with 1" x 1¾" cross-section; window opening 2⅛" x ¾". Two choke cores with ⅞" x 1¾" cross-section; window opening ½" x 1¾"; .014" air gap. The laminations are stamped from high-grade Silicon sheet steel having 1.92 watts loss per pound. The joints in the transformer are all overlapping,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

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

(7)—Total weight of block 16 lbs.

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

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



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

FILAMENT-PLATE SUPPLY

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

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

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

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

FILAMENT SUPPLY

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

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

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

NO C. O. D. ORDERS.

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

P245 PS (code Cyclops)..........................$10.00
P245 S40 (code Cyclone).......................... 13.50
P245 S25 (Code Cypress).......................... 14.50
PFT (code Cyclist).......................... 4.25
P40 FT (code Cyanide).......................... 6.25
PFPS (code Cymbal).......................... 7.50
P40 FPS (code Cylinder).......................... 10.00

In ordering by telegraph use code designations.

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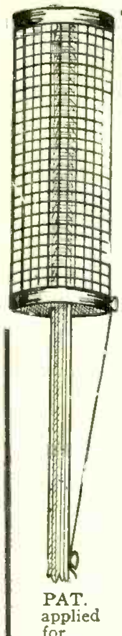
5-DAY MONEY-BACK GUARANTEE!



PAT. applied for

This Makes a Good Radio Set Better

With this aerial on a Stewart-Warner Set these stations are picked up every evening, and why?

The magnetic ether travels over the outside or skin effect. Our screen has 440 square inches outside and the same inside, totals 880 square inches in capacity.

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KWKH, Shreveport
CKLC, Canada
JOHK, Japan

It has proven 80% more selective than any other aerial.

Sent by express in strong box on receipt of price, P. O. money order. None genuine without Homeside stamp on pole. Send for logging card free. Screen is enameled copper on insulated Blocks.

Price $6.00

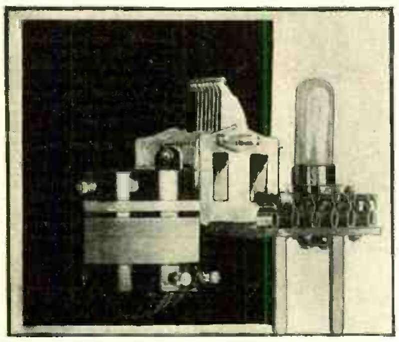
HOMESIDE RADIO
233 Scott St. San Francisco, Calif.

SCHOOLBOYS

Can Build a Broadcast Receiver for Only $4.28

Using Component Parts for the Schoolboy 1-Tube DX Circuit

as described by Jack Tully



Side view of the Schoolboy's One-Tube Receiver

COMPONENT PARTS

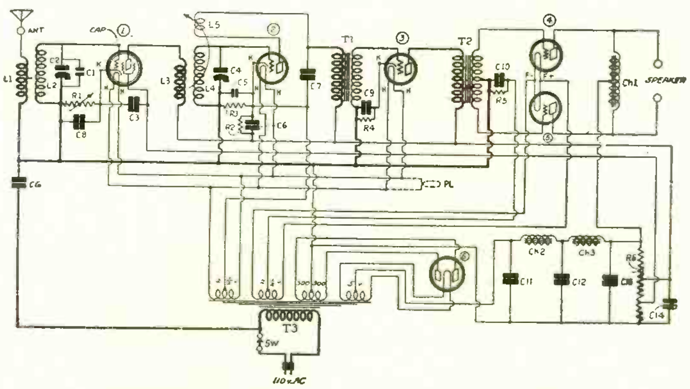
[Check those you want.]

	Price
L1, L2, L3—3 circuit .00035 tuner knob	$1.30
C1—Tuning condenser, .00035 mfd.	.30
C2—Grid condenser, .00025 with clips	.21
C3—Fixed condenser, .0005 mfd.	.19
R1—One 2-meg. leak	.30
R2—One 30-ohm rheostat, knob	.32
One 7 x 10" front panel	.59
One 3 x 6" subpanel	.42
One dial with pointer	.43
Six supporting brackets at .04	.24
☐ All parts	$4.28

GUARANTY RADIO GOODS CO.
143 West 45th Street
New York, N. Y.

RADIO WORLD, published every Wednesday, dated Saturday of same week, from publication office, Hennessy Radio Publications Corporation, 145 West 45th Street, New York, N. Y., just east of Broadway. Roland Burke Hennessy, President; M. B. Hennessy, Vice-President; Herman Bernard, Secretary. Roland Burke Hennessy, Editor; Herman Bernard, Managing Editor; J. E. Anderson, Technical Editor.

PARTS FOR PUSH-PULL DIAMOND



Circuit Diagram of AC Screen Grid Push-Pull Diamond of the Air

L1, L2—One antenna coil (Cat. AC5)	$0.75
L3, L4, L5—One SG 3-circuit tuner (Cat. SGT5)	1.25
C1—One Hammarlund equalizer, 70 mmfd.	.35
C2, C4—One Hammarlund dual condenser, .0005 (Cat. MLD23)	5.50
CG, C3, C5, C6, C8, C9—Six Aerovox .02 mfd. fixed condensers each	.80
C7—One Aerovox .0005 mfd. fixed condenser	.20
C10—One Aerovox 4 mfd. bypass condenser	1.50
C11, C12, C13, C14—Mershon 8-18-18-8	5.76
R1—One Electrad Royalty variable resistor, 5,000 ohms, with 110-volt AC switch	1.50
R2, R3—One 25,000 ohm Electrad resistor type B (with 3 terminals)	.75
R4—One 1,000 ohm Electrad resistance strip	.20
R5—One 800 ohm Electrad resistance strip	.20
R6—One Aerovox Pyrohm type B (750, 750, 2,800, 3,000)	1.00
T1—One National A100 audio transformer	5.70
T2—One National push-pull input transformer	5.70
T3—One power transformer (5, 2.5, 2.5, 300, 300v.)	10.00
Ch1—One push-pull output choke	5.00
Ch2, Ch3—One S-M Unichoke 331	4.80
Ant., Gnd., Speaker—, Speaker+—four binding posts each	.15
One 7 x 21" front panel	1.65
One flat type dial, with dial pointer	.95
Two knobs each	.20
One roll Corwico Braidite	.35
One 2.5v AC pilot light, with bracket	.60

Above is complete, less baseboard, sockets, tubes and cabinet.

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

Component Parts for the SCHOOLBOY'S 3-Tube Circuit

as described by Jack Tully

L1L2—One antenna coupler, RF3	$ .80
L3L4—One screen grid coupler, TP3	.95
C1C2—One double condenser, .00035 mfd. ea.	1.50
CT—One Hammarlund 80 mfd. equalizer	.35
C3—One .00025 mfd. mica grid cond. clips	.21
C4, C5—Two, .01 mfd. mica fixed cond. (both)	.70
C6—One .0025 mfd. mica fixed condenser	.21
R1, R4, R7—Three 5.0 meg. grid leaks (all 3)	1.05
R2, Sw—One 75-ohm rheostat with switch	.80
R3—One 1.0 meg. metallized resistor	.35
R5—One 6.5-ohm fixed filament resistor	.25
R6—One 0.25 meg. metallized resistor	.21
R8—One 1.3-ohm fixed filament resistor	.20
Ant., Gnd., Sp. — Sp. +,—All 4 binding posts	.40
1, 2, 3—Three UX sockets (all 3)	.90
One seven-lead battery cable	.50
Four resistor mountings (all four)	.84
One dial	.33
Hardware as prescribed by Jack Tully	.46
All Parts	$11.10
Three Kelly tubes: one 222, 240, 112a	$5.70

All prices are strictly net and represent extreme discount already deducted.

Guaranty Radio Goods Co.
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(Just East of Broadway)

Component Parts for SCHOOLBOY'S 2-Stage Audio Amplifier

Two 3-to-1 audio transformers, $1.25 each	$2.50
One .00025 mfd. condenser	.21
Two UV sockets at .26	.52
One binding post strip with 10 posts	1.50
Four brackets at .05 each	.20
One 2-ohm filament resistor	.30
	$5.23

[Order what parts you want. You do not need to order all of them.]

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

Component Parts for SCHOOLBOY'S 4-TUBE CIRCUIT

(Order what parts you want. Check off items in squares at left.)

☐ Two RF3 RF transformers @ 0.80	$ 1.60
☐ Two .00035 mfd. tuning cond. @ 0.30	.60
☐ One .00025 mfd. grid cond., clips	.21
☐ One .00025 mfd.	.21
☐ One 4 ohm filament resistor	.20
☐ One switched rheostat 30 ohms	.60
☐ One 5 meg. leak	.30
☐ One 1.3 ohm filament resistor	.20
☐ Two 3-to-1 AF transformers @ $1.25	2.50
☐ Four sockets @ 0.24	.96
☐ Speaker (+) (—) posts @ 0.10	.20
☐ Nine wires in cable @ .07	.63
☐ Two dials @ 0.33	.66
☐ 7 x 14" front panel	1.85
☐ One 8½ x 13½" baseboard	1.00
☐ All parts	$11.72

Guaranty Radio Goods Co.
143 West 45th Street
New York, N. Y.

One Tube? Two Tubes? Three Tubes? Four Tubes?

Circuits for Schoolboys—Easy to Build, Very, Very Inexpensive!

A One Tube Receiver, parts costing $4.28!
A Two Tube Audio Amplifier, parts costing $5.23!
A Three Tube Speaker—Operating Circuit, parts costing $11.10!
A Four Tube Speaker—Operating Circuit, parts costing $12.72!

The construction of these circuits, with a pictorial diagram as one of the illustrations, was described by Jack Tully, himself a schoolboy, in RADIO WORLD. See list below.

- ☐ Sept. 21st and 28th issues, One-Tube DX Set, by Jack Tully; two-part article.
- ☐ Oct. 5th, Three-Tube Single Dial Speaker Set, by Jack Tully.
- ☐ Oct. 12th, Two Stage Transformer, Coupled Audio Amplifier, by Jack Tully.
- ☐ Oct. 19th, Four-Tube DX Speaker Set, by Jack Tully.

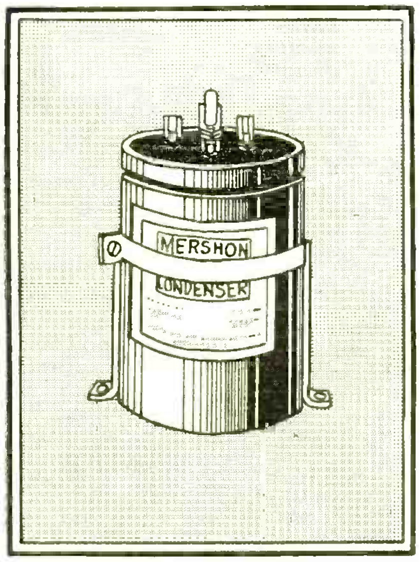
15 cents a copy. Order at once while these copies are available.

RADIO WORLD, 145 W. 45th St., New York

EVERY WEEK in RADIO WORLD appears a feature article of intense interest to schoolboys. Parents and other relatives will bring great delight to youngsters by sending $3 for a 6 months' subscription for RADIO WORLD (26 issues) in the youngster's name.—RADIO WORLD, 145 West 45th Street, New York City.

MERSHON

Electrolytic Condensers at Professional Discounts



Mershon Electrolytic Condensers for Filtering Circuits of B supplies, rated at 400 volts D.C., or for by-pass condensers, give enormous capacities in compact form. We offer, at attractive discount, genuine Mershons made by the Amrad Corporation.

Cat. No. Q 8 — $4.67 NET

Consists of four Condensers of 8 mfd each, all in one small copper case (less brackets), List Price, $7.95..........

[Cat. Q 8B same as above, but includes mounting bracket. No brackets sold separately...................... $4.87]

Cat. Q 2-8, 2-18 — $5.55 NET

Consists of four Condensers, two of 8 mfd. each, and two of 18 mfd. each, all in one small copper case (less brackets), List Price, $9.45...........

[Cat. Q 2-8, 2-18B, same as above, but includes mounting bracket. No brackets sold separately............ $5.75]

Mershon electrolytic condensers are instantly self-heating. They will break down only under an applied voltage in excess of 415 volts D.C. (commercial rating; 400 volts D.C.) but even if they do break down because overvoltaged, no damage to them will result, unless the amount of leakage current and consequent heating of the electrodes and solution cause the solution to boil. Voltages as high as 1,000 volts will cause no particular harm to the condenser unless the current is high enough to cause heating, or the high voltage is applied constantly over a long period.

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

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

How to connect: The copper case (the cathode) always is connected to negative. The lugs at top (anodes) are connected to positive. Where there are two different capacities the SMALLER capacity is closer to the copper case.

Mershons of equal capacity may be connected in series for doubling the voltage rating, or in parallel (any combination) to increase the capacity to the sum of the individual capacities, the rating remaining the same, 400 volts.

When series connection is used, the copper case of one condenser the anode of which goes to the high voltage should be connected to a lug or to lugs of the other condenser. The copper case of the second condenser goes to the negative.

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

OTHER CAPACITIES OF MERSHONS

["S" stands for single condenser, "D" for double, "T" for triple and "Q" for quadruple. First figure between hyphens denotes quantity, second capacity per anode.]

Cat. No. S-8, list price $4.10; net, $2.41
Cat. No. S-9, list price $4.25; net, $2.49
Cat. No. S-18, list price $4.80; net, $2.82
Cat. No. S-40, list price $5.40; net, $3.17
Cat. No. S-72, list price $10.00; net, $5.88
Cat. No. D-8, list price $5.25; net, $3.08
Cat. No. D-9, list price $5.75; net, $3.38
Cat. No. D-18, list price, $6.15; net, $3.62
Cat. No. T-8 list price $6.30; net, $3.70
Cat. No. T-9, list price $6.45; net, $3.79
Cat. No. T 1-8, 2-18, list price $7.90; net, $4.65
Cat. No. 1-18, 2-9, list price $7.50; net, $4.41

[Note: Add 20c to above prices if bracket is desired. No brackets sold separately.]

No. C.O.D. orders on Mershon Condensers

GUARANTY RADIO GOODS CO.
143 West 45th Street, New York, N. Y.
(Just East of Broadway)

PEERLESS

12" AC Super Dynamic Speaker in SONORA Highboy Cabinet

At Only **$37.50**

LIST PRICE, $155.00

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

Amazing Buy!

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

Money-Back Guarantee!

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

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

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

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

☐ Speaker alone $23.50

☐ Cabinet alone $15.00

Name ....

Address ....

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

5-DAY MONEY-BACK GUARANTEE

FLECHTHEIM

1,000 v. DC 500 v. AC(rms)

Filter Condensers at Professional Discounts

Filter Condenser, Actual Size

Result of Years of Experimenting

UNBELIEVABLY compact, light in weight, made of the highest grade materials, these condensers are the result of many years of patient and constant research. The marvelous achievement is exemplified and substantiated by independent tests.

Types HV can be used to replace all types of condensers having a continuous working voltage up to 1,000 volts DC and will give utmost satisfaction and dependability for a rectified AC voltage up to and including 550 volts rms. Hence, it is just the filter condenser you want for 171A, 245 or 210 power packs, single or push-pull.

Twelve Telling Points

(1) Rated conservatively at voltages up to 1,000 volts DC (500 rms. AC.)
(2) Tested and re-tested at 1,500 volts DC.
(3) Breakdown voltage of 2,500 volts DC.
(4) Breakdown voltage, foil to case, 5,000 volts AC.
(5) Power factor (voltage loss) less than 1%.
(6) Resistance over 600 megohms per mfd.
(7) Negligible dielectric losses.
(8) Capacity is non-inductive and is accurate to within 5% of rating.
(9) Remarkably compact size; all capacities same height.
(10) Great saving in weight.
(11) Highly perfected terminal connectors and insulators.
(12) Proved by fatigue tests to have longer life.

THREE-IN-ONE

Type HV244 is a high-grade capacity bank to operate at voltages up to and including 750 rms AC. Just the unit to use for a B supply for the 250 tubes, single or push-pull. Consists of a bank of condensers tapped 0-2-4-4 mfd. The 2 mfd. section is made to withstand the terrific punishment of voltage surges, and sudden transient line voltages.

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

Please send at once the Flechtheim condensers specified below. Quantity desired is marked in square.

☐ Send C.O.D. (check off).

☐ Remittance enclosed. (check off).

Type	Capacity Mfd.	Size	List Price	Net Price
☐ HV 5	.05	2 x1⅛x ⅝	$1.75	$1.03
☐ HV 10	.10	2 x1⅛x ⅝	2.00	1.18
☐ HV 25	.25	2 x1⅛x ⅝	2.25	1.32
☐ HV 50	.50	2 x1⅛x ⅝	2.50	1.47
☐ HV 100	1	2 x1⅛x ⅝	3.00	1.76
☐ HV 200	2	2 x1⅛x1⅛	5.00	2.94
☐ HV 400	4	2 x1⅛x2⅜	9.00	5.29
☐ HV 244	0-2-4-4	3 9/16x4 x2¾	25.00	

Name ....

Address ....

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

Surpassing Results from HB Compact!

Screen Grid Circuit for AC or Batt ery Operation Is a Knockout!

THE screen grid tubes, both AC and battery types, 222 and 224, promised much. They could be used to provide actual amplification of 150 per stage, as compared with 8 per stage for a general purpose tube. If only the screen grid tube could be used at full practical amplification! Then a few tubes would do the work of many! At radio frequencies it was found that tuning the plate circuit put the mule kick into the set.

Sensitivity

But the whole wave band could not be tuned in. So Herman Bernard invented a coil—the Bernard dynamic tuner—that accomplished the trick. Full amplification plus full wave-band coverage! That's why his HB Compacts, only four tubes (plus a 280 in the AC model) perform like eight-tube sets! The sensitivity is incredibly high.

Realism

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

Economy

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

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

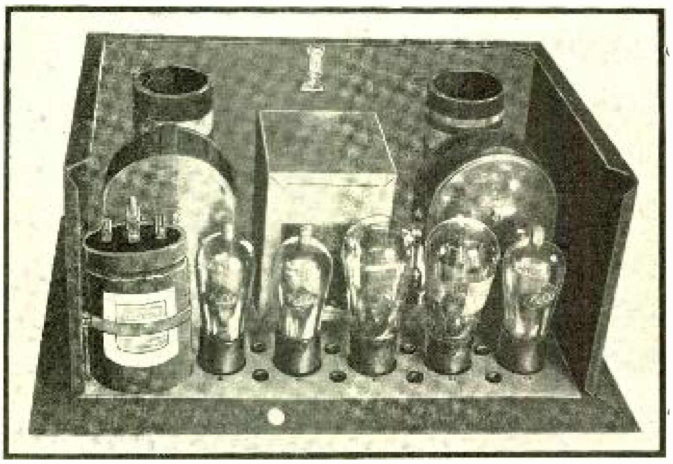
Selectivity

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

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

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

Order what individual parts you want.



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

Component Parts for HB Compacts

AC MODEL

L1L2L3—Bernard Antenna Tuner BT5A	$2.50
L4L5L6—Bernard Interstage Tuner BT5B	2.50
CT—One 80 mmfd. equalizer	.35
C1, C2—Two .0005 Dustproof @ $2.50	5.00
C, C3, C4, C5—Four .01 mfd. @ .35	1.40
C7—One 1 mfd. 500V AC	.85
C8, C9, C10, C11—Mershon Q2-8, 2-18B	5.75
C12, C13—Two 1 mfd. 200 V. DC @ .50	1.00
R—One 25,000 ohm wire-wound pot	1.50
R1, R2, R3, R4—.5, 1.0, .05 5.0 meg. @ .35	1.40
T1—Polo 245 Power Supply Cat. P245PS	10.00
2500, 4400, 774, 50, 8 (20 watt) Voltage Divider	1.75
PL—Bracket and 2.5 v. AC lamp	.70
OC, C6—Output choke, 2 mfd. 500 v. AC cond.	3.85
SP—, SP+—Two binding posts @ .10	.20
Three National grid clips @ .06	.18
F—One 1 amp. cart. fuse with base	.50
Aluminum socketed subpanel, 9½x14¼", 8 brackets	3.25
Steel cabinet, crackled brown finish, 7x15x9½	4.00
3 Insulating washers @ .03	.09
Two full-vision dials with pointers @ 75c	1.50
One AC pendant switch, double opening	.40
One 12 ft. length AC cable	.72
Two rolls Corwico braidite @ .35	.70
Two flexible couplers (links) @ .35	.70
	$50.79
Kelly tubes: Three 224 @ $3, one 245 @ $2.25, one 280 @ $1.75	$13.00

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

BATTERY MODEL

L1L2L3—One Bernard Tuner for antenna circuit, for .0005 mfd. tuning (BT5A of Screen Grid Coil Co.)	$2.50
L4L5L6—One Bernard Tuner for screen grid interstage coupling, for .0005 mfd. tuning (BT5B of Screen Grid Coil Co.)	2.50
C1, C2—Two .0005 mfd. Dustproof tuning condensers @ $2.50	5.00
CT—One Hammarlund 80 mmfd. equalizing condenser	.35
C3, C4, C5—Three .01 mfd. mica fixed condensers @ .35	1.05
R1—One .25 meg. metallized resistors	.30
R2, R4—Two 5.0 meg. metallized resistors @ .30	.60
R3—One .075 meg. metallized resistor	.40
R5, SW—One 75-ohm rheostat with switch attached	.80
R6—Two resistors, one 1.3 ohms, the other 6.5 ohms (both)	.45
Ant., Gnd., Sp.—, Sp.+. Four binding posts (all)	.40
One drilled steel cabinet 7" high, 9½" front to back, 15" wide	4.00
Two dials with pointers (both)	1.50
One pilot light bracket with 6-volt DC lamp	.70
One 9½x14¼" satin finish aluminum subpanel with sockets affixed, and supplied with insulated bushings, supporting brackets, and resistor clips	2.00
Two insulated links (flexible couplers) (both)	.70
One 7-lead battery cable	.50
	$23.75

Kelly tubes: Two 222, one 240, one 112A or 171A, total, $9.20.
[National Coils for the battery model, vernier condensers, see note under AC Model.]

[The HB Compacts were designed and built by Herman Bernard. The battery model was described in the August 24th, 31st, September 7th and 14th issues of Radio World.]
[The AC Model is now being described. See pages 12 and 13 of this issue.]

Please Use This Coupon

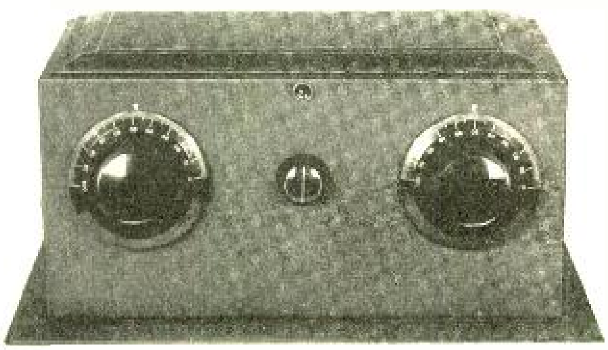
GUARANTY RADIO GOODS CO.
143 West 45th St., N. Y. City, Just E. of B'way.

Enclosed please find $. .... for which please send me component parts for the HB Compact as checked off above.

NAME ....

ADDRESS ....

CITY .... STATE ....



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

New J-245 Trouble-Shooting Jiffy Tester

Tests All Modern Circuits at Plate Voltages up to 300 Volts, Finds Shorts and Opens, Judges Tube Performance—All in a Neat, Small Steel Case with Crackle Finish in Brown

THE handiest, dandiest compact Jiffy Tester is the J-245, especially designed to test up-to-date receivers, particularly those using screen grid tubes and 245 single or push-pull, testing out-of-date receivers just as well. It has an extensive usefulness and brilliant eye appeal. It tests sets with 201A, 200A, UX199, UX120, 240, 171, 171A, 112, 112A, 245, 224, 222, 228, 280 and 281 tubes without extra adapters.

Into the case are built the following meters: one reading O-20 ma. and O-100 ma, for plate current, change-over switch included; one reading O-60, O-300 volts DC for plate voltages and DC house line voltages; and one reading O-10, O-140 volts AC and DC (though the meter is marked AC), thus O-140 may be used for DC line voltage.

Two switches and nine tip jacks are on the panel. The jacks are marked to receive the four-tipped leads which emerge from the plugged cable conector. These leads are colored red, blue, brown and white, and so are little rings around the tip jacks that the leads connect to. All nine jacks are marked besides.

The switches are for change-over on the milliammeter, and for connecting and disconnecting the grid return to note a tube's "liveliness." How this is noted is explained in the instruction sheet accompanying the J-245.

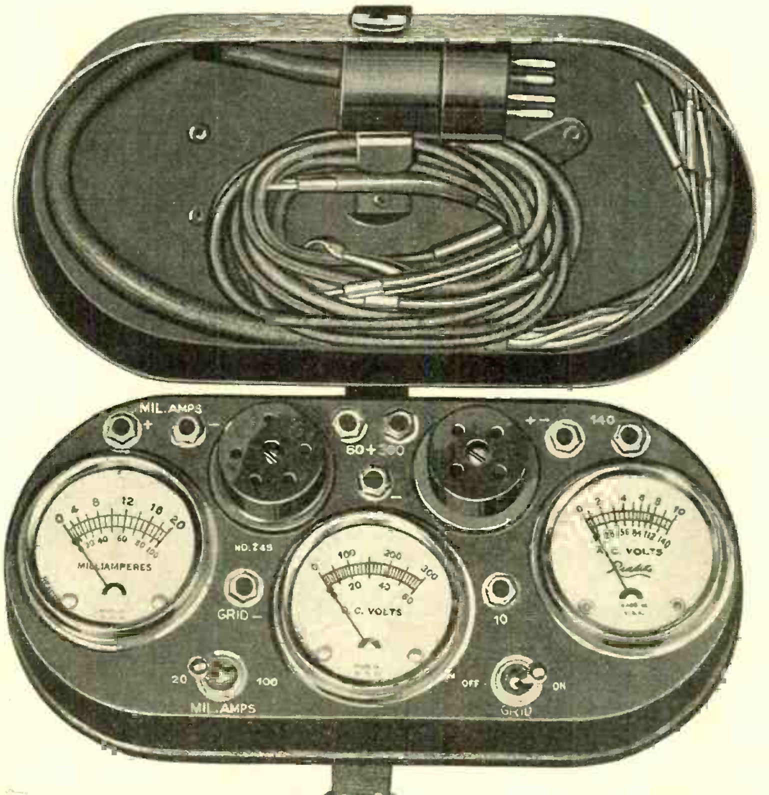
Two sockets are on the panel, one 5-prong, the other 4-prong, for holding the UX and UY tubes, including screen grid tubes, both AC and battery types. To enable full test of screen grid tubes, including AC 224 and DC 222, a screen grid cable is supplied.

The compact J-245 therefore tests all plate voltages up to 300 volts, including B eliminators; all filament voltages, DC or AC, up to 10 volts; all plate current up to 100 ma. Besides, it provides close readings for plate current of 20 ma. or less and for B voltages of 60 volts or less, and AC voltage readings up to 140, including AC line voltage. Besides, it reads screen grid voltage.

The base that contains the meters has four feet on it, is only 1¼" high, and snugly receives the cover. Inside the cover is a spring clip to hold the plugged cable, with a 4-prong adapter, as well as the red and black separate test leads for use of each meter independently, and the screen grid cable. You have three separate double-range meters independently accessible, in other words, six-meter service, besides the plug-in feature for joint use of all meters in testing receivers, tubes, continuity, shorts, opens, etc., as described in the instruction sheet.

This outfit has a genuine leather handle on the top for carrying, and a braided strap for keeping the cover from coming off accidentally. It is the very thing that the service man, experimenter, student and teacher have been looking for.

Order Cat. J-245 and you will be surely overjoyed at the possession of such a handy, dandy, reliable and rugged Jiffy Tester, the neatest one you ever saw, and one that abundantly answers the purposes of service work. You don't need to know in advance how to use it. The instruction sheet gives a simple but comprehensive explanation. Besides, a tube data sheet tells how to determine if tubes are O.K.



Three meters built into a case, 3⅛" high, 4" front to back, 8½" long, with slip-on cover, both brown crackle-finished steel. Makes all tests of filament voltages, AC or DC, with AC voltage readings up to 140, plate voltages up to 300, plate current up to 100 ma. Tests 4-prong and 5-prong tubes, including screen grid tubes. Test leads and instruction sheet included.

$11.76

Note the fascinating appearance of the new J-245 Jiffy Tester, with connector plugs and cable tucked beside the screen grid tube testing cable and the color-identified pair of test leads for using each of the three meters individually. As each meter is double-range, you get six meter service from this splendid outfit. This is the most popular type of Jiffy Tester and the most desirable in the low price range.

Remit $11.76 with order, and we pay cartage!

Successful Servicing Is Impossible Without Meters

IF you are a service man you are lost without meters. You may carry individual meters around with you and still remain perplexed, for lack of any means of obtaining access to the voltages or currents you desire to test. Therefore an analyzer like the J-245 is just the thing, and it is much more neatly made than you could possibly make a tester yourself, since, besides the engineering talent required to design such a device, thousands on thousands of dollars must be invested in dies. You reap the benefit of expert engineering design, quantity production and careful instruction as to use when you buy a J-245. It is unqualifiedly recommended as superior to any tester that is anywhere near so low in price. You could pay twice as much and get half as much value!

NEVER again need you be stumped for want of the necessary measuring equipment. Suppose you want to know the AC line voltage or DC line voltage—the right hand meter gives it to you. Simply plug the red test lead into the "140" tip jack, the black test lead into the "+" tip jack. If you desire to read the plate current of one tube, insert the tube in the proper socket of the J-245, connect the plug (with the aid of the 4-prong adapter, if necessary) into the emptied socket of the receiver, switch the milliammeter to "O-20" reading, insert the four-colored cable leads into the corresponding marked and colored tip jacks and turn on the set. These are only some of the fifteen tests you can make.

Independent Access to All Three Meters Insures Versatility

BESIDES fetching appearance, sturdiness, compactness and low cost, the J-245 affords versatility by rendering individual access to each meter. Use the red and black test leads for this purpose. Suppose you want to know the total plate current drain of all tubes of a receiver. Use the milliammeter at its "O-100" setting, connect the test leads to "milliamps +,—" and the other ends of the leads in the negative B line.

This accessibility of each meter—six-meter service, remember—heightens the value of the J-245 more than 100%, and is a new feature.

YOU are all set to go when you possess the J-245. The only limitations you will possibly encounter, and these are rare instances, apply to the testing of the B voltages on 210 and 250 tubes, and to testing the Kellogg tubes, which have filament emerging from a cap at top.

The plate voltage on a 210 is usually 350 volts while that on a 250 is usually 450 volts, and the B voltmeter reads up to 300 volts. But a series resistor will extend the range. This multiplier is an extra, and those deeming it necessary may order Cat. No. J-10; at 88c net, to increase scale to O-600 volts.

Likewise, a Kellogg tube adapter is available, Cat. No. J-24 at 60c net. If UV199 tubes are to be tested, a pair of adapters is necessary, as these tubes have a unique base. The UX199 tubes can be tested without adapters. For UV199 tubes order Cat. No. J-19 at 60c net, which changes the UV socket of the receiver to accommodate the UX plug of the J-245, and Cat. No. J-20 at 36c net, to change the 4-prong socket of the J-245 to receive the UV199 tube.

NET PRICES AT MORE THAN 40% OFF LIST PRICE!

J-245, consisting of the complete outfit, less multiplier, UV adapters and Kellogg tube adapter. Net price.......... $11.76
J-106, resistor to be connected in series with O-300 voltmeter to increase reading to 600 volts. (Jack terminals optional. See coupon.) Net price J-106 only .... .88
J-19 and J-20, pair of adapters for testing UV199 tubes. Net price for both.. .96
J-24, Adapter for testing, Kellogg and old Arcturus tubes. Net price...... .60

GUARANTY RADIO GOODS CO.
143 West 45th Street, (Just East of Broadway), New York, N. Y.

Gentlemen: Enclosed please find $.............. Send me at once at your expense:

- ☐ One J-245 with instruction sheet, net price.......... $11.76
- ☐ One J-106 multiplier, net price.......... .88
- ☐ Jack Terminals optional for J-106, order JT, net price.......... .30
- ☐ One pair of UV adapters, J-19 and J-20, price of both, net .96
- ☐ One adapter for testing Kellogg and old type Arcturus tubes, J-24, net price.......... .60

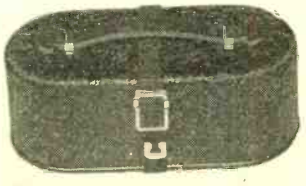
All prices are net and represent extreme professional discount already deducted.

Your name .... City..............................

Your address .... State..............................

5-DAY MONEY-BACK GUARANTY

A Neat Carrying Case



How the J-245 looks when the cover is slipped on and the strap is tightened. The handle is genuine leather.

Order a J-245 today. It is sold on a 5-day money-back guaranty, which nobody else offers. Try it out for five days after receipt. If not fully satisfied for any reason, or for no reason at all, send it back with a letter asking for refund of the money you paid. The refund will be made promptly. There are no strings to this guaranty!