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NEW ACCESSOR

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How to Design Circuits Using 82 Rectifier Tube

Short-Wave Converter

Measurements of A-C Currents and Voltages

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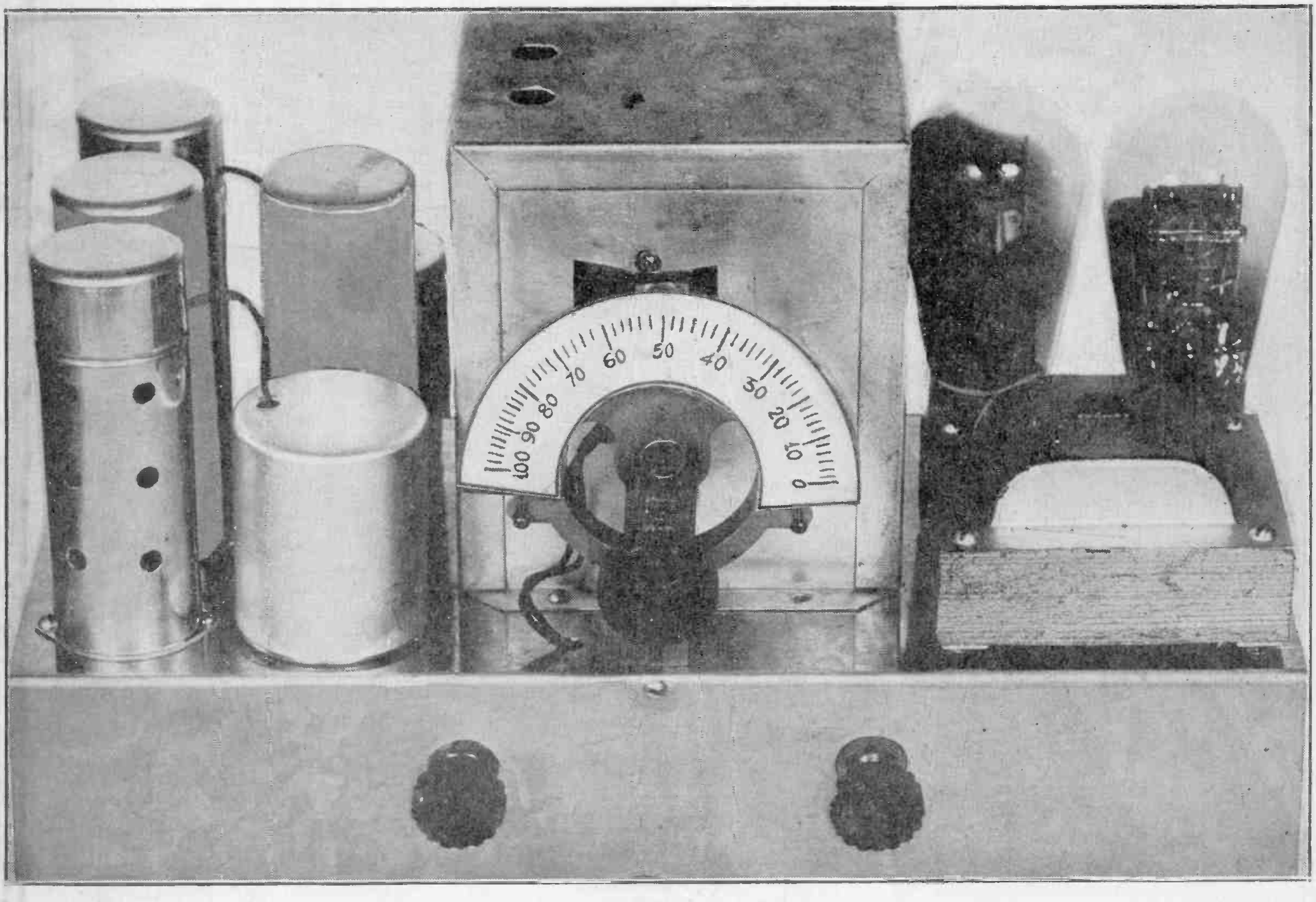

View of the receiver as built by the designer. See page 12.

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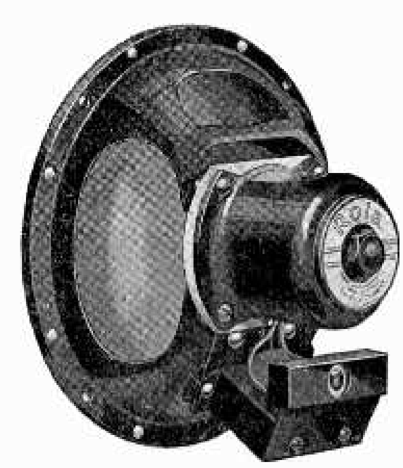

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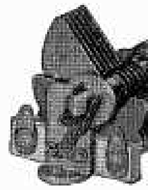

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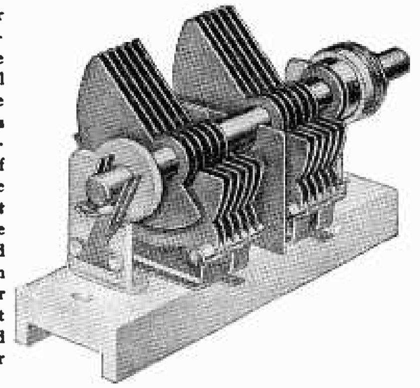

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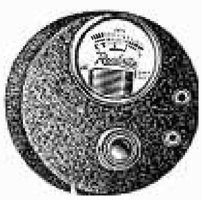

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A NEW ACCESSOR

Single Switch Provides Four Current, Five Voltage Readings from Set

USE YOUR OWN METERS WITH THIS IMPROVED DEVICE

THE subject of obtaining merely access to a receiver to measure currents and voltages has aroused much interest. In the July 30th, 1932, issue was an article on how to accomplish this, using two switches. Here is an exposition of how to do it, using only one switch.

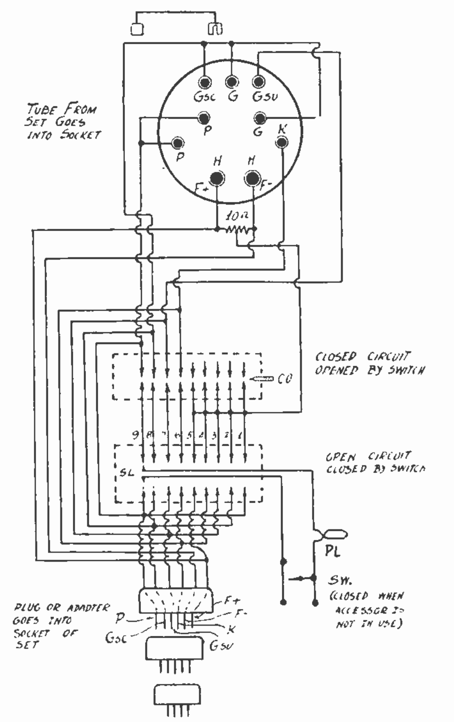
The deep interest in the subject arises, of course, from the constant necessity of obtaining such access, which can be done with commercial testers and analyzers, but all of them contain meters. The assumption appears to be well-founded, judging from the interest shown, that service men and experimenters have the meters, and what they desire is an accessory that will enable them to connect the proper meter at the terminals of the device and obtain the readings.

Switch Does Trick

With the thought in mind that meters one already has must be pressed into service, the accessor principle was developed. So far as is known there is no such commercial device on the market. But the keen interested manifested has led commercial companies to consider marketing one, and it is expected that the model about to be described will be commercialized.

To make it practical to build the accessor it was necessary to obtain the switch that would do the trick. This switch has nine different positions. Two switching functions are performed at each position. A closed circuit is opened and an open circuit is closed simultaneously. For the four current readings this simultaneous operation is necessary. For the voltage readings the closed circuit portion need not be used, so it is "jumped."

It is of course readily understood that to make the accessor a part of the receiver by adaptation a tube must be taken from the set, a plug of the accessor inserted in the set socket previously occupied by the tube, and the tube must be put in a socket on the accessor. Since there are three principal types of tubes, classified as to base pins, we would need a UX, a UY and a six-pin socket. However, a new universal socket for just such a combination purpose has been put on the market recently. This socket



KEY TO DIAGRAM

At top is a flexible lead, preferably at least a foot long, grid cap at one end, grid clip at other end, for use with tubes having metal cap at top of glass envelope. Below it is a universal socket, into which UX, UY or six-pin tube may be inserted. Designations are given for three general types of tubes: UX filament type, UY heater type and six-pin heater type. For UX, as in 245, H and H are filament, upper P is plate, lower G, control grid. F plus and F minus have significance for battery type tubes only. For UY heater type, as in '27 and 56, heater same; lower P is plate, upper G is control grid, K is cathode. For six-pin type, as 57 and 58, heater, plate and cathode as in '27, but Gsc is screen grid and Gsu is suppressor grid. The switch has nine positions, four lugs to a position, lugs represented by major arrow heads in perpendicular symmetry. CO is the circuit-opening insulated traveller, SL the circuit-closing conductive slider. PL is a flashlight bulb, any commercial voltage (1.5, 6 etc.) The switch points go indirectly to five cable leads, the sixth lead, F plus, going to cable direct, without being intercepted by the switch.

recives any UX, UY or six-pin base tube, and has nine springs. No more than six and no less than four are used at any one time. Only so many springs are used as the type of tube base requires, and this is automatic.

Only One Socket on Panel

So on the accessor panel there need be only one socket. There are other type tubes not accommodated by this arrangement, e.g., V-99, X-99, WD-11, WD-12, etc., but these are infrequently encountered, and if any one wants to provide for them he needs extra adapters, which are obtainable and they would have to be in two sets, one for the accessor panel and the other for the receiver end.

However, we shall consider only the general run of tubes, and exclude from discussion the special and infrequent types for testing which provision may be made by the constructor.

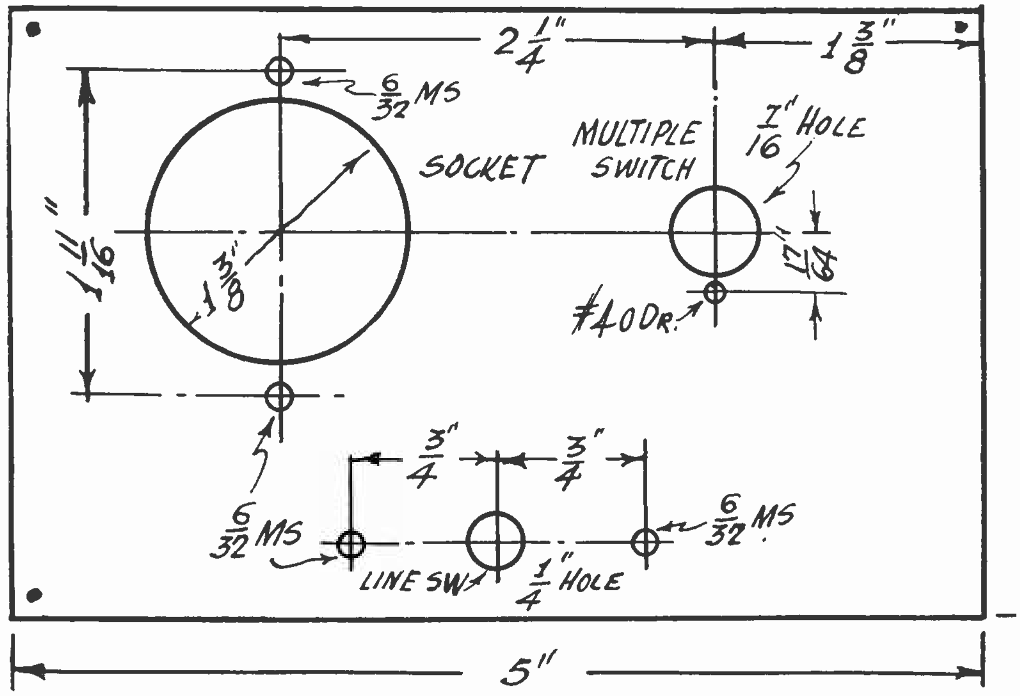
The third consideration was the permanent plug for insertion in the receiver socket. Most adapters necessarily work forward, in that respect, because designed before the six-pin base tubes came out. Now, however, we may use a six-pin plug permanently attached to the six-lead cable, and use adapters that have six-spring tops, but UX and UY bases respectively for receiver service.

All these parts—switch, universal socket and six-pin plug with UX and UY adapters—are now obtainable. Any commercial questions regarding them or other parts will be answered by the Trade Editor, RADIO WORLD, 145 West 45th Street, New York City.

The Three Types

Now let us consider the universal socket. Since it will take three types of tube bases, let us assign a tube to each such purpose, and identify the connections accordingly. For the UX tube let us take a '45, for the UY a '27 or 56, and for the six-pin a 57 or 58.

First, the UX socket, type '45 tube. The socket is illustrated as seen from the bot-
(Continued on next page)



KEY TO DIAGRAM
The panel on which the line switch, multiple switch and universal socket are mounted is 5 x 3⅛ inches, and is reproduced herewith full scale. The two holes on either side of the line switch are for the binding posts to which meter is to be connected. The four holes at corners are for screws to enter pillars of a wooden box. The inside height of such a box need not exceed 1½ inches. This diagram does not provide for a pilot lamp.

(*Continued from preceding page*)
tom, with filament prongs toward you. Since the socket is upside down, by virtue of being turned over either to left or right, the filament position is not altered in a front-and-back direction, but it is in a left-and-right direction. So the socket must be read, in a clockwise direction, from one heater, or equivalent F plus, as follows: plate, grid, heater adjoining grid, heater adjoining plate. So plate is to the left. Keep this in mind.

The designations therefore are H, H, P and G as diagramed.

Second, the UY socket, type '27 or 56 tube. The heater position is the same as the filament position in the case of the '45 and the plate is in the same position as formerly. However, the control grid is at top, and is marked G. The cathode is the extra connection, and occupies its own position. Thus the five connections are accounted for, and moreover it is obvious that there can be no duplication of connections or shorts, for tubes have only as many pins as they have. Therefore we may interconnect some of the socket springs. The two differently positioned plates come to mind first. The control grid of the '27 or 56 and the control grid as found in the '45 may be interconnected.

Third, the six-spring socket for type 57 or 58 tube. The heater is as before. The plate and cathode are as in the UY discussion. Then there are the screen grid, which adjoins the plate, and the suppressor grid, which adjoins the cathode. The control grid is the metal cap at top of glass envelope.

Where Cap Is Control Grid

Now, the old-style screen grid a-c tubes, e.g., '24, '35, '55, etc., have control grid at the top of the tube, represented by a metal cap. These tubes require UY sockets. The apex of the triangle formed with the heater, constituting the control grid of the '27 and 56, is the screen grid of the '24, '35, '55, etc. Therefore we may interconnect the G post of the UY system with the screen grid post of the six-pin system. The code is as follows: G_{sg} = screen grid, G = control grid for '27 and 56 tubes but screen grid for '24, '35, '55, etc.; G_{su} = suppressor grid, K = cathode, H and H = heater, or in battery-operated sets, F minus and F plus.

Thus with a socket that his nine springs we consolidate three connections in one instance, leaving seven, and also consolidate two others independently, leaving six. So we have provision for a six-lead cable and use of a six-pin plug at the other end of that cable.

As has been stated, despite the consolidation there will be no misconnections, for tube pins do not change positions, but stay put, and on them depends the resultant connections.

Other Connections

The switch has nine connections, and usually there are thus nine different positions available through the switch, of which four are devoted to currents and five to voltages, as will be explained. However, with screen grid tubes that have metal cap at top for control grid, current and voltage may be read, constituting the tenth and eleventh tests. This is done externally. For current the meter is interposed between the cap of tube placed in the accessor, and the connection to the grid clip in the set. Only grid current would be measurable this way, and it is often absent, and nearly always very small, so it is doubtful if with most meters any reading will be obtained. The voltage measurement would be taken externally from grid cap to filament or heater center, with switch at any voltage position, using the filament side of meter for one connection, and between grid cap for the other.

By selecting the cathode voltage measurement position the control grid voltage may be read in respect to cathode, from control grid itself, although the same voltage reading obtains in r-f circuits when the reading is taken from the heater center, which is done by one of the switch positions. What currents and voltages are read at the different positions will be explained.

There are other types of tubes than those discussed. Let us take up some of them. The 55 or 85 duplex diode-triode, for instance. That has heater the same as previously, cathode and plate standard (triode section), but has two separate anodes. These are the same positions as occupied by the screen grid and suppressor grid of the 57 and 58. An examination of the socket diagram will disclose that these two anode positions are not interconnected, therefore the current readings may be taken as to either or both of them, and so may the voltage readings.

Let us take next the 201A. That is representative of the battery series of tubes, including the '30, '31, '32, '34, or 2-volt series. The situation is the same as with the '45, except that the filament is battery operated, instead of a-c powered.

The center-tapped 30-ohm resistor across the heater or filament provides a mid-voltage point, and that is used as reference as being the most suitable method of picking up grounded B minus in a-c receivers. In such sets it is otherwise hard to get readings from B minus, for the cathode can not be relied on for that, but heater center is usually grounded B minus. In battery-operated sets, however, a difficulty arises.

Voltage Compensation

The plate and screen voltage readings to B minus will be off by half the filament voltage. Not only is that not serious, but if you want to correct for it, subtract half the filament voltage from the reading that obtains. In any event of filament or heater voltage measurement, since the potential is only half that of the total, the actual voltage in this single instance is twice the reading or the reading is half the actual filament or heater voltage, a-c or d-c. Bear in mind, therefore, that this voltage reading must be multiplied by two.

The grid cap and clip connector is diagramed at top, and perhaps a word about this is necessary. When you take a screen grid tube out of a set and thus disconnect grid clip from cap, putting the tube in the accessor, you have this situation: the socket in the receiver is empty, the grid clip in the receiver is connected nowhere, or shorted against metal chassis or shield, and the tube is in the accessor without grid cap connected. Therefore a long lead is necessary, flexible wire preferred, with a grid clip at one end and a grid cap (like that on top of a tube) at the other end. The dangling grid clip in the set is connected to the cap on the cable, the grid clip at other end of cable is connected to open cap of the tube. Since this lead is external and removable it may be used for grid voltage and current readings as previously stated. The remaining connection to establish operation is of course to insert the six-pin plug of the accessor cable in the vacant receiver socket.

Switch Analyzed

Now, as for the function and operation of the switch and the uses derived therefrom.

All switching arrangements in connection with testers and analyzers look prohibitive at a glance, and besides it must be admitted that the explanations that go with them do not always give all the facts a man desires. So a special effort will be made to clarify the switch.

First, a description of what it looks like. There are four stacks of insulation material, held together with tie rods. On each stack are nine lugs. The stacks have lugs paired as to purpose, so that the front circle of lugs and the circle immediately behind it are contacted, two lugs at a time, by two sliders insulated from each other. This slider system is diagramed just above the plug, and marked SL. The slider connections are brought out to two lugs that occupy a lone tenth position, and the meter posts are connected to these two lugs. The function of the part of the switch just discussed is to close an open circuit. This particular switching may be described as double-pole, nine-throw, meaning that a circuit is established at two points for each of nine different switch settings.

In line with the nine open-circuit switches that close are pairs of lugs for nine closed-circuit switches that open at the same time the others close.

If we want to measure current we must open a circuit to permit putting the meter in series therewith, but on such occasions as the meter is not to be used for measuring the current in a particular circuit that circuit must be closed. Therefore the fixed position of the eight other switching adjuncts, in a nine-point system, is one of being closed, yet for the one position utilized the switch circuit must be open. If we put the meter between the open points the circuit is then closed and the meter is in series with the line in which the current measurement is to be taken.

Contacts Explained

So the switch has four tiers, with four lugs directly behind each other in nine positions, 36 lugs plus two more for sliders. To close an open circuit the front pair are used, the rear pair of tiers, with lugs in line with the others, to open a closed circuit. Whether a current reading is taken or not, the circuit must be closed so that it will be complete, and it should be understood that the meter itself, for current measuring purposes, closes the circuit otherwise opened by the rear pair of lugs.

A circuit-opener, remarked CO on the diagram, slides between the two contacting points of the rear pair of lugs, and automatically opens these circuits. There is no wiper connecting lug, as none is necessary. However, as stated, there are two lugs for each of the two separate purposes, or four lugs to be considered for switching at any given position.

Now let us unite the purposes of the switch.

The two functions are separated diagramatically in blocks marked "Closed Circuit Opened by Switch" and "Open Circuit Closed by Switch."

Consider the plate current. The plate springs of the socket are connected together. The lead is brought to the rear post of the closed circuit switch at extreme left in diagram, represented by position 9, as the switch is viewed from bottom, and the 9 in actual operation (top view) is extreme right. The switch has a numerical marker plate. The other corresponding closed circuit switch lug is right in front of the previous one, and it is connected to the nearer lug of the open circuit switch, that is, the lugs of second and third row, either direction, are interconnected. Then the front and rear row lugs are interconnected. The result is that at position 9 the plate circuit has been opened, but the closing switch, to the slider of which the meter is connected, has put the meter between the otherwise open points.

What You Read

When this wiring is repeated for Gsc and G twice, using the next four lugs in line on the same plan as previously, control and screen grid currents are readable at (8), while when there is further repetition in the same direction, the currents flowing in the G_{su} (7) and K (6) circuits are measurable. With different tubes the currents may be of different circuits, sometimes, but the constructor may not know which socket post is represented, therefore the complete data are given in the tables herewith, including data on all tubes to be announced during the next month, and not out yet.

So plate, control grid, screen grid and cathode currents are readable, these being the four previously mentioned. No heater or filament current is readable, unless some other current reading is omitted to make room for it, since it generally suffices to know the filament or heater voltage, and if it is correct the tube should take care of the current.

Pilot Lamp Used

Postions 5, 4, 3, 2 and 1 are for reading the voltages in the following order: 5, one-half of heater or filament voltage; 4, full cathode voltage; 3, full suppressor voltage; 2, full screen votage; 1, full plate voltage. The reason for reversing the direction is to have an extreme setting represent highest voltage, as a safety method. When finished testing, turn switch knob to plate voltage.

The voltage readings are taken between filament center and high potential, but as reckoning from cathode to plate is standard, the cathode readings should be subtracted from the plate and screen readings.

No reversing switch is necessary, as the meter connections to posts may be reversed to take care of cathode readings or any others that develop wrong polarity.

There are a pilot light and a short-circuiting on-off switch. This switch should remain closed, and the accessor used only if the pilot lamp (small flashlight cell) does not light. Then open the switch and use the accessor. If the lamp lights there is a short, or if there is a short it may blow the lamp, so the lamp acts as a fuse. The meter will not register after the lamp has "gone west," because the circuit is open.

Be extraordinarily careful to have the right meter, or right multiplier or shunt, in circuit for intended readings, principally not strictly current meters for voltage readings, otherwise you may burn out the meter.—Herman Bernard.

DETECTORS AND AMPLIFIERS IN NUMERICAL ORDER

Ip—plate current; Isc—screen current; Isu—suppressor current.
Ik—cathode current; Ia'—one diode's current. Ia"—Other diode's current.
Ef—one-half the filament voltage; Ek—cathode voltage; Esc—screen voltage.
Esu—supressor voltage; Eg—control grid voltage; Ep—plate voltage.
Ea'—one diode's voltage; Ea"—other diode's voltage.

Readings Obtained at Numerical Positions

Tube Type	1	2	3	4	5	6	7	8	9
11*	Ep	Eg	...	....	Ef	....	....	Ig	Ip
12*	Ep	Eg	....	....	Ef	....	....	Ig	Ip
55**	Ep	Ea'	Ea"	Ek	Ef	Ik	Ia"	Ia'	Ip
56	Ep	Eg	....	Ek	Ef	Ik	....	Ig	Ip
57	Ep	Eg	....	Ek	Ef	Ik	....	Ig	Ip
58**	Ep	Esc	Esu	Ek	Ef	Ik	Isu	Isc	Ip
85**	Ep	Ea'	Ea"	Ek	Ef	Ik	Ia"	Ia'	Ip
112A	Ep	Eg	....	....	Ef	....	....	Ig	Ip
V99*	Ep	Eg	....	....	Ef	....	....	Ig	Ip
X99	Ep	Eg	....	....	Ef	....	....	Ig	Ip
200A	Ep	Eg	....	....	Ef	....	....	Ig	Ip
201A	Ep	Eg	....	....	Ef	....	....	Ig	Ip
222**	Ep	Esc	....	....	Ef	....	....	Isc	Ip
224**	Ep	Esc	....	Ek	Ef	Ik	....	Isc	Ip
226	Ep	Eg	....	....	Ef	....	....	Ig	Ip
227	Ep	Eg	....	Ek	Ef	Ik	....	Ig	Ip
230	Ep	Eg	....	....	Ef	....	....	Ig	Ip
232**	Ep	Esc	....	....	Ef	....	....	Isc	Ip
234**	Ep	Esc	....	....	Ef	....	....	Isc	Ip
235**	Ep	Esc	....	....	Ef	Ik	....	Isc	Ip
236**	Ep	Esc	....	Ek	Ef	Ik	....	Isc	Ip
237	Ep	Eg	....	Ek	Ef	Ik	....	Ig	Ip
239**	Ep	Esc	....	Ek	Ef	Ik	....	Isc	Ip
240	Ep	Eg	....	....	Ef	....	....	Ig	Ip

* *Two special adapters required, one for Accessor, other for receiver.*
** *Control grid is cap on top of tube. Use grid cap-clip connector. Measure grid current and voltage externally.*

POWER AMPLIFIERS IN NUMERICAL ORDER

Ip—plate current; Ig—grid current; Isc—screen current; Isu—suppressor current.
Ik—cathode current.
Ef—one-half the filament voltage; Ek—cathode voltage.
Eg—control grid voltage; Esc—screen voltage; Ep—plate voltage.

Readings Obtained at Numerical Positions

Tube Type	1	2	3	4	5	6	7	8	9
46(A)	Ep	Eg	....	Ep	Ef	Ip	....	Ig	Ip
46(B)	Ep	Eg	....	Eg	Ef	Ig	....	Ig	Ip
89(1)**	Ep	Ep	Ep	Ek	Ef	Ik	Ip	Ip	Ip
89(2)**	Ep	Ek	Ek	Ek	Ef	Ik	Ik	Esc	Ip
89(3)**	Ep	Ep	Eg	Ek	Ef	Ik	Ip	Esc	Ip
112A	Ep	Eg	....	....	Ef	....	....	Ig	Ip
120	Ep	Eg	....	....	Ef	....	....	Ig	Ip
171A	Ep	Eg	....	....	Ef	....	....	Ig	Ip
210	Ep	Eg	....	....	Ef	....	....	Ig	Ip
231	Ep	Eg	....	....	Ef	....	....	Ig	Ip
233	Ep	Eg	....	Esc	Ef	Isc	....	Ig	Ip
238*	Ep	Esc	....	Ek	Ef	Ek	....	Ig	Ip
245	Ep	Eg	....	....	Ef	....	....	Ig	Ip
247	Ep	Eg	...	Esc	Ef	Isc	....	Ig	Ip
250	Ep	Eg	....	....	Ef	....	....	Ig	Ip
841	Ep	Eg	....	....	Ef	....	....	Ig	Ip
842	Ep	Eg	....	....	Ef	....	....	Ig	Ip

(A) Class A amplifier. K of socket in set is tied to plate.
(B) Class B amplifier. K of socket in set is tied to G of socket.
(1) Class A triode.
(2) Class A pentode.
(3) Class B triode.
** *Control grid is cap of tube. Measure Eg and Ig externally.*

RECTIFIERS IN NUMERICAL ORDER

Et' = voltage drop in tube measured from filament center to one plate, a. c. or d. c.
Et" = voltage drop in tube measured from filament center to other plate, a. c. or d. c.
Et = voltage drop in tube measured from filament center to plate of half-wave rectifier, a. c. or d. c.
Ef = one-half of filament voltage.
Ip' = current in one plate, a. c. and d. c.
Ip" = current in other plate, a. c. and d. c.
Ip = plate current of half-wave rectifier, a. c. and d. c.

The output voltage is not measurable by this system at the rectifier.

Readings Obtained at Numerical Positions

Tube Type	1	2	3	4	5	6	7	8	9
'80	Et'	Et"	....	....	Ef	....	....	Ip'	Ip"
'81	Et	....	....	....	Ef	....	....	....	Ip
82	Et'	Et"	....	....	Ef	....	....	Ip'	Ip"
83	Et'	Et"	....	....	Ef	....	....	Ip'	Ip"

CHOICE OF CONSTANTS FOR THE 82 RECTIFIER

VALUES FOR BOTH CHOKE AND CONDENSER INPUT

[The following technical discussion of the application of the type 82 tube, prepared by the applications laboratory of RCA Radiotron Company, Inc., and E. T. Cunningham, Inc., is published by special consent of those two corporations.—EDITOR.]

THE type 82 tube was developed to supply the need for a rectifier tube for use in circuits requiring good voltage regulation and high efficiency. It is a full-wave thermionic rectifier tube differing from the well-known high-vacuum types in that mercury vapor is used in the tube. The bulb size is smaller than that of high-vacuum tubes of equal rating.

The principle of operation employed in the type 82 is essentially that of a high-vacuum, electron-conducting tube rather than a gaseous, ion-conducting tube. When positive voltage is applied to the plates of this tube, the start of the electron flow ionizes the mercury vapor. The positive mercury ions reduce the negative space-charge due to the electrons surrounding the filament. The resulting low space-charge-voltage drop is an essential feature of the tube.

When the space-charge-voltage drop is less than approximately 22 volts, the mercury ions do not have sufficient velocity to affect the active surface of the filament. The result is that the normal high-vacuum performance of the filament is obtained without the high space-charge-voltage loss occurring in other types.

Practically Constant Drop

When the tube is operating at normal temperature with sufficient electron emission from the filament to adequately supply the peak current demands on the tube, the space-charge-voltage drop in the tube will be approximately 15 volts. Since the voltage drop in the tube is practically constant for any current within the emission limits of the filament, the regulation of the output voltage is that of the supply voltage, transformer and circuit.

High efficiency results from the low voltage drop and the low power loss in the tube. The power dissipated at the plates is only a small fraction of the value occurring in other rectifier types. Due to the low power dissipation in the tube, a small S-14 size bulb is used. The small size of the tube is an advantage where space is limited.

In the design of apparatus in which this tube is to be used, it is well to observe the following precautions. Low filament voltage, high peak currents, or temporary overloads reduce the electron emission of the filament. If the electron emission is reduced to the extent that the voltage drop in the tube exceeds approximately 22 volts, the mercury ions will bombard the filament with sufficient velocity to cause rapid filament disintegration. When operated at recommended voltages, however, the filament has sufficient emission so that the tube drop is only about 15 volts. On the other hand, too high a filament voltage evaporates the active surface materials as in the case of other tube types. The operating life of the tube depends upon maintaining the active electron-emitting surface of the filament.

The tube operates normally between temperature limits which maintain the vapor pressure of the mercury high enough to reduce the space-charge-voltage drop to approximately 15 volts and low enough to prevent flash-back due to the peak inverse voltage. Insufficient ventilation might cause the temperature of the tube to rise to a point where the peak inverse voltage would cause a flash-back. The temperature ranges in present receivers of proper design are safely within the limits of this tube.

Determining the Output

With high-vacuum rectifier types, the voltage drop in the tube is frequently an appreciable percentage of the total voltage in the circuit. This drop varies with the current in the tube. Because of this characteristic, it is necessary for the designer of rectifier systems to have curves of the d-c output voltage versus the d-c output current. Data for these curves are read in a circuit having relatively low losses. In designing a circuit with the aid of these curves, the engineer subtracts from the curve reading the additional IR drop of the circuit and obtains the d-c output voltage.

In the type 82, however, the voltage drop in the tube (15 volts) is small and practically constant for any value of current. The d-c output of a rectifier employing this tube depends almost entirely on the resistances of the other components of the circuit. In the types of circuits particularly adapted for utilizing the good voltage regulation characteristics of this tube, the d-c output voltage is readily calculated without the aid of curves. The accuracy of the calculated output is considerably better than the accuracy obtained for high-vacuum types with the aid of curves.

The following discussion reviews briefly the principles involved in the operation of a rectifier. Fig. 1 shows the schematic circuit for a full-wave rectifier. The a-c supply voltage E_1 is connected to the transformer primary. The high-voltage secondary winding is connected to the plates of the rectifier tube. The center tap of the high-voltage winding is connected to the output terminal 2. The low-voltage secondary winding is connected to the filament of the rectifier tube. The center tap of the low-voltage winding is connected to the output terminal 1.

Component Voltages

Assume for the moment that the circuit is an ideal one in which transformer losses are negligible and that the voltage drop in the rectifier tube also is negligible in the conducting direction and infinite in the non-conducting direction. A simple resistance load R is connected to the terminals 1 and 2. Let a sine wave voltage E_1 be applied to the transformer. Then, the secondary voltage applied to the plates of the rectifier tube is a sine wave of peak value E (max). The rectified voltage is expressed;

$$e = E\ (max)\ (0.636 - 0.424 \cos 2q - 0.085 \cos 4q - \ldots) \quad (1)$$

This equation denotes several component voltages of different frequencies. The first term, 0.636 E (max) is the total d-c value of the rectified voltage. The second term represents a component having twice the frequency of the voltage E_1 and an amplitude equal to 0.424 times the amplitude of the impressed voltage E(max). The remaining terms of the series represent higher-frequency components of small amplitude.

As an example of the use of equation (1), suppose the impressed a-c voltage per plate is 70.7 volts RMS and the frequency is 60 c.p.c. Then, E(max) equals 100 volts and the d-c output voltage equals 63.6 volts. The 120-cycle ripple voltage equals 42.4 volts peak and the 240-cycle ripple voltage equals 8.5 volts peak. These voltages all appear across the load resistance R, and are independent of the value of R since the losses in the transformer and the tube were assumed negligible. The current of each component frequency will, of course, be the voltage of that component frequency divided by the load resistance.

Voltage Across the Load

If there is resistance and/or series inductive reactance (choke-input filter) in the circuit in addition to the load resistance, the voltage across the load of any component can be found as follows: Calculate the rectified voltage from the voltage induced in the transformer secondary rather than from the terminal voltage. When calculated in this way, the total value of the rectified voltage impressed in the circuit is obtained. For any one component of the rectified voltage, calculate the total impedance of the circuit for the frequency of this component. Dividing the impressed voltage of this component by the circuit impedance gives the current for this component.

Multiplying the load resistance (or impedance) by the current through it gives the value of the output voltage. For example, assume the following conditions: The a-c voltage induced in one-half of the transformer secondary is 100 volts RMS or 141 volts peak; the d-c resistance of one-half of the transformer secondary equals 500 ohms; and the load resistance R equals 1,500 ohms. Assume that a type 82 rectifier tube is used so that a constant voltage drop of 15 volts occurs in the tube. The d-c voltage impressed in the circuit equals (141 x 0.636) = 90 volts. When the 15 volt drop in the tube is subtracted from the 90 volts impressed in the circuit, the d-c voltage drop in the remainder of the circuit is 75 volts. The total resistance of the circuit is 2,000 ohms. The current in the circuit is 75 divided by 2,000 and equals 37.5 ma. The d-c voltage across the load is (1,500 x 0.0375) and equals 56.2 volts. Similarly, the a-c ripple components may be calculated. Usually a rough calculation for the 120-cycle component is sufficient.

The oscillograms in Fig. 1 show the wave forms of the a-c voltage V induced in one-half of the high-voltage secondary, the rectified voltage E_2 from the tube, and the rectified current I_2 from the tube. The voltage E_2 consists of a d-c voltage equal to the average value of E_2 and an a-c ripple voltage superimposed upon it. Likewise, the current I_2 consists of a d-c current equal to the average value of I_2 with an a-c ripple current superimposed upon it.

The voltage impressed in the rectifier circuit is that induced in the high-voltage secondary winding. The induced voltage is measured on a separate winding (see Fig. 1) having a known ratio of turns to the high voltage winding. If no current is drawn from the separate winding, a true indication of the induced voltage is shown even though the rectifier is in normal operation.

Effects of Filter Circuits

When a filter circuit is connected between the rectifier tube and the load resistance, the a-c ripple voltage across the load is reduced to a low value. Also, the arrangement of the input section of the filter has considerable effect on the mode of operation of the rectifier tubes. Fig. 2 shows the schematic circuit of a choke-input filter. Fig. 3 shows a condenser-input filter.

The oscillograms in Fig. 2 show the wave forms (time increases from right to left) of the impressed voltage V, the rectified voltage E_2, and the rectified current I_2, for a choke-input filament. The rectified voltage E_2 is similar to that obtained with the simple resistance load in Fig. 1. The current I_2 is largely a steady d-c current with a small value of a-c ripple current superimposed upon it.

The mode of operation with the choke-input filter is as follows: The change of current-flow through the inductance is great voltage which tends to maintain the current-flow through the rectifier tube. When the current-flow through the inductance is great enough so that the inductive voltage is equal to or greater than the back-voltage on the following condenser, some value of current I_2 will flow through the tube at all parts of the cycle. The rectified voltage then becomes the average of V rectified. For higher currents, the d-c output voltage remains constant except as affected by the IR drop in the circuit and by the regulation of the voltage induced in the transformer secondary.

Constant Voltage Points

Fig. 4 shows the rectified d-c voltage versus the d-c current for different values of the input inductance L. The data for these curves were read with the induced voltage in the transformer secondary held constant at 480 volts RMS per plate. Starting at zero current on these curves, the rectified voltage is equal to the peak value of 480 volts RMS or 679 volts. This high voltage is due to what is termed in this discussion as the "condenser effect." The back-voltage developed across the condenser following the choke limits the current-flow through the rectifier tube to less than the full cycle as explained in the following section on condenser-input filters.

As current is drawn from the rectifier, the voltage developed in the choke opposes the back-voltage on the condenser. The d-c voltage falls rapidly to a value (422 volts) equal to the d-c component obtained by rectifying 480 volts RMS minus the voltage drop in the tube. The d-c voltage remains constant at this value for all higher values

OSCILLOGRAMS FOR RECTIFIER SYSTEMS.
INPUT VOLTAGE, OUTPUT VOLTAGE AND CURRENT.

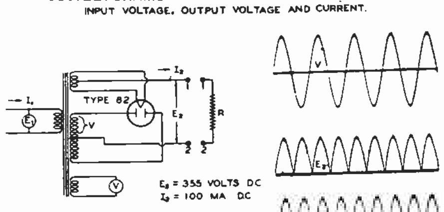


FIG 1

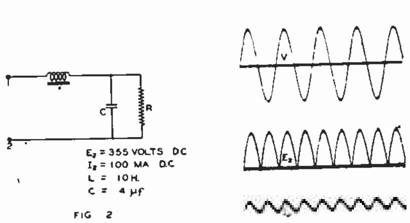


FIG 2

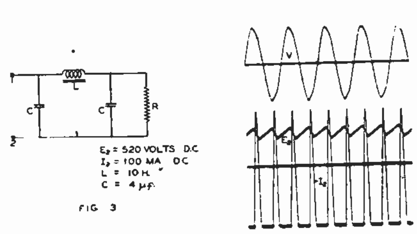


FIG 3

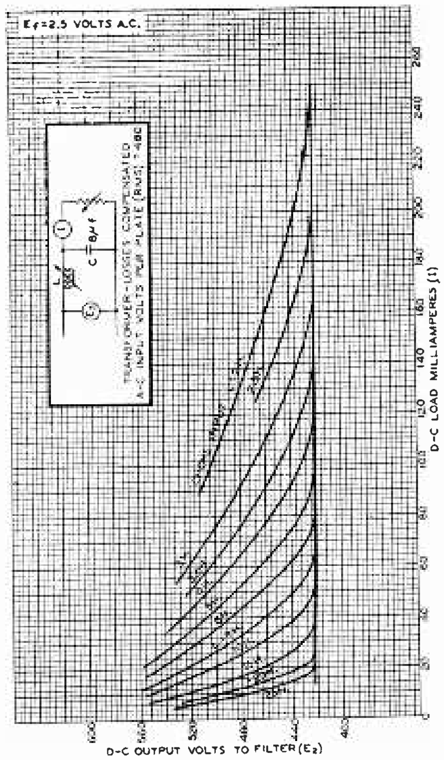


FIG. 4

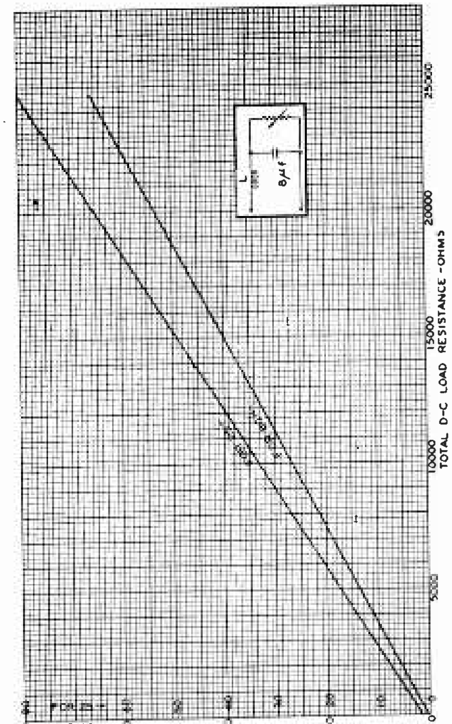


FIG. 5

of current (the curves have been corrected for IR drop). The point at which the curve, for any given value of inductance, reaches the constant voltage condition depends on the load current and load voltage and, hence, on the load resistance.

Fig. 5 shows the minimum value of the inductance L versus the total d-c load resistance (after the first filter condenser) for operation on the constant voltage part of the curve. On the constant voltage part of the curve, the total rectified value of the impressed voltage is effective in the circuit; hence, the voltages may be calculated as explained for the simple resistance load.

The oscillograms in Fig. 3 (time increases from right to left) show the impressed voltage V, the rectified voltage E_2, and the rectified current I_2, for the condenser-input filter. The current I_2 flows during only a small part of the cycle and has a high peak value. The input condenser is charged during this part of the cycle. During the remainder of the cycle, the condenser discharges and the back-voltage of the condenser prevents current-flow through the rectifier tubes.

Charging Voltage of Condenser

The voltage E_2 is due to the charge and discharge voltages across the input condenser. The average value of the charging voltage equals the average value of the discharging voltage across the condenser. Hence, if the d-c load current is small, the condenser discharge-voltage remains high, and the condenser charging-voltage is also high. The average voltage during the condenser charging-period is higher than the d-c value of the rectified a-c input. This effect of the condenser in causing an increase in the d-c output voltage is the "condenser effect."

In an ideal circuit in which the resistance in the transformer, tube and condenser are zero, and the capacitance is large, the condenser would charge and discharge at a value of voltage equal to the peak of the impressed voltage. In this case, the d-c output voltage would remain constant for all values of d-c output current.

Actually, the practical limits for the time-constant of the input condenser and its associated input circuit are such that the discharge-voltage of the condenser varies considerably with the load current.

Increasing the capacitance of the input condenser increases the d-c output voltage and improves the voltage regulation. Due to the limitations previously mentioned an increase in the value of capacitance above 4 uf. has little effect on the operation. When the type 82 tube is operated at maximum d-c output, the peak-current limit of the tube (400 ma.) limits the capacitance of the condenser which can be used. For d-c output currents less than 75 ma., any value of capacitance may be used without exceeding the 400 ma. peak-current limit.

D-C Output Curves for Type 82

Fig. 6 shows the d-c output voltage versus a-c input voltage for a rectifier employing the type 82 tube. The upper set of curves in this figure is for a condenser-input filter. The lower set of curves is for a choke-input filter. The data for these curves were obtained in a circuit having low resistance. The constants of the circuit are given in the figure.

For most applications, the circuit resistances will be greater than those which were used in obtaining these curves. If the IR drops due to the additional resistances in the circuit are subtracted from the d-c voltage shown on the curve a good approximation of the output voltage will be obtained.

The zero-current curve of the upper set shows that the d-c output voltage is equal to the peak value of the a-c input volts per plate. The other curves of this group show the d-c output voltage for several values of current.

The lower set of curves for the choke-input filter are close to the d-c value of the rectified a-c input volts per plate. The upper curve of this group shows the calculated d-c voltage impressed in the circuit. The curves for different values of current were plotted from experimental data. These curves fall below the curve of impressed d-c voltage by the amount of the IR drop in the circuit used for the measurements.

Rectifier Output Calculations

As an illustration of the type of calculation which may be employed in the design of circuits requiring good voltage regulation, the following examples are given. These examples are supplemented by curves showing such additional information as the peak current through the tube and the a-c ripple voltage across the load.

(Continued on next page)

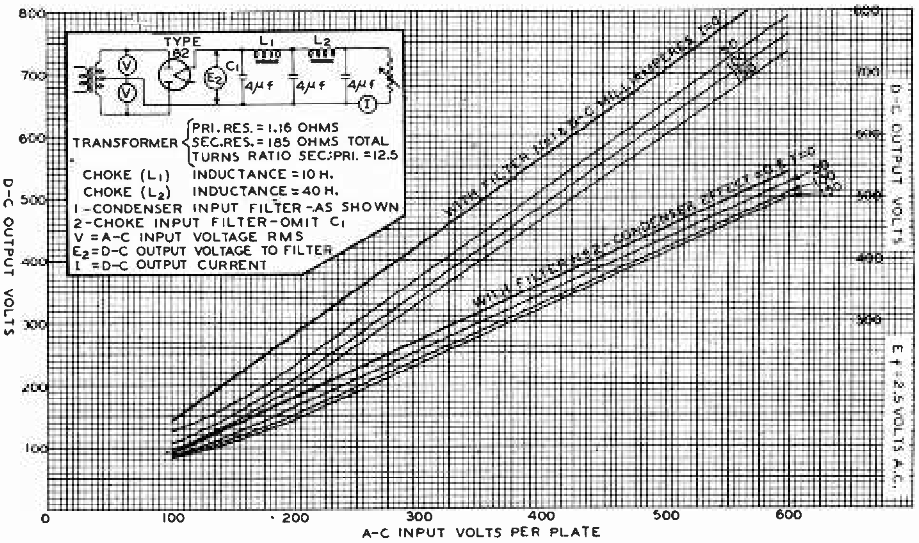


FIG. 6

(*Continued from preceding page*)

EXAMPLE NO. 1

Resistance Load Without a Filter

Assume the following conditions: D-c output voltage of 400 volts; maximum d-c output current of 100 ma.; resistance load; no filter; voltage regulations of 10 per cent for the current range of 10 to 100 ma. The d-c output voltage rise for 10% regulation
= (400 x 0.10) = 40 volts
The resistance equivalent of the voltage regulation
= 40/(0.100 — 0.010) = 444 ohms.

The voltage regulation of the transformer will be due to the d-c current change in the secondary and the a-c current change in the primary. Suppose that the 444 ohms is distributed as follows: 244 ohms in one side of the secondary winding, and the equivalent of the remaining 200 ohms in the primary winding.

D-c output voltage at full load— = 400 volts
D-c voltage drop in the tube.. = 15 volts
D-c voltage drop in the transformer secondary at full load
= (244 x 0.100) = 24.4 volts

The load on the transformer secondary is effective on only one-half at a time so that the losses in only one-half need be considered.

Total rectified d-c voltage required at full load = (400 + 15 + 24.4) = 439.4 volts

The peak a-c voltage induced in one-half of the transformer secondary at full load
= (439.4/0.636) = 692 volts

RMS voltage induced in one-half of the transformer secondary at full load
= (692 x 0.707) = 488 volts

The peak current at full load
— (0.100/0.636) = 0.157 amp.

RMS secondary current (I_2) at full load
= (0.100 x 1.11) = 0.111 amp.

RMS secondary current (I_2) at minimum load
= (0.010 x 1.11) = 0.011 amp.

RMS current change from full load to minimum load
= (0.111 — 0.011) = 0.100 amp.

The change in the RMS voltage induced in the secondary, due to the primary resistance
= (0.100 x 200) = 20 volts

RMS voltage induced in one-half of the secondary at minimum load
= (488 + 20) = 508 volts

Total d-c rectified voltage at minimum load
= (508 x 0.636/0.707) = 457 volts

D-c output voltage at minimum load
= (457 — 15 — 0.010 x 244) = 439.6 volts

D-c output voltage regulation
= (439.6 — 400) /400 x 100% = 9.9%

The peak inverse voltage at minimum load
= (508 x 1.414 x 2) -- 15 — 244 x 0.0157
= 1419 volts

The ripple voltage effective in the circuit is equal to the a-c part of the rectified voltage E_2. The RMS value of the ripple voltage, including the higher-frequency components, equals 0.435 times the RMS voltage impressed in the circuit.

The RMS ripple voltage across the minimum load,
R = 439.6/0.010 = 43960 ohms, is
(508 x 0.435 x 43960) / (43960 + 244)
= 220 volts

The RMS ripple voltage across the maximum load,
R = 400/0.100 = 4000 ohms, is
(488 x 0.435 x 4,000) / (4000 + 244)
= 200 volts.

EXAMPLE NO. 2

Choke Input Filter

Assume that a full load output of 400 volts and 100 ma. is required with 5% output voltage regulation for currents from 100 ma. to 20 ma. The ripple voltage across the condenser following the first choke should not exceed 10 volts RMS at full load.

The d-c output voltage rise for 5% regulation
= (400 x 0.5) = 20 volts

The resistance equivalent of the voltage regulation
= 20/ (0.100 — 0.020) = 250 ohms.

Suppose that this resistance is distributed as follows: 90 ohms in the choke, 80 ohms in the secondary (per side), and the equivalent of 80 ohms in the primary circuit.

D-c output voltage at full load = 400 volts.

D-c voltage drop in the tube = 15 volts.

D-c voltage drop in the transformer secondary at full load = (80 x 0.100) = 8 volts.

D-c voltage drop in the choke at full load
= (90 x 0.100) = 9 volts

Total rectified d-c voltage at full load
= (400 + 15 + 8 + 9) = 432 volts

RMS voltage induced in the transformer secondary at full load
= (432 x 1.11) = 480 volts

RMS secondary current at full load (approximate)
= (0.100 x 1.11) = 0.111 amp.

RMS secondary current at minimum load (approximate)
= (0.020 x 1.11) = 0.022 amp.

RMS current change from full load to minimum load
= (0.111 — 0.022) = 0.089 amp.

The change in the RMS voltage induced in the secondary due to primary resistance
= 0.089 x 80) = 7.12 volts

RMS voltage induced in the secondary at minimum load
= (480 + 7.12) = 487.1 volts

Total rectified d-c voltage at minimum load
= (487.1 x 0.90) = 440 volts

D-c output voltage at min. load
= (440 — 15 — 0.020 x (80 + 90)
= 421.6 volts

D-c output voltage regulation
= 100 x (421.6 — 400) /400 = 5.4%

The peak inverse voltage at minimum load
= (487.1 x 1.414 x 2 — 15 — 80 x 0.031)
= 1360 volts

Inductance Required

The inductance L required for a minimum current of 20 ma. at 421.6 volts is shown in Fig. 5. For 60-cycle supply and a load resistance of (421.6/0.020) = 21100 ohms, the inductance should be 28 henries. For higher values of current, less inductance is required to maintain operation on the constant voltage part of the curve. The inductance decreases somewhat as the d-c current is increased. If the decrease in inductance with current occurs at a great enough rate, the voltage may rise slightly. This effect might be utilized for compensating IR drops in the circuit, but it is difficult to get the inductance to change at a great enough rate. Generally, in practice, the inductance will change but the voltage regulation will not be affected.

The RMS ripple-voltage, double-frequency component impressed in the circuit at full load
= (480 x 0.424) = 204 volts
And at minimum load
= (487.1 x 0.424) = 207 volts

The reactance of the choke to a frequency at 120 c.p.s.
= (6.28 x 120 x 28) = 21100 ohms

The reactance of a 4 uf. condenser to 120 c.p.s.
= 1/ (6.28 x 120 x 4/1000000) = 331 ohms

The total circuit impedance will be approximately equal to the difference between the reactance of the inductance and the condenser.

The maximum ripple voltage across the condenser will be approximately
= 207 x 331/(21100 — 331) = 3.3 volts
when the inductance remains constant. The value of the inductance with full output would usually be used for this calculation.

Question and Answer Talks Please Farmers

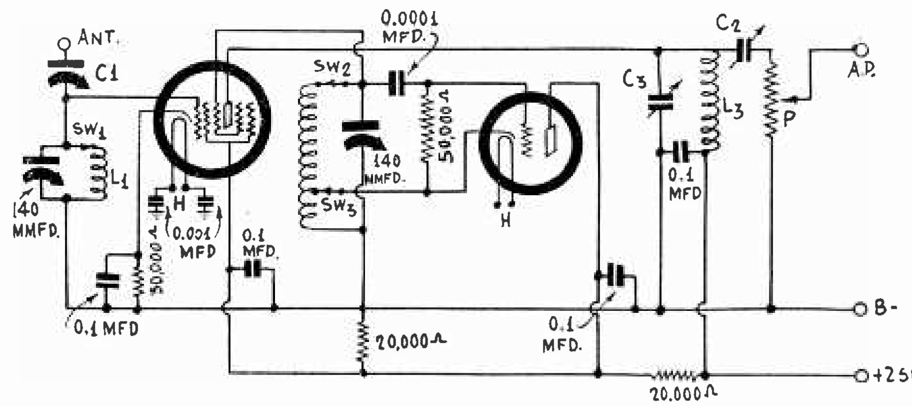
Washington

In a test of the preferences of farmers for different kinds of radio talk, conducted by the Department of Agriculture, it has been demonstrated that farmers prefer talks in the question-and-answer form. The conclusions were based on reports from farmers on a series of 16 test programs of different type. Programs presented in the form of a news story, as a logically outlined public speech, as a sales talk, as a talk interlarded with jokes and humorous verse, in the form of a fable, as a narrative, were less popular with the farmer listeners than were the programs written in the form of experience reports from different farmers, those prepared in the form of simple questions and answers, those in a style requiring listener participation by the use of paper and pencil for taking notes and drawing simple charts, or those in a style in which special care was taken to state minor details in specific, concrete terms.

Running through the whole series of reports is a chain of comments which show that one of the best ways to get and to hold farmer interest is to talk to him in a straightforward, sincere, informal, friendly farmer fashion, and to talk to him about what other farmers have actually done on their farms.

Short-Wave Converter Using New A-C Tubes

By Einar Andrews



THIS IS the time when radio fans become interested in short wave sets and converters, and the interest now centers on the new tubes. Improvements in these should be evident when they are used in short wave circuits, whether converters or complete receivers.

One of the conditions for a good short-wave circuit of any kind is simplicity. One great radio authority made the statement that, in general, the simpler the circuit the more efficient it is. Of course, this does not mean that a circuit having one or two tubes is as sensitive as one having many tubes, for a multituber of proper design and construction may be exceedingly sensitive. But it does mean that, tube for tube, the simpler circuit is the more efficient.

The new tubes, especially the 57 and the 56, seem to be well adapted to use in a converter, the 57 being used for first detector and the 56 for oscillator. The 56 is a reliable oscillator and the 57 is a very sensitive detector.

Separate Tuning Condensers

In a converter utilizing these tubes there should be two tuned circuits at the high frequency level, one for tuning to the carrier frequency desired and another for adjusting the oscillator frequency to the required value for any given carrier. There is always a temptation to gang the two condensers for tuning the two circuits because of the simplification, but in this respect the simplicity is not consistent with best results. Far from it. Of course, it is possible to arrange the circuit so that ganging is permissible, but then we have to use a manual trimmer for one of the circuits, and that makes the circuit less simple. The best arrangement is to use two separate tuning condensers, one for the oscillator and one for the input to the detector. This not only provides for much closer tuning, and hence greater sensitivity, but it makes the coil design and construction less critical.

In most short wave circuits the capacity of the tuning condensers is 140 mmfd. While this capacity is not at all necessary it is a good compromise among several conflicting factors. Some of these are band coverage. which is increased with increased capacity, and sensitivity, which is increased with decreased capacity. As the band coverage is decreased the number of units in a set of plug-in coils is increased, or the number of taps on a tapped coil is increased. Neither is desirable. On the other hand, when the tuning condenser is large, the tuning is critical because such a wide range of frequencies is crowded into each band. This is not desirable either. Of course, a condenser of 200 mmfd., or 150 mmfd., or even 125 mmfd., would be all right provided the coils are designed for them.

Coupling to Antenna

The coupling to the antenna in this circuit is the best there is. A small condenser C1 is inserted in series with the antenna lead. If this is made small the results are practically independent of the length of the antenna. It is best to use a tiny variable condenser for then the adjustment of the capacity can be made for any case and to suit any experimenter. The minimum capacity of a trimmer type midget may be too large, although the maximum capacity may not be more than 20 mmfd. Sometimes a sufficient coupling capacity can be obtained by twisting together two insulated wires. By twisting more or less the capacity can be varied. That is certainly an inexpensive way of getting the condenser C1. However, a regular air condenser with two or three small plates would be the best, and a condenser of this type can be mounted on the front panel for easy accessibility.

The small condenser C1 removes the antenna resistance from the tuned circuit, and also the antenna capacity. Hence the tuning will be more regular and sensitivity will be greater because the selectivity of the r-f tuned circuit will be much greater than it would be if the antenna were coupled closely to the tuned circuit.

High Detecting Efficiency

To get a sensitive converter we must make certain that we have an efficient detector or frequency changer. To start with we can choose the 57 tube, which is the best grid bias detector so far brought out. But we can make this either a good or a bad detector by selecting different operating conditions. Suppose we give the plate the full 250 volts recommended for this tube. Then we can vary the detecting efficiency by varying the grid bias, the screen voltage, and the suppressor voltage. On the screen we can apply any voltage from about 50 to 100 volts. For fixed values of plate and screen voltage we can vary the bias to find the most effective detecting point. It has been found that if the grid bias resistor is 30,000 ohms the detecting efficiency is good, but this requires that the screen voltage be somewhat less than the maximum 100 volts recommended.

Since the tube is a frequency changer we must also introduce an oscillator voltage. We may apply this in the cathode lead in series with the bias resistor, or in the control grid lead, in the plate, in the screen, or suppressor leads. The particular method of coupling should be equally efficient at all frequencies and should not require the use of another winding on the oscillator coil, at least not if a switching arrangement is to be used for changing the frequency band. The suppressor grid of the 57 offers a means for constant coupling without the use of an extra winding on the oscillator coil. The suppressor grid may be connected to the stator of the oscillator condenser. Or, if this results in excessive coupling the suppressor grid may be connected to the cathode of the oscillator tube, provided the oscillator shown in Fig. 1 is used.

How It Modulates

Ordinarily the suppressor grid is connected to the cathode of the tube so that the operating suppressor voltage is zero. If we so connect the suppressor grid that it returns to the cathode after having picked up the oscillator voltage, it would be positive part of the time. But the tube does not seem to function well with a positive suppressor grid. In this case the current drawn by the suppressor grid might stop the oscillation, which would make the entire circuit inoperative. The way the circuit in Fig. 1 is connected the suppressor grid is normally negative by an amount equal to the grid bias of the tube. Thus the oscillator voltage may equal to grid bias before the suppressor goes positive. The more negative the suppressor is the less the plate current will be because the transconductance decreases with increased negative suppressor voltage.

(Continued on next page)

LIST OF PARTS

Coils

L1—One set of four r-f coils as described.
L2—One set of four oscillator coils as described.
L3—One r-f tuning coil as described.

Condensers

C1—One midget condenser, or two insulated wires twisted together.
C2—One adjustable midget condenser.
C3—One 100 mmfd. trimmer type condenser.
Two 140 mmfd. tuning condensers, with vernier dials.
Two 0.001 mfd. by-pass condensers.
Four 0.1 mfd. by-pass condensers.
One 0.0001 mfd. condenser.

Resistors

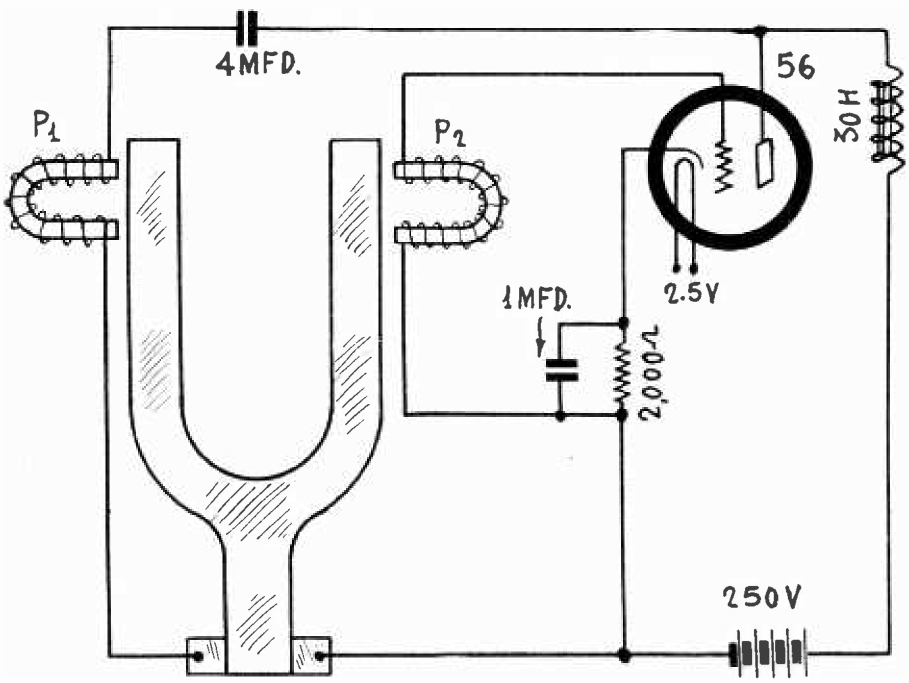
One 30,000 ohm bias resistor.
One 50,000 ohm grid leak.
Two 20,000 ohm resistors, 3 watt size.
One half megohm potentiometer.
Other requirements.
One six-contact socket.
One five-contact socket.
One three-deck, four point switch.
One grid clip.
Four binding posts.
One small chassis.

STANDARD RESISTOR COLOR CODE

Megohms	Ohms	Body Color	Dot Color	End Color
0.02	20,000	Red	Orange	Black
0.03	30,000	Orange	Orange	Black
0.05	50,000	Green	Orange	Black

The Effect of Transients on Quality of Output

By J. E. Anderson



WHEN SIDEBAND suppression in tuned circuits is considered it is usually done from the point of view of the "steady state" condition. The resulting analysis is simple but it does not yield a complete solution, for the signal is not in the "steady state." But quantitatively we have to be content with the "steady state" solution for a complete solution is beyond analysis.

Before we proceed let us define the "steady state." Suppose we hook up a simple circuit containing resistance and inductance in series with a battery. When we first close that circuit the current does not attain a steady value instantly but it increases gradually. After a long time, say 0.1 of a second, the current no longer changes, at least measurably, and then the steady state has been reached. The period between the closing of the switch and the attainment of the final steady value of current is called the transient period. The steady state current is determined by Ohm's law, that is, by dividing the voltage in the circuit by the total value of the resistance. The duration of the transient period is determined by the time constant of the circuit, which in this case is the ratio of the inductance in henries to the

Design for Short-Wave Converter

(*Continued from preceding page*)

As the oscillator varies the suppressor voltage the plate current is changed. Also, as the signal varies the control grid voltage, the plate current changes. Sometimes the two change the current in the same direction and sometimes in the opposite. The result is that the output current will vary according to the difference between the two. That is, the plate current will contain the difference frequency. Then if we put a selecting circuit in the output of the tube and tune this to the difference frequency we shall have a strong intermediate frequency signal.

The more effective use we can make of this intermediate frequency signal the more sensitive will be the converter. In this case the load on the detector tube is a resonant circuit consisting of a coil L3 and a condenser C3. L3 may consist of the secondary of an ordinary radio frequency coil and C3 a trimmer type variable condenser. If the coil used has been designed for a tuning condenser of 350 mmfd. the inductance will be 245 microhenries. Then what should the capacity of C3 be? It depends on the frequency we wish to use for intermediate. We may choose any frequency between 550 and 1,500 kc because the broadcast set can be tuned to any frequency in this range. A frequency of 1,000 kc is all right. This would require that the capacity of C3 be slightly over 100 mmfd. There is a trimmer of this size available. Since there will be considerable distributed capacity this condenser will easily reach 1,000 kc, and the range is large enough to permit tuning up to 1,500 kc. If we want to go much lower than 1,000 kc we have to add more capacity to the trimmer, either with a fixed or variable condenser.

It is not necessary to provide for any frequency in the broadcast band, but only for a narrow band of frequencies. The reason a variable condenser is used at all is that if a fixed frequency were used there might be local interference on that frequency and there would be no means of avoiding it. With a variable condenser the intermediate frequency can always be selected so as to avoid local interference. For example, there may be a strong local station on 1,000 kc but the ether may be quite clear at 950 or 1,050 kc. Then it is only necessary to change the setting of the condenser C3 and retune the broadcast set.

The output coupler is the unknown quantity for a converter. The best one must be found experimentally in each case. Lack of proper coupling between the converter and the broadcast set has been one of the reasons many converters have failed to give good results. The broadcast set may have been first class as to sensitivity and selectivity. Likewise the converter. Yet the combination of the two has been a failure. To correct the trouble in any case it is only necessary to change the coupler.

In Fig. 1 the type of coupling is such as to fit most sets, with very little adjustment. The variable condenser C2 is used to reduce the coupling for the same reason that C1 is used in the antenna. The potentiometer is used as a volume control. It should have a high resistance, say 500,000 ohms or more. C2 may be of the same type and capacity as C3 or it may be a little larger. With the output arrangement shown the output terminal AP may be connected to the grid of the first tube in the set, or it may be connected to the antenna binding post. If it is connected to the grid, the tuned output circuit in the converter takes the place of the first tuner in the broadcast set. If it is connected to the antenna binding post it becomes an additional tuner. The grid connection is preferable from the sensitivity point of view but it is not quite so convenient, since it is necessary to enter the set to reach the grid and the antenna binding post is accessible from the outside.

The two tubes in the converter require only two amperes for the heaters. In most cases this current can be obtained from the broadcast set by running leads to the nearest points across which the voltage is 2.5 volts. If this proves inconvenient a small 2.5 volt filament transformer should be built into the converter.

A condenser of 0.001 mfd. is connected between ground and each side of the heater circuit. These condensers should be put near the detector tube. Their purpose is to eliminate hum.

The plate and screen voltages are best obtained from the set with which the converter is operated, for that obviates the necessity of building a B supply. It only requires one lead between the converter and the high point of the voltage divider. This voltage is obtainable at many different points in the set. Of course we must also provide for a return connection. The junction between the two chassis serves for this as well as for the ground of the converter.

If the tuning condenser in the r-f circuit is 140 mmfd. we are justified in assuming that the minimum capacity can be made 30 mmfd. Then the capacity ratio of the tuner is 140/30 and the frequency ratio is 2.18. Therefore if we make the largest coil so that it will just reach 1,500 kc that coil will tune up to 3,270 kc. We can select the next coil so that it will go from 3,200 to 7,000 kc, the third so that it will cover the band from 7,000 to 15,000 kc, and the fourth so that it will go from 15,000 to about 33,000 kc.

[Coil data next week.]

resistance in ohms. If the time constant is 0.01 second it requires about 0.046 second for the current to build up to within one per cent. of the final value.

Charging a Condenser

Suppose we hook up a circuit containing a battery, a condenser, and a resistor. When we first close the circuit there is a sudden surge of current but the current dies down gradually. After a certain time the condenser is charged to a voltage equal to the battery voltage and the current in the circuit is zero. Then the steady state has been reached. The time required for the charge is determined by the time constant of the circuit, which in this case is the product of the resistance in ohms and the capacity in farads. If the time constant of this circuit is the same as that of the preceding inductance circuit, it requires the same time to charge the condenser as it did to reach the steady state current in the inductance circuit. That is, if the time constant is 0.01 second, the condenser will be charged to within one per cent. of its final charge in the 0.046 second.

The gradual change in the current can be detected in either case with a d-c ammeter of sufficient sensitivity, provided that the time constant is not too small. The meter itself has a time constant and that may be greater than that of the circuit, in which case the effect would not be noticeable.

If we use an alternating voltage instead of a steady voltage the amplitude of the alternating current will change in the same manner as the direct current in the corresponding d-c case. For the same time constant it will take the same time for the alternating current to build up to the steady state. The final amplitude will be determined by the amplitude of the alternating voltage and the impedance in the circuit. That is, it will be E/Z, in which E is the alternating voltage amplitude and Z is the effective impedance of the circuit. But choosing the correct impedance the expression holds for both the inductance and the capacity cases. E/Z is the steady state amplitude.

Case of Tuned Circuit

In case the circuit consists of a resistance, an inductance, and a capacity, all in series with each other and with an alternating voltage, we have a similar situation. After a certain time has elapsed, depending on the time constant of the circuit, the alternating current will not change, and then the steady state condition has been reached. During the time the current is building up there is a transient current present, and this may be oscillatory, that is, it may be independent of the driving voltage as to frequency. The steady state current amplitude will depend on the driving e.m.f. amplitude and on the effective impedance of the circuit. This impedance will be determined by the resistance, capacity and the inductance.

If the reactance of the inductance and the reactance of the condenser are equal, the total reactance in the circuit is zero and the only impedance is the resistance. When this condition obtains the circuit is in resonance with the driving voltage. The resonant current $I = (E/R) \sin wt$, in which I is the amplitude of the resonant current, E the amplitude of the driving voltage, R is the resistance in the circuit, and w is 2π times the frequency of the driving voltage. In order to have resonance with the driving voltage it is necessary that $w^2 = 1/LC$. This is the condition for driven resonance and not for resonance in a freely oscillating circuit.

Free Resonance

The 2π frequency of a freely oscillating circuit is $(1/LC - R^2/4L^2)^{\frac{1}{2}}$. Thus the natural frequency of a freely oscillating circuit is less than the natural frequency of the same circuit when it is driven, and the amount by which it is less depends on the time constant of the circuit. The time constant in this case is 2L/R, in which L is the inductance in henries and R the resistance in the circuit in ohms. The time constant is given in seconds.

Free oscillations in a circuit occur after the circuit has received an electric shock of some kind, such as the discharge of a condenser, a sudden surge of current through the coil or through a coil coupled to the coil in the circuit. They also occur a short time after an alternating voltage has been applied to or removed from the circuit. Transients also occur after every sudden change in the amplitude or frequency of the driving voltage, and it is in this respect that the steady state treatment of selectivity and sideband suppression is faulty.

In the ordinary theory of sideband suppression, the steady state formula for alternating current in a circuit containing resistance, inductance, and capacity is taken, and it is tacitly assumed that the carrier as well as each one of the side frequencies is steady. Whether we look at the modulated radio wave as modulated in amplitude or as a wave of constant amplitude with constant side frequencies, the assumption is not correct. The side frequencies, particularly, are not steady. Certain sustained notes in music may be regarded so, but most sounds transmitted are of too short duration to be considered steady. The consonants in speech, for example, are transient in nature and a much wider band is needed to reproduce them than if they were tones of appreciable duration.

The consonants are carried by the higher audio frequencies and it is usually assumed that if frequencies up to 10,000 cycles are reproduced full strength that the consonants will be reproduced correctly because the ear does not respond to much higher frequencies. But this does not necessarily hold, due to the transient nature of the sounds. Correct reproduction of a certain consonants may require the amplification of frequencies even twice as high as the highest audible frequency in order that the sounds may be heard just as they are. This does not mean that the consonants are not understandable if they are not reproduced just as they are, because the brain interprets them correctly even if they are not exactly true. But the farther they are from true, the more difficulty the brain will have interpreting them.

Time Lag Effects

Suppose that a sound consists of a sudden burst of vibration. It may be that the sound is a pure tone as long as it lasts. It requires a certain time for that sound to build up to the maximum value, but before it has had time to build up the burst is over, and then it takes some time for it to die down. It neither starts nor stops suddenly as demanded by the original. The more selective the circuit at the receiver, the longer will be the time it takes for the sound to build up, and also for it to die down again. Now, if the tone is of considerable duration, the periods of building up and dying down are short compared with the total time the sound lasts and the less will be the effect of the transients. Sustained musical tones and the vowels in speech last a considerable time and therefore they are reproduced correctly even when the circuit is very selective.

The lingering effect of a sound is often noticed in reproduction of tones, but only when the effect occurs in the audio amplifier or the loudspeaker. As a rule, the effect is due to a resonance condition in the audio part of the circuit. The tone appears to be stronger than it should be and to last too long, which is just the case. The effect is unpleasant. A similar effect occurs in the radio tuner, and the booming effect of extremely resonant circuits, especially regenerative, is nothing but this lingering of the sound after the time it should have ceased. Since there is also a corresponding delay in starting, the whole sound is displaced in time with respect to other sounds. However, when the delay occurs in the radio circuit it is likely to delay all sounds by about the same amount except that the higher audio frequencies, and superaudible frequencies, are likely to be delayed more, or even suppressed entirely.

Delay in Mechanical Resonance

The delay due to high selectivity is strong in mechanical resonators. In a vacuum tube driven tuning fork of 100 cycles per second it required approximately 30,000 cycles for the amplitude of the fork to build up to the steady state, that is, constant amplitude. In terms of time this means that five minutes elapsed between the time the power was applied and the time the amplitude reached its maximum value. In this case the resonator, the fork, was extremely selective and the coupling between it and the driving force was very loose. The delay in dying down was even longer, for the fork kept vibrating sensibly more than ten minutes after the driving force was removed.

In a radio set the current continues to flow in the resonant circuits after the driving e.m.f. has ceased, just as in the case of the tuning fork, except that the time is not so long because the selectivity is less. And it also takes a time for the current to build up after the driving force has been applied. These effects occur every time there is a change in the driving e.m.f., either a sudden increase or a sudden decrease. And the ordinary radio signal consists largely of sudden changes in the intensity. Hence, the transients are present all the time. Unfortunately, it is not possible to analyze the transients because of their complexity. The steady state treatment is about the best that can be done. And this leads qualitatively to the correct condition, that is, that the selectivity of the circuit should not be excessive if the reproduced signals are to be close copies of the original.

Mechanical Oscillator

In Fig. 1 is the circuit arrangement of a tuning-fork oscillator of the type referred to above. The fork is rigidly mounted in a metal clamp. Two headphone magnets are mounted rigidly near the ends of the prongs of the fork in the manner indicated. The coil of one of these is connected in the grid circuit of a good vacuum tube and the other is connected in the plate circuit. A filter consisting of a 4 mfd. condenser and a 30 henry choke are used to keep the d-c out of the driver winding P1. If the leads to the magnets are connected in the proper phase the fork will vibrate as long as power is supplied to the tube. The coupling will depend on how close the magnets are to the prongs of the fork. In some cases, especially if the natural frequency of the fork is 1,000 cycles or more, it may be necessary to tune one of the windings with a condenser, or else to use another tube so that there are two stages of amplification.

One-Third of Schools in Germany Have Sets

Washington

One out of every three schools in Germany is now equipped with radio, says Dr. C. M. Koon, specialist in education by radio at the Federal Office of Education. The German school radio programs now reach 2,500,000 pupils and 65,000 teachers.

SPECIAL ANTENNA T

"MAKES" 193

TWO TUNED CIRCUITS

By Hern

RESISTOR COLOR CODE

Ohms	*Megohms*	*Body*	*Dot*	*End*
350	.....	Orange	Brown	Green
800	.....	Gray	Brown	Black
1,200	0.0012	Brown	Red	Red
50,000	0.05	Green	Orange	Black
20,000	0.02	Red	Orange	Black
100,000	0.1	Brown	Yellow	Black
2,000,000	2	Red	Orange	Black
5,000,000	5	Green	Orange	Black

I

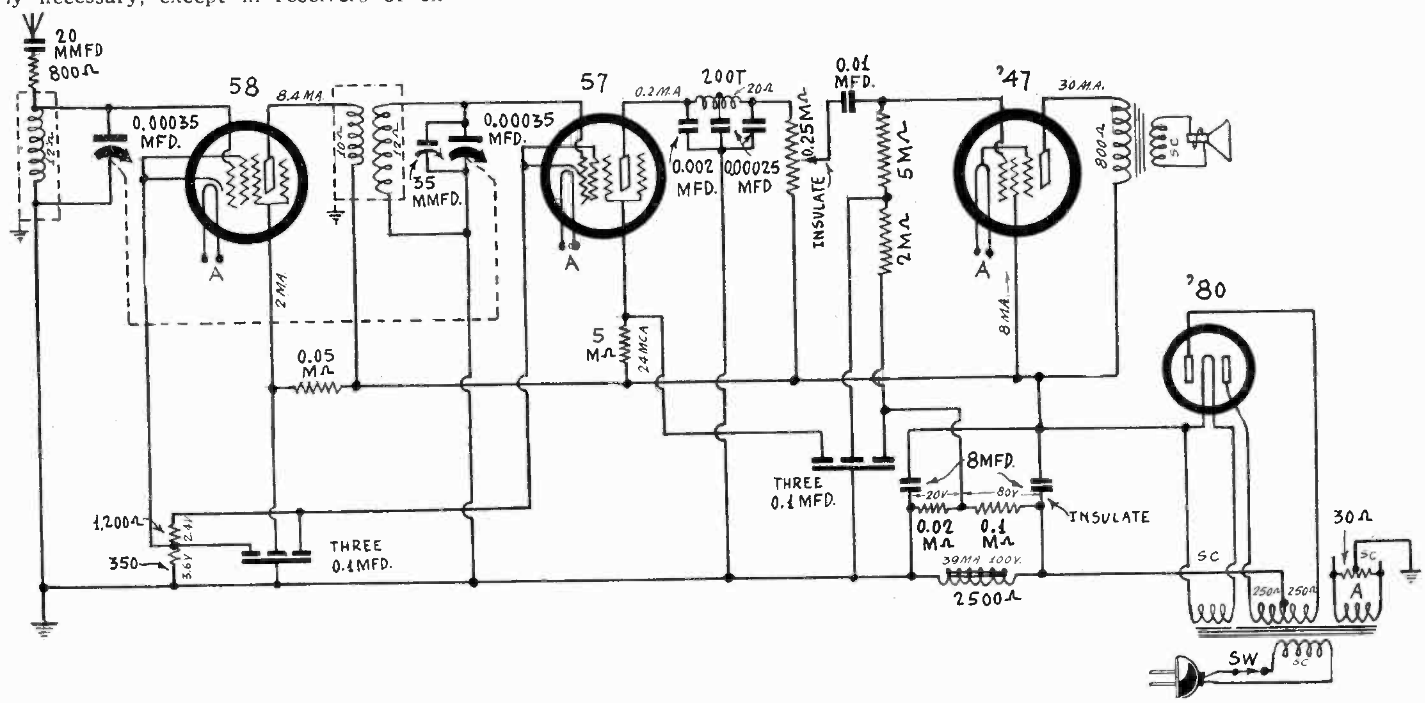
Theory of the Circuit

THE conventional method of coupling the aerial to a receiver is through a primary inductively related to a secondary, using close coupling. This method has long been regarded as virtually necessary, except in receivers of extremely high sensitivity. The necessity was deemed to arise from the requirement of a strong input, so that the volume of sound in the final output would be sufficiently large.

If a series condenser were used it was for improving the selectivity, which indeed it does, because it loosens the coupling. But this always was accompanied by proportionate reduction in the volume of sound. That is, considering the aerial, ground and receiver as a system, close coupling resulted in greater sensitivity, at the expense of selectivity, loose coupling in greater selectivity at the expense of sensitivity.

If a series condenser were used for broadcast purposes it was no larger than 0.0001 mfd., whether connected to a primary or directly to the grid when a tuned impedance system was used. As stated, not unless the receiver was exceptionally sensitive would the series condenser be used at all.

This standard method overlooks one important consideration, and so far as known the point has not been raised before: if a series condenser is made small enough, the sensitivity of the receiver itself and also the system as a whole (including aerial and ground) will increase. The reason is that a condenser of 0.0001 mfd. or a conventional primary introduces considerable antenna r-f resistance into the first tuned circuit, and if only two tuned circuits are used the selectivity will not be high enough nor will the selectivity, and as one can be improved by the usual antenna connection only at the expense of the other, there would be no remedy to create a receiver suitable for the close requirements of to-day, without utilizing regeneration. On the other hand, if the series condenser used is made as small as 20 mmfd., a value never before suggested for the broadcast band, or if the condenser is made still smaller, the



KEY TO THE SCHEMATIC DIAGRAM

The resistance values, currents and principal voltages are given on the diagram. The total voltage, measured from ground to B plus maximum, was 230 volts, but this may differ slightly, being 250 volts or thereabouts, or even a little less than 230 volts, depending on the power transformer voltage, line voltage, resistance of the field coil and actual capacity of the condensers marked 8 mfd. If these capacities are lower, particularly the condenser next to the rectifier, the B voltages will be lower.

The following voltages may be read with the usual meters:

3.6 volts, negative bias on the r-f amplifier, measured between ground and cathode.

a-c heater and filament voltage, which should be 2.5 volts, preferably not higher, but may be 2.4 volts.

a-c line voltage.

a-c voltage across each high-voltage secondary.

Screen voltage on pentode, same as voltage between ground and maximum B plus (230 volts).

B voltage on r-f amplifier, which should read total 230 volts, if measured between ground and plate, but actual plate voltage applied is that between cathode and plate supply, therefore would be 230 volts less the bias voltage, or 226.4 volts. There is substantially no difference between the effective and the applied plate voltages, as the resistance of the load is only 10 ohms.

Effective plate voltage on the pentode, which equals the maximum B voltage, measured between ground and maximum B plus for this tube, less the drop in the primary of the output transformer. This drop should be around 24 volts, so the effective plate voltage should be around 206 volts.

Voltage drop across the field coil, approximately 100 volts.

Screen voltage on the r-f amplifier, which will read around 110 volts between ground and screen, although actually higher (130 volts). The true screen voltage is that between cathode and screen, or 126.4 volts.

Voltages that can be measured accurately only by electrostatic means, or which can be computed, due to the known or ascertainable values of current and resistance, in relation to voltage differences:

Negative grid bias voltage on the 57 detector grid, measured between cathode and ground. The reading obtained with ordinary meters (1000 ohms per volt) is about the same between these two points as between r-f tube cathode and ground, due to the small current, a trifle more than 0.2 ma., through the 1200 ohms.

Screen voltage on the 57 detector, actually 104 volts, but affording readings of around 30 volts on ordinary meters.

Effective plate voltage on the 57 detector, actually 180 volts, although measuring considerably less on ordinary meters.

Voltage drop across the resistors paralleling the field coil. The proportion of the resistors may be determined by the proportion of the voltage readings, but the current through these resistors is only a little in excess of 0.8 ma., so the voltages read on ordinary meters will be too low. Determine the bias by adjusting the '47 plate current to 30 ma.

REATMENT
DIAMOND OF THE AIR
PERFORM EXCELLENTLY

n Bernard

LIST OF PARTS

Coils

One impedance coil for antenna stage, for 0.00035 mfd.
One r-f transformer for interstage coupler, for 0.00035 mfd.
One 200-turn center-tapped choke coil.
One power transformer.

Condensers

One two-gang shielded 0.00035 mfd. straight frequency line condenser.
One 20-100 mmfd. equalizing condenser.
One 35 mmfd. manual trimming condenser.
Two shielded blocks, three 0.1 mfd. in each block (black leads are common, go to ground).
One 0.002 mfd. mica fixed condenser.
Two 0.00025 mfd. mica fixed condensers.
One 0.01 mfd. mica fixed condenser.
Two 8 mfd. electrolytic condensers, one with two insulating washers and a special connecting lug.

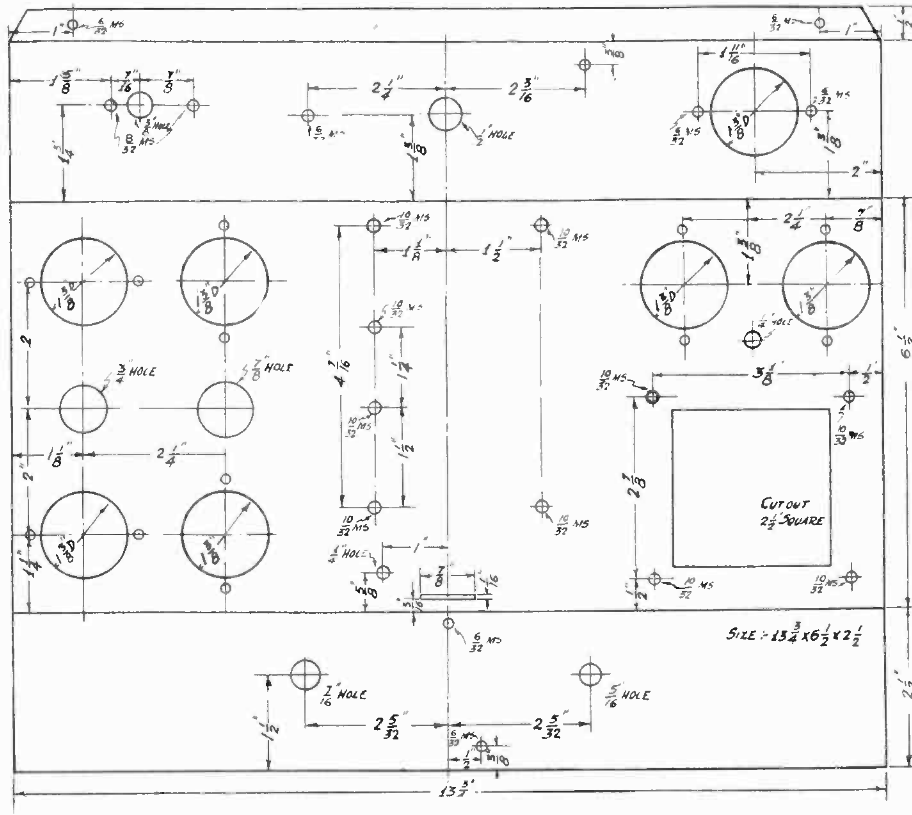
Resistors

One 30-ohm potentiometer, setscrew adjustment.
One 350-ohm pigtail resistor.
One 800-ohm pigtail resistor.
One 1200-ohm pigtail resistor.
One 0.02-meg. pigtail resistor (20,000 ohms).
One 0.05-meg. pigtail resistor (50,000 ohms).
One 0.1-meg. pigtail resistor (100,000 ohms).
One 0.25 meg. potentiometer (250,000 ohms) with a-c switch attached; insulating washers.
One 2-meg. pigtail resistor.
One 5-meg. pigtail resistor.

Other Requirements

One chassis, 13¾ inches wide x 2½ inches high x 6½ inches front to back.
One vernier dial, travelling light type, with bracket and pilot lamp; dial reads, left to right, 100 to 0.
Three knobs (one for dial, one for volume control-switch, one for manual trimmer).
One dynamic speaker, 2500-ohm field coil, output transformer built in, has matched impedance for '47 tube.
One shelf 6¼ x 2½ inches, with two brackets.
Two six-prong, two five-spring (UY) and one four-spring (UX) sockets. The extra UY is for speaker plug.
One a-c cable and plug.
Two special aluminum shields for the 57 and 58 tubes.
One rubber grommet for a-c cable exit.
Tubes required: one 57, one 58, one '47 and one '80.

keenness of the circuit is increased so greatly that there would be considerable oscillation. This might hold over the entire broadcast band, instead of being confined as conventionally to a few of the higher frequency channels, with no special precautions taken to avoid oscillation.



KEY TO CHASSIS LAYOUT

The lower oblong is the front elevation, the next upper one, the largest, is the chassis top or plan, the next upper one is the rear elevation, while the small extension to the rear elevation (extreme top) is a flap bent at right angles to rear elevation for securing chassis to a cabinet bottom or shelf.

Front elevation: The 7/16-inch hole at left is for volume control, the 6/32 hole at center top is for securing a dial bracket, the 6/32 hole ½-inch from center is for shelf bracket, the 5/16-inch hole is for manual trimmer condenser.

Top: Three holes, extreme left, top to bottom, are for r-f tube, 8 mfd. uninsulated, and detector tube, respectively. Second row from left, antenna coil, 8 mfd. insulated, and detector coil, respectively. Third row from left, four 10/32 holes, top and bottom for condenser shield, inside holes for outleads from condenser stator lugs. Just to right, bottom, ¼-inch hole is for pilot light leads. Slot to right is for dial bracket. Fourth row from left, two 10/32 holes for condenser shield. Cutout square and four 10/32 holes are for power transformer. Sockets at right rear, power tube and ectifier, left to right: The ¼-inch hole between these socket holes is for the hum adjuster.

Rear elevation: Three holes at left for antenna and ground post assembly, next (fourth) hole to right, for three 0.1 mfd. in one case, center ½-inch hole for rubber grommet and a-c cable exit, next small hole for other bracket of shelf, and socket at right for speaker plug. One 6/32 hole for extra three 0.1 mfd. not shown.

Rear bottom: Mounting flap with two holes for driving wood screws to cabinet floor or shelf.

While a series condenser is shown, variation of the actual physical length of the aerial would have the same effect. A series condenser is preferable, as it is too uncertain to depend on adjusting aerial lengths by mechanical means, and it is much easier to set an equalizer at minimum in the receiver.

Just as an example, a standard hookup was used, transformer in antenna and detector stages. The first or second tube, or both tubes, cross-modulated, the selectivity was low generally, as would be expected from normal two-tuned circuits, volume was fairly good, and there was squealing only at the few channels near the high frequency extreme. This oscillation, however, was exceedingly intense. As an experiment, turns were removed from the primary of the interstage coupler, as this loosened coupling, and when sufficient turns were removed to prevent squealing, the volume on the lower frequency stations was so low that the receiver was utterly unsatisfactory. Now, this has been the common experience for a long time, that when either selectivity or sensitivity is increased the other is decreased, and more tuned stages and more amplification are required.

However, when a 20-foot indoor aerial was connected to the grid directly, although one stage would not track well with another, it was found that conditions were still worse, as expected, for the coupling was unity. Then the aerial was cut to a length of 10 feet, there was an improvement in both selectivity and sensitivity over the conventional system. As the aerial was reduced more and more in physical length, until it was less than 3 feet, and did not quite reach the floor from the table on which the experiment was being conducted, the set came nearer and nearer to the squeal oscillation point,

(Continued on next page)

(*Continued from preceding page*)
and finally squealed at all positions on the dial.

One of the best signs is oscillation, as you then know you have a circuit that is over-keen, and something can be done to tame it, although when there is never any sign of oscillation during experiments the situation begins to look discouraging.

It was obvious, therefore, that a key to new performance, using few tubes, existed in the proper proportion of the coupling and other considerations affecting r-f resistance. When an approximate adjustment was made, using 20 mmfd. between aerial and grid, and restoring the 20-foot indoor length, the receiver was much more sensitive than it had been under the conditions of conventional usage, and moreover the set was much more selective. That is, the improvement of one characteristic also improved the other, and that was something new.

Since the series condenser was 20 mmfd. (an equalizer of 20-100 mmfd. set at minimum capacity, plates disengaged as much as possible) any average aerial would have next to no effect on the capacity introduced into the grid circuit by way of the aerial. The only result would be a small reduction of the capacity in the tuned circuit, and it shows up as a parallel capacity, by the way. The antenna is one condenser, the series condenser is the other, and if the antenna is of 0.0002 mfd. capacity, it is in series with a capacity only one-tenth as great, so the capacity change is negligible. Not so, however, of the resistance change, nor of the pickup effect. The inductive and resistive effects on the grid circuit are considerable, despite the 20 mmfd. series capacity.

The actual values were worked out therefore for duplication. First, the 20 mmfd. series condenser was made a permanent contribution to the new system, then a 20-foot indoor aerial around a moulding was used, as almost any aerial will amount to that much inductance, resistance and pickup, and then the circuit operation was studied for squealing effects. These were present all over the dial the moment the aerial was reduced to a few feet, but were present only at the higher frequency end when the 20-foot aerial was utilized.

It had been found that removing primary turns from the interstage coupler was not a good remedy, and as the radio frequency tube now had too little resistance in the circuit at the high frequencies, it was decided to use a series resistor in the aerial. This would be much more effective at the high frequencies than at the low, or, to express it relatively as to its effect, it was like a variable resistor that was a high resistance to high frequencies and a low resistance to low frequencies. In this way the squealing was stopped completely, and when the test was made for results on the low radio frequencies, it was found, with an output meter, that there was no readable difference.

When 800 ohms was the value used as series resistor the circuit performed excellently.

Therefore the first tuned circuit was subjected to reduction in radio frequency resistance until there was abundance of oscillation, whereupon some extra resistance was introduced to bring the circuit's resistance from a negative value to a low effective positive value. The net result, a low value of resistance, decreases greatly the losses found in conventional systems. The reduction can not be pressed beyond a certain point and retain practical value, for negative values of resistance result in oscillation.

There was no cross-talk, no cross-modulation, but there were excellent gain, total stability, when the new treatment was applied to the antenna circuit and first tube.

The values given are not controlling. They are simply tested values that will give excellent results, along the lines indicated, for commercial practice, or for home-construction of receivers. It is quite possible to choose other values. A smaller capacity than 20 mmfd. was used, with a much smaller aerial, but a larger series resistor, and results were about the same, aerial consisting of less than 3 feet of wire. Such a length could be run down the back of a console, or might be simply a wire dropped from the antenna post of the set as far as the floor. Then you would have a four-tube set "that didn't need any aerial," as the saying goes. But when the aerial is so short you don't hear anything much unless you have a ground, while with the values previously given the set works very well indeed without any external ground, although it is not suggested that no ground be used.

There is some contribution by the aerial to the resistance introduced in the first stage, even with the 800 ohms in series, for if no aerial or ground is connected, the set will squeal. That is, the aerial itself is depended on to some extent to produce stability all over the dial.

The antenna treatment outlined was such a considerable improvement over other systems used over ten years of experimenting that it is commended to experimenters and technicians, particularly as it permits selectivity and sensitivity of a sufficiently high order for modern requirements, although employing only two tuned circuits. Sensitivity at 1,000 kc should be around 10 microvolts per meter.

The advantage of confinement to two tuned circuits is that the more tuned circuits there are the greater the tracking trouble. Tuned radio frequency sets with six tuned circuits—three stages of t-r-f with some band pass filtration—nearly always have selectivity trouble. With only two tuned stages it is not a good plan to use fixed trimming condensers, because no matter what method of antenna coupling is used, there is bound to be some difference. It may be only the difference in inductance of coils or capacity of the sections.

When more stages are used, with multi-section condensers, enough of them may just hit it right at any and all frequencies to give you passable results, but with two tuned stages there is no substitute for an adjustable trimmer. Expressed in the unscientific but overpowering terms of stations received, 13 more were brought in with a manual trimmer than when fixed trimming was used. When the manual trimmer is included there need be no trimming capacity across the condenser section in the antenna stage.

The mainspring of the 1933 Diamond of the Air—as the four-tube circuit is called —is the special treatment of the antenna circuit, the rest of the circuit being of orthodox type, except so far as actual experimental data require otherwise, as will be explained.

The 58 r-f tube is worked at 3.6 volts negative bias, the 57 detector tube at 6 volts negative bias, both values at no signal. Since the 57 should not exclusively bias itself, because of the wobbly plate current condition (that is, the very high detecting efficiency), the bias of the 58 is taken as a starter and the rest from an additional biasing resistor through which flows 57 current. Thus the current produces 2.4 volts bias, and the proportion is, 10/17 derived from the 58, 7/17 derived from the 57.

The detector has two unusual features, one the use of a very high resistance in the screen circuit (5 meg.) and the other the high total value of detector plate bypass condenser. The 57 is the detector. Its plate current is 0.2 ma, and its screen current only 24 microamperes (0.024 ma). Thus the voltage drop, which you can not measure on meters that draw current from the measured source, is 120 volts across the 5 meg., and the screen voltage equals 104 volts, if the applied voltage is 230 volts, as it was. The screen voltage, one should remember, is the voltage between cathode and screen, and not between B minus and screen.

It is interesting to investigate whether the effective screen voltage is higher than the effective plate voltage. At 0.2 ma the drop in 0.25 meg. is 100 volts, and bias voltage is 6, so the effective plate voltage is 230 minus 106, or 124 volts. The effective screen voltage is therefore 20 volts lower than the effective plate voltage on the detector.

The three-section pi-filter in the detector plate circuit does only one thing, bypass radio frequencies, but in so doing serves two purposes. It prevents squealing, because removing the r-f from the intense amplification it would be subjected to in the pentode, and also improves greatly the detecting efficiency.

Audio Considerations

First there is a capacity of 0.002 mfd., next there are two 0.00025 mfd. The inductive part of the filter is a 200-turn center-tapped honeycomb coil, inductance about 600 microhenries. The attenuation is much greater than that present in most other receivers, but it is a part of the audio balancing, for the pentode has a strong high audio frequency response, and it is good practice to use capacity large enough to reduce this, and thus level the audio response curve. In fact, compensating systems are sometimes found in the primary of the output transformers to accomplish substantially the same purpose, and speaker manufacturers recommend such. The present method is to the same purpose.

The leak values in the pentode circuit are high, and should be, for sensitivity to audio frequencies, particularly for giving support to the low notes, which come out beautifully in this receiver. The whole system surrounding the output tube, including leak values and biasing resistors, is consistent with audio frequency regeneration, which is present in this receiver and is responsible in a measure for the extremely high gain developed from the single audio tube.

That the feedback is positive is evidenced from the fact that there is scarcely any change if 50 mfd. is put across the 0.02 meg. resistor, and by the further fact that high capacity across the detector screen resistor or detector biasing resistor will result in motorboating. As the radio frequency portion should be operated below the oscillation point, but not too far below, so should audio channel be operated below the motorboating or other oscillating frequency point, but not too far below.

The 0.02 meg. in the biasing system, which is one of the voltage-apportioning resistors across the field coil of the dynamic speaker used as B supply choke, is part of the grid leak system of the pentode tube, and so is the 0.1 meg., for that matter, but the voltage is apportioned approximately on the basis of the resistance proportion.

The current distribution in this network is not in the same direction, that is, there are opposing currents, as was discovered when a galvanometer was connected across the 0.02 meg. When it was directly across the 0.02 meg. the current was in one direction, when it was connected from field coil terminal at the speaker to joint of the two resistors, it was in the other direction. This is probably only one instance of bucking currents, for the sum of the individual B currents in the various tubes equals 48.624 ma, while the net B current in the field coil is only 39 ma.

II

Construction of the Circuit

The circuit is built on a metal chassis, 14¾ inches wide by 2½ inches high by 6½ inches front to back, with an extra flap at rear bottom, for use in mounting

(*Continued on next page*)

MEASURING A-C

The Various Methods and Their Accuracy

By Einar Andrews

WHEN measuring alternating current it is usually necessary to employ some kind of rectifier in conjunction with a sensitive d-c microammeter. The simplest form of rectifier is the thermo-couple, which has been used more than any other type of a-c meter. A thermo-couple is a junction of two dissimilar metal filaments. If two fine wires are twisted or welded together and the junction is heated by any means whatsoever there will be a unidirectional voltage developed, and if the other two ends of the wires are connected to a microammeter a direct current will flow. This current will depend on the temperature of the heated junction as well as on the materials of the two different wires. The relation between the temperature and the current is quite definite so that it is possible to use the couple for measuring the temperature of the junction. When the thermo-couple is to be used for measuring current, the junction is heated with the current to be measured. The relation between the heating current and the current in the meter is just as definite as the relation between the temperature and the current.

A Thermo-Junction

In Fig. 1 we have a typical thermocouple set-up. E is the source of the electric current to be measured, AB and CD are the two wires of different materials, J is the junction of the two, usually welded or hard-soldered, and M is the microammeter with which the current developed is measured. No part of the heater current flows through the microammeter.

The sensitivity of the thermo-couple depends on many factors. First, it depends on the materials of the two wires; second, it depends on the heat developed at the junction and, third, on the heat dissipated from the junction.

Since the current in the meter depends on the temperature of the junction and on the heat developed at the junction by the current to be measured, anything that will carry away heat will make the couple less sensitive. Heat may be carried away by radiation. To minimize this the wires used for the couple are highly polished. for radiation from a polished surface is much less than that from a rough surface. The radiation of heat is also proportional to the surface. Hence, to make a sensitive thermo-couple, the wires should be find so that the surface will be as small as possible. The wires should also be short for the same reason. The use of fine short wires will also concentrate the heat developed at the junction, which increases the sensitivity.

Heat is also conducted away from the junction by the wires themselves. This conduction will be greater the heavier the wires, and this is another reason why they should be fine, for a thin wire will carry less heat than a heavy one, just as a small pipe carries less water than a large pipe.

Heat Loss by Convection

Another way in which heat can be carried away is by air convection. To prevent this, a sensitive thermo-couple is put in a vacuum tube. When no air or other gas is present there can be no convection and hence no heat loss by this means. But even in a vacuum-mounted thermo-couple there will be radiation to the glass envelope and if this is placed in air there will be convection which would render the couple less sensitive. To minimize this loss the glass envelope is wrapped in cotton. This will prevent convection from the glass bulb. Not only that, but the cotton-wrapped bulb is put inside a wooden box which aids in preventing cooling of the junction. With these precautions it is possible to measure alternating currents as low as one milliampere with the aid of a microammeter having a full-range scale of 100 microamperes, and still smaller currents with a microammeter or a galvanometer having greater sensitivity.

One of the most sensitive a-c meters utilizing the thermo-couple is the Duddell thermo-galvanometer. In this case the junction is a part of the armature of the galvanometer and the galvanometer coil consists of a single turn of silver wire. Silver is used because it has the lowest resistance to electrical current, so that for a given voltage developed at the heated junction the current in the galvanometer will be greatest. The current to be measured is passed through a platinum heater placed below and as close as possible to the junction. The current to be measured heats the platinum and this in turn transmits its heat by radiation and convection to the junction. The current in the junction then causes the galvanometer to deflect, and the deflection bears a definite relation to the current passing through the heater. By this means alternating currents of a few microamperes can be measured.

Use of Crystal Rectifier

Another way of measuring alternating current is to use a crystal rectifier in conjunction with a microammeter or a galvanometer. This arrangement is very sensitive but it suffers from the uncertainties of the crystal rectifier. In order to get dependable readings it is necessary to calibrate the crystal immediately be-

(*Continued on next page*)

Special Antenna Treatment "Makes" 1933 Diamond of the Air

(*Continued from preceding page*)

to a wooden support as found in a cabinet. A front panel through which the shafts protrude will suffice for anchorage in this direction.

The radio frequency amplifier tube is at left rear, and the coil is next to it, almost completely hidden in the front cover illustration. It was found advisable to have the antenna coil just as close as possible to the antenna post. Thus the left front socket is for the detector tube. and the interstage coil is between this tube and the condenser shield. Between the coils in one instance and the tubes in the other instance are the two 8 mfd. condensers, the one insulated from the chassis being nearer the tuning condenser shield. This insulation is provided by two washers, one of them extruded, which goes on top, the other flat, which goes on bottom. a special lug being connected below, by first inserting the lug at bottom and then turning the mounting screw against it. Wet electrolytic condensers of the inverted mounting type were used.

The tuning condenser shield has two holes at top, intended for adjusting fixed equalizers, but as such equalizers are not used in this circuit, the two holes should be ignored. The connections from condenser stators to coils and tubes are made by bringing two leads through chassis holes, down to the bottom of the chassis.

> **BLUEPRINT OF 1933 DIAMOND**
>
> *A blueprint of the 1933 Diamond of the Air is in preparation and will be announced when ready, possibly next week, issue of September 10th. The circuit this week is shown as it exists. Changes, if any, will be announced in these columns, and will be embodied in the blueprint.*—EDITOR.

At right front is mounted the power transformer, while behind it are the pentode tube (left) and the 280 rectifier.

Front panel controls are manual trimming condenser at left and volume control-switch at right. The a-c switch is built into the volume control.

Underneath the chassis a few parts are mounted on a shelf for convenience, approximately under the tuning condenser. They are the two 0.00025 mfd. fixed condensers, the 200-turn r-f choke coil and the 0.01 mfd. mica dielectric stopping condenser.

Altogether the distribution is such that leads are short where they should be short, and whenever they are long they concern audio frequencies, which makes the length rather immaterial. One exceptional case is the detector screen bypass of r-f, which may be long without danger.

At rear are an antenna-ground binding post assembly, a hum adjuster and a speaker socket. This socket is to receive the speaker plug, and although there are only four outleads—primary of output transformer, and the two field coil connections—a UY socket is recommended, as some will have speakers that have a suitable tap, and for bias, and thus can use the UY socket to advantage, whereas those with four-lead speakers may use UY plug, one connection blank. The almost standard connection is, plate of speaker socket to ground, cathode to B minus, heaters interchangeably to plate and B plus, these speaker primary connections to be reversed experimentally for selection of the polarity that reduces the hum greater. If a tapped choke is used the tap must be at the right point and would be brought to grid spring of speaker socket. (*Continued next week*)

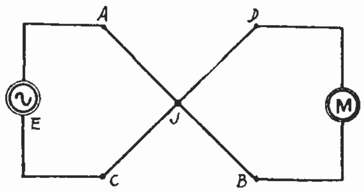


FIG. 1
The essential arrangement of elements in a thermo-couple type a-c meter. AB and CD are the two dissimilar wires.

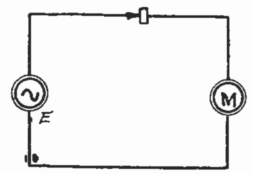


FIG. 2
A crystal rectifier can be used for measuring alternating current if used in conjunction with a sensitive microammeter.

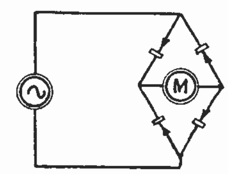


FIG. 3
Crystals can be used in a full wave rectifier for measuring alternating current. This may also be a copper oxide rectifier.

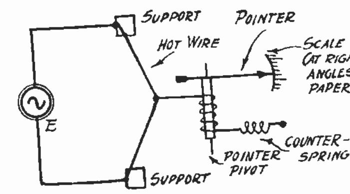


FIG. 4
The essential features of a hot wire type alternating current meter. The heat causes a slack in the wire.

(*Continued from preceding page*)
fore it is used, and usually after a measurement has been made to make certain that the calibration has not changed. The arrangement of a crystal rectifier for measuring a-c is shown in Fig. 2.

It is possible to use four crystals in a circuit so as to get full wave rectification. This is shown in Fig. 3. It will be noted that the rectified current always flows through the microammeter in the same direction regardless of the direction of the alternating current.

During the last year or so another method of measuring alternating current has come into use, based on the rectifying properties of copper oxide. This method has been applied to commercial meters for measuring alternating current of frequencies up to about 35,000 cycles per second. For much higher frequencies copper oxide rectifier is not accurate because of the high capacity of the rectifying elements. However, for the lower frequencies this is one of the best methods of measurement and is constantly finding more and more applications.

It should be pointed out that the crystal and thermo-couple type of meters are practically independent of frequency and they can be used for the highest radio frequencies.

The circuit in Fig. 3 can be considered as that of a full wave copper oxide rectifier as well as that of a full wave crystal rectifier.

Hot Wire Instrument

Still another method of measuring alternating current is that of the hot wire. A fine resistance wire is stretched between two insulating supports and the current to be measured is passed through it. The stretched wire is pulled to one side, like the string of a bow, by means of a wire connected to the center of the hot wire, and this wire in turn is connected to a sprung needle on a meter. As the current passes through the stretched wire the heat developed lengthens the wire and permits the spring controlling the needle to move the needle over the scale. The slack, so to speak, of the stretched wire, and hence the deflection of the needle, repends on the amount of current passing through the stretched wire.

The hot wire instrument is useful at all frequencies, as well as for direct current, but it suffers from drifting of the zero adjustment. In order to keep this instrument accurate it is necessary to readjust the spring so that when no current passes through the instrument the needle can be brought to zero. Much of the drifting of the zero is due to room temperature changes.

Calibration of Instruments

The thermo-couple type of meter is usually calibrated against direct current. However, the passage of current in one direction is usually different from that in the other direction, so that in calibrating it is necessary to reverse the direct current and take the mean value, for when a-c flows through the junction the current is alternately in one direction and then in the other.

Of course, a thermo-couple can be calibrated directly against another a-c meter which has been calibrated previously.

The calibration of a crystal rectifier is best done with the aid of an a-c meter previously calibrated, but it can be done with d-c as well, but in this case the precaution of reversing the current should be taken just as in calibrating a thermocouple. About the same applies to the case of the copper oxide rectifier, but in this case allowance should be made for frequency error. Hence it is best to calibrate the meter against an a-c meter previously calibrated at the same frequency.

Measuring Alternating Voltages

The measurement of alternating voltages is about the same as the measurement of current, provided we are satisfied with current-drawing voltmeters. All we have to do is to measure the current in a high resistance connected across the line and then multiply the current by the resistance. That is just what is done in measuring direct voltages, and the method is just as applicable to alternating. Just as a d-c milliammeter is used in measuring direct voltages, in conjunction with a high resistance, so may an a-c milliammeter be used for measuring alternating voltages. The only condition is that the a-c milliammeter used is sensitive so that the voltmeter will have an adequate ohms-per-volt sensitivity.

Fortunately, we have a much better means of measuring alternating voltages in the vacuum tube voltmeter. This is essentially a potential meter, for it does not draw any current. It is true that for very high frequencies the capacity between the elements of the tube will draw current, but this is negligible for most radio frequencies now used in broadcasting. Even when the current in tube capacity is not negligible the error in the voltage reading obtained is sometimes negligible provided that the circuit is retuned.

A Trans-rectifier

In every vacuum tube voltmeter the tube is used as a transrectifier. That is, the tube is used as a grid bias detector and the effect of the unknown voltage on the plate current is observed. As a rule, the most accurate results will be obtained if all the voltages are obtained from batteries. This is particularly the case with the grid bias because the output varies rapidly with changes in the grid voltage.

The sensitivity of the vacuum tube voltage depends on the amplification constant of the tube used. The higher the mu of the tube the greater the sensitivity. Therefore if we want to measure small alternating voltages accurately we should use a tube with a high amplification constant and if we want to measure larger voltages with less accuracy we should use a power tube with a low amplification factor.

Variable Mu Tube

A variable mu tube should not be used because it is not a good detector, except that it may be substituted for a low mu tube alternating voltage meter. In Fig. 5 we have a typical vacuum tube alternating voltage meter. Ex is the unknown voltage, Ec is the grid bias, which should be adjusted so that the plate current is nearly zero when the Ex terminals are shorted. Es is the screen voltage suitable for the tube used and Ex plus Eb is the plate voltage. A by-pass condenser, preferably one mfd. or more, is connected across each of these voltages. The milliammeter M is a d-c instrument that will give the plate current and R is a high resistance to limit the current to the range of the meter M.

The adjustment of R should be such that the meter M reads nearly full scale when the value of Ec is zero, or when the grid of the tube is connected to the cathode. This will allow measurement of alternating voltages having peak values approximately equal to the value of Ec. The value of this voltage in turn should be such that the plate current is nearly zero when the Ex terminals are shorted. It is clear that Ec depends on the mu of the tube and on the voltages on the other elements. It does not depend on R.

Suitable Tubes

For measuring low voltage tubes like the 222, 232, 236, 224A, and the 57 are suitable. For measuring higher voltage tubes like the 245, 171A, 250, 231, 220, 46 and the 89. The 46 and 89 tubes are only suitable for high voltages when they are used as three element tubes.

Fig. 5 shows a heater type tube, which may be a 236, a 57, or a 224A. In case the tube is a filament type tube, the cathode should be considered as the negative end of the filament.

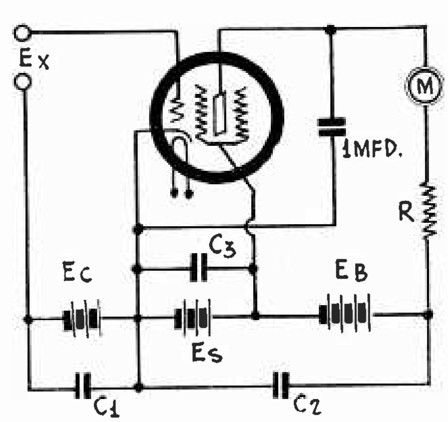


FIG. 5
A vacuum tube voltmeter is the most satisfactory means of measuring alternating voltages in radio circuits.

Radio University

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Output Indicator

I AM KEENLY DESIROUS of using some sort of an output meter, not necessarily to determine actual values of voltages, but at least relative values, though I may not know exactly what they are. All I have is a 0 to 1 milliameter with two voltage resistors of 5,000 and 100,000 ohms, for 0-5, 0-100 volts. How can I put this into service for the purpose outlined?—K. H. T., Roanoke, Va.

Since electrolytic condensers pass current in only one direction they are rectifiers, and if you use the 0-100-volt voltmeter, as outlined, connecting it in series with an 8 mfd. condenser of the electrolytic type, the voltage that you will read will be a rectified one, that is, the meter will respond to it. The voltage will not be the actual one, but, as you state, relative values of are sufficient, and this method should give you what you desire at small cost, as 8 mfd. condensers can be bought now for 49c.

* * *

The Two Argued

TWO FELLOWS were arguing in a street car. One of them said that if the radio installation in the other man's home was not approved by the fire insurance company the insurance was void. The other man denied this, but couldn't cite law. Then they talked about the risk of lightning, radio's effect thereon, and whether lightning rods are any good. Can you answer any of these questions?—K. W. Q., Montreal, P. Q., Canada.

Fire insurance policies are not voided because of absence of inspection of a radio installation. In the early days of radio the fire insurance companies were very alert about making such inspections, as it wasn't known how much, if any, a radio set contributed to the fire risk. Since then it has been learned that the contribution to the risk is virtually nil. The general rule concerning the set is that it must be one approved by the Board of Fire Underwriters, and there are some subsidiary rules concerning damages, whereby the damage to the instrument is not included in the risk insured, but these vary in different States. Radio and lightning have no tangible relationship, as the percentage of houses struck by lightning has not been changed in either direction due to the presence or absence of radio sets. Naturally, as the number of sets in use becomes a greater percentage of the total number of homes, the percentage of homes having sets that are struck by lightning will increase, but this has nothing to do with the relationship of radio sets to lightning. As a precaution to the tubes in the set, during a thunder storm it is well to disconnect aerial from set, but further than that the risk is unchanged. Whether lightning rods are "any good" we can not say. Certainly Benjamin Franklin got a lot of publicity over the idea, and there is theoretical background for his hopes, but in actual practice the lightning rod gets little scientific encouragement. The Bureau of Standards in a report, while not disputing the effectiveness of the lightning rod, pointed out that verified instances of its practicality were few indeed, and hinted that the rod itself might not be capable of the high discharge voltages of the directed currents. What we do know is that one hears less and less about lightning rods as the years roll on.

* * *

Radio Nearly Perfect?

DO YOU THINK THAT radio has progressed to a point where there can be little advance, and that only minor refinements may be expected, or do you think that surprisingly effective inventions will be developed?—R. B. J., Saginaw, Mich.

Certainly radio has not developed to that point beyond which it can not advance more than trivially. Less than a century ago the Commissioner in charge of the United States Patent Office recommended that the Office be closed, as nearly everything of value had been invented and patented. To assign to radio a state of perfection comparable to the honorable Commissioner's ideas of the world and science would be to act with comparable sense. Once tonal values are reproduced faithfully it can be said that one can go no farther. But simplification of methods of achieving even this constitutes a fruitful field for invention. On the radio frequency side the field is almost unlimited, and the ultra frequencies on which some work is being done now are much nearer to being a complete mystery than to being even a half-solution. In receivers, likewise, methods and treatments improving the radio frequency performance, giving better results with fewer tuned circuits and tubes, are bound to be invented, and new and better tubes surely will come along, just as they have emerged from the laboratories in the past. Where these ideas of a condition even faintly approaching perfection originate we don't know, but we do feel there is nothing but silliness to them. You must include television in the major radio classification, and can you say, on the one hand, that television has been perfected, when, on the other hand, there is nothing whatever to give the smallest proof of even a well-devised, commercially practical and dependable system, much less one vested with perfection? And then think of television in colors! If there is nothing left to invent, we suggest to the distracted that they try this colored television problem. To solve it in the span of a single lifetime would constitute a feat.

* * *

Recurrent Phenomena

PLEASE EXPLAIN alternating current, as to cycles. I can understand what the frequency is, but the idea of the cycle is not quite so easy to grasp. Why do radio waves penetrate?—H. F. V., Ames, Ia.

The ease of grasping is about equal as to cycle and frequency, but the definition of frequency is simpler, i.e., frequency equals the numbers of cycles per second. A cycle is one complete recurrence of a periodic phenomenon. One of the most familiar periodic phenomena is found in the pendulum of a clock. Suppose the pendulum is at rest. Suppose it is started in a left-hand direction, vibrating in a plane. It swings to the extreme of its displacement, then actually stops, returns to the zero point, passes it and is then bound in the opposite direction to formerly, reaches the right-hand extreme, stops, returns to and passes the zero point, and then continues on its second cycle. Since frequency is the number of cycles per second, and the pendulum let us say goes through one complete cycle in one second, the frequency is one. We may refer to the left-hand vibration as negative, the right-hand vibration as positive. We conceive of the pendulum in motion. Therefore for each cycle it passes the zero point twice. The cycle may be measured from any equal points. Take the left-hand extreme. To complete the first half-cycle, or alternation, the pendulum passes the zero point once, then goes to the right-hand extreme. It stops and then returns to zero (second time in same cycle) and completes the cycle at the left-hand extreme position. The analogy of this mechanical system with the electrical system is a good one, as the alternating voltage actually stops at the extremes, positive and negative maximum amplitudes. Thus in a conductor the voltage is reversed at any point as many times per second in direct equality with the frequency. As to the penetration of radio waves through something or other, this unknown quantity is conveniently referred to as "the ether," but it has no scientific definition. One might say that the ether is that property of matter by virtue of which radio waves are conducted. Then one might paraphrase the old joke and ask: "Thank you, but will you kindly explain to me just what the ether is?"

* * *

Circuits Compared

IS NOT the superheterodyne the circuit of circuits, and if so why are there tuned radio frequency sets? Few large set manufacturers make tuned radio frequency sets. They seem to recognize the super's the thing, which is my view, too.—U. S. W., Rome, N. Y.

The superheterodyne is the superior circuit, no doubt, but that does not deny the usefulness of tuned radio frequency sets. The trouble with t-r-f sets has been that, though sensitivity could be developed abundantly, selectivity could not, as the more tuned stages used with a gang condenser, the greater the danger of mistuning. The actual tracking in t-r-f sets is never scientifically perfect, except by the merest accident, and production can not be based on accident. Nevertheless, by using fewer tuned stages, and by reducing the losses in the tuned circuits, much can be accomplished, so that today there is a four-tube a-c set that separates all locals and tunes in distance between locals, which is satisfactory service.

Newsman at Corner

By ROLAND BURKE HENNESSY

(From The American News Trade Journal)

I'm not looking for a million;
I'm not trying to get rich;
I'm not seeking easy money;
I'm just trying to prove which
Is the better for my family—
Be a sport and have great fun,
Or just work from morn till night time
Till my daily task is done.

I don't fill my heart with envy
When a banker comes my way,
Buys my papers, pays his money—
That helps out the needy day.

I don't smile with cold derision
When a youngster, gay or sad,
Asks to read "Help Wanted" columns—
I call out: "Good luck, my lady!"

I am just a human being,
Trying hard to stand the test.
When I'm gone I hope my neighbors
Say of me: 'He did his best!'

A THOUGHT FOR THE WEEK

COMMERCIAL SPONSORS on the big broadcasting systems are not supposed to mention the prices of the goods they are to sell to the public over the air. How difficult it must be for listeners-in to guess the cost of an article when the announcer says: "And as to cost—why, the price of a couple of rides on the subway!"

Surely, that couldn't mean the small sum of a dime, a tenth of a dollar, ladies and gentlemen!

RADIO WORLD
Reg. U. S. Pat. Off.
The First and Only National Radio Weekly
Eleventh Year
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, New York, N. Y.; M. B. Hennessy, vice-president, 145 West 45th Street, New York, N. Y.; Herman Bernard, secretary, 145 West 45th Street, New York, N. Y.
Roland Burke Hennessy, editor; Herman Bernard, managing editor and business manager; J. E. Anderson, technical editor; J. Murray Barron, advertising manager.

NEW 842 TUBE TOBEUSEDFOR REPLACING210

Official announcement is expected to be made of a new power tube, intended as a successor to the 210, and to be known as the 842. The tube will be serviceable also as a modulator and oscillator for amateur purposes.

The principal differences between the 842 and the 210 are expected to be the much greater signal that the 842 will stand before overloading, a system consistent with the much greater sensitivity of up-to-date receivers, and the larger undistorted power output. Also the tube will be a sort of recognition of the continuing importance of Class A amplification, as it caters to that exclusively, with the single technical exception of the use of the tube as modulator.

Tabulation of Two Tubes

Here is a tabulated comparison of the 210 with the expected rating of the 842:

Type Tube	*Fil. Volts*	*Fil. Current*	*Neg. Grid. Bias*	*Plate Voltage*	*Plate Current*	*Power Output*
210	7.5	1.25	31	350	16	0.9
			39	425	18	1.6
842	7.5	1.25	72	350	34	2.1
			100	425	28	3.0

It can be seen that not only will at least twice as great a signal be withstood before overloading, but also that the tube has an undistorted power output in watts also on about the 2-to-1 basis. The amplification factor, however, will be less, or about 3, compared to 8 for the 210.

The plate resistance in the lower voltage instance will be 2400 ohms, in the higher voltage instance 2500 ohms, compared to 11,000 and 10,200 ohms for the 210.

While nothing official is contained in these prophecies of what the new tube's characteristics will be, it is known that tube laboratories have been working on this valve, and that samples exist that have characteristics on the basis outlined. In the usual course of events it would be several weeks, at least, before official announcement of the tube is made.

Difference of 4 Volts

The announcement is expected to set forth that the 842 is an audio frequency power amplifier to replace the 210, that it has a maximum dissipation of 12 watts, and that the maximum permissible grid swing for the lower plate voltage (72 volts negative grid bias) is 68 volts, and for the higher plate voltage (100 volts negative bias) is 96 volts. Thus a 4-volt difference will be pointed out, and moreover if the tube, really intended for a-c operation, is to be used with d.c. on the filament, that the negative grid bias should be less than the figures stated, by 4 volts in each instance.

The load resistance of the lower voltage condition should be 5,000 ohms and that for the higher voltage condition 8,000 ohms.

A mutual conductance of 1,250 micromhos is indicated for the typical use at 350 plate volts, and 1,200 micromhos for the higher voltage service.

Grid Leak Value

When the tube is used in resistance-coupled amplifiers the value of the grid leak is important, due to the gas action arising if high values of leak are employed. Thus 1 meg. may be cited as maximum, but under conditions where the tube may be overloaded by signal there would be an augmentation of the grid current arising originally from the gas effect, and the drop in the grid leak would develop a voltage that bucks the bias voltage, hence increases the plate current and the grid current. This cumulative effect of the grid current vice has to be safeguarded against, and in instances where the tube is worked so near the maximum input signal swing that danger from overload by signal is always present, the grid leak value may be as low as 0.25 meg., and that is considered a value rendering freedom from grid current certain. Even very tiny values of grid current would cause a considerable voltage drop, or actual bias reduction, if the leak value were large.

These remarks apply to a power stage that has self-bias. If the bias is wholly independent of effect from the signal, as when a separate C supply is used, the remarks don't hold.

Parallel and Push-Pull

Two of the 842 tubes may be connected in parallel, which produces twice the output without increasing the maximum permissible grid signal swing, or may be connected in push-pull, which gives twice the output at the same grid bias that withstands twice the input signal. That is, the parallel connection does not alter the permissible grid swing, but does double the power output, while the push-pull connection enables a grid swing twice as great, without actually altering the bias, and at the same time doubles the output.

In the push-pull circuit, the negative bias may be increased beyond the values stated, to accommodate greater grid swing, as there is no resultant second harmonic distortion otherwise present when such increase is effected, since push-pull balances out the even order harmonics.

Modulator and Oscillator

At 425 plate volts, the tube used as modulator and oscillator or radio frequency amplifier, at the same plate voltages, has 12 watts output, while as an oscillator or r-f amplifier at 350 plate volts the plate current is 40 ma d-c.

As a modulator and oscillator or r-f amplifier at 350 plate volts, the grid voltage may be 88 volts, the modulation factor will be 0.6, peak grid swing permissible, 84 volts of oscillation per modulator tube, and the power dissipation 8 watts.

A RIBBON THAT VIBRATES USED IN NEW "MIKE"

Announcement has been made by the RCA-Victor Company of the perfection of a new microphone which is said to respond with fidelity to all frequencies in the audible range up to 14,000 cycles per second. The new instrument is of the velocity type, which means that it responds to the motion of the air resulting from sound rather than to the pressure of air due to sound. In place of the usual diaphragm the new microphone utilizes a sensitive duralumin ribbon which vibrates exactly with the movement of the air set up by the sound wave.

It is well known that if a very light disc or ribbon be placed in the way of a sound wave, and if the angle made by the plane of the disc or ribbon bears a certain relation to the direction of the wave, the ribbon or disc will tend to set itself at right angles to the wave. This principle is used in the calibration of other microphones because the intensity of the wave can be computed from the amount the disc turns out of its original position.

But the disc, or ribbon, responds to the intensity of the sound without regard to direction, that is, whether the air is moving in one direction or in the opposite. In a sound wave the movement of the air is back and forth. Hence a device like that would respond to twice the frequency if the disc were used as microphone.

Mutual Movement

It is also known that if there is a curved ribbon and a curved edge, or two curved ribbons, with the convex sides facing each other, there will be a movement of the ribbons toward each other as a jet of air passes between them, according to the Bernoulli principle. This principle is applied to such varied things as the flight of an airplane, the curves in baseball, fluid pressure guages, and vacuum pumps. But in the microphone this, too, would result in double frequency response, because the movement of the air is in both directions. The new microphone may be based on the same principle but with some kind of polarizing device so the air can flow passed the ribbon in only one direction.

An illustration of the principle can be arranged very simply with the aid of a pair of ping-pong balls and some strings. Suspend the ping-pong balls with the strings so that the balls are almost touching. Blow a jet of air between the balls. The natural thing to expect is that the balls will fly apart, but the reverse takes place. The balls will fly together. It makes no difference from which direction the air comes, just so the jet passes between the balls.

Conversion Question

A point not made clear in the announcement is how the movement of the ribbon is converted into electrical equivalents of the air motion. In the carbon microphone the air pressure changes the resistance of the carbon and the varying resistance in turn varies the electrical current. In the condenser microphone the air pressure changes the capacity of the small condenser constituting the microphone, and the varying capacity in turn varies an electric current.

In the dynamic microphone the pressure of the air produces a motion of the armature, and this in turn produces, in conjunction with the strong magnetic field, an electromotive force in the moving coil.

STATION SPARKS

By Alice Remsen

The Wind

FOR "WITCH'S TALE"

WOR Mondays, 9:30 p.m.

Oh listen to the sad wind, the mad wind, the bad wind;
It's dancing 'round the corner to the piping of the storm.
Oh listen to the old wind, the bold wind, the cold wind,
It makes you glad you're sitting in a cottage nice and warm.

Crowding 'round the fire with red flames dancing,
Listening to a tale that makes your blood run cold;
Listening to a witch's tale of wild romancing,
Of smuggled goods, pirate ships and hidden gold.
A tale to make your flesh creep about a traitor,
Slaughtered long ago beside the castle wall;
Carrying his head upon a ghostly waiter,
Gliding through the ruins of the banquet hall.

Oh listen to the sad wind, the mad wind, the bad wind;
It's dancing 'round the corner to the piping of the storm.
Oh, listen to the old wind, the bold wind, the cold wind,
It makes you glad you're sitting in a cottage nice and warm.

—A. R.

* * *

AND OLD NANCY in "The Witch's Tale," as portrayed by Adelaide Fitzallen, will surely make your flesh creep if you listen in to her weird cackling voice, which helps to lend such fascinating atmosphere to this fine dramatic program.

* * *

NEWS OF THE STUDIOS

NBC

Another Benedict in NBC ranks; George Hicks, the smart young sports announcer, took a vacation recently; it wasn't merely a vacation; it was a honeymoon also—yes, young George took unto himself a wife, in the delectable person of Ann Thir, a non-professional. The happy couple were married at City Hall, New York, but kept it a secret from their friends until after said honeymoon-vacation, which was spent in a log cabin up in the hills of Vermont, where George learned that his little Russian wife was also a good cook.

* * *

WABC

Reis and Dunn started a new program series on August 7th; Sundays from 12:30 to 12:45 p.m., and Monday and Tuesday evenings from 6:15 to 6:30 p.m. EDST. In addition to their new broadcast schedule, these singing comedians will again appear in vaudeville, in an eight-week engagement for the Loew circuit.

* * *

WOR

Two popular air comedians, Brad Browne and Al Llewelyn, are being presented by Best Foods, Inc., in a new series of programs over WOR. On Tuesday and Thursday evenings, from 8:15 to 8:30. Fifteen minutes of nonsense. You will remember these two boys from WABC, when they worked together on "Cellar Knights," "Tramp, Tramp, Tramp," and many other programs. Brad Browne was the originator of the "Nit Wits"—the craziest program on the air.

* * *

WINS

Billie Dauscha is a very faithful supporter of WINS, for even though this clever girl is heard regularly on chain programs, she still puts on her weekly broadcast for her old friends at WINS. Ethel Park Richardson is also doing two programs over this station that should attract attention—"Cindy Brown" and "The Passerby." Miss Richardson will be remembered as the originator of "The House by the Side of the Road," a very fine program.

* * *

THE RADIO RIALTO

What a day! What a day! Hot as blazes—you could fry an egg on the pavement of Broadway—it's two o'clock in the afternoon and the musicians' hang-out around 49th Street is deserted—usually at this time of the day you can't move an inch for them—out-of-work cornet players, saxophonists, drummers, some carrying their instruments in the hope of a hurry-call—they have no club-house—the street is their selling mart—it is nothing strange for an office boy to come scurrying along, inquiring as he goes: "Have you seen so-and-so? There's a job over at WABC for him right away." And so-and-so, who is a first class musician, gets a few days work, filling in for a sick brother—radio has been a god-send to a few lucky musicians—when the majority of theatres cut out live orchestras for canned music, thousands of musicians were thrown out of a job—and a few weeks ago, all radio stations cut down on their personnel—which worked hardships on a few more tooters and blowers—but—all signs indicate that business is picking up in all branches of the amusement world.

Well, here we are at Leo Feist's, whose slogan, "You can't go wrong with a Feist song," has been blazoned around the world. First person we bump into is Abel Baer, composer of "The Night When Love Was Born"; he is escorting Ralph Kirberry, the Dream Singer, into his inner sanctum—I go right along with them, and listen while Ralph tries over a new song; it is a ballad such as Ralph loves to sing, "Only a Summer Night's Dream"—I predict you'll hear it a-plenty over the air-waves this season. . . There's Freddie Coots, in white linen suit, shoes and hat, with a bright blue shirt to match his eyes, and the dapper young man with him is Roy Turk; these two boys have several new melody-lyric combinations coming out with various publishers—they write well together.

I shake the dust of Feist's from my feet and hie me to Witmark's—there I find demure little Ann Leaf, Columbia's swell organist, just returned from a trip to the Coast—while there she played a week at a Paramount theatre as special attraction; nice salary, too—so her trip cost her nothing and she made money besides. . . The well-tanned blonde girl is Mabel Wayne, composer of "Ramona" and countless other hits; what lovely teeth she has; all the better to smile with, my dear. . . And there's Mary Coward, who opened at the Park Central Roof on August 26th.

Down Broadway once again, past Lindy's—there's that good-looking Smith Ballew, who just blew into town with his band. Smith has a secret yen for a London engagement; he'd go well over there; just the type of fellow for the British taste—smart dresser, well-educated and a good musician.

Now for 711, NBC castle. . . It is Frank Parker's last day with the Cities Service program before sailing for Europe. Yes, he is going to Italy via S.S. Augusta, but only for a month. So let's take a peek at the Cities Service rehearsal. Up to the fifteenth floor, into the large studio. . . Rosario Bourdon is there, very seriously studying musical scores. . . Over by the piano is the dark-eyed Countess Albani, who is going over an intricate part of one of her solos. . . In a huddle behind the piano are the Cavaliers—Frank Parker, John Seagle, Henry Shope and Elliot Shaw—humming over a few bars of their big number; and sitting at two pianos waiting for Maestro Bourdon's signal, are those two extraordinary pianists, Milton Rettenberg and Frank Banta. Ah, something is going to happen; Mr. Bourdon looks up and smiles, raises his baton, the orchestra comes to life and starts to play one of my favorites, the exquisite, "In a Monastery Garden." . . Everybody works in this; the Countess sings "Ave Maria" and the Cavaliers become a choir of cowled monks, slowly pacing the cloisters, chanting "Kyrie Eleison."

Well, must get along. . . Out on to Fifth Avenue again—only to run up against tall and willowy Tim Sullivan, the casting director of McCann-Erickson's advertising agency de luxe, who tells me that the Stanco program, "Big Time," featuring Johnny Hart, may go on the air five times weekly; nice break for Johnny and incidentally for yours truly who sometimes works on the program. . . This time we'll take a jaunt over to WOR, so into a cab. . . "1440 Broadway, please." . . Not much doing over here in the daytime. George Shackley is home sick; rather bad case of blood poisoning. . . Poor George needs a rest; he's worked hard for years. . . Hoffman Hour rehearsal in progress; slender Bill Daly, with a curly mop of iron gray hair, is waving a stick before an assorted bunch of musickers. . . Nelson Eddy is the start of the program, supporting him are Harold Hansen, tenor, Margaret Speaks, niece of the famed composer, soprano, and Veronica Wiggins, well-known contralto; this is one of the finest hours on the air. . . what we call a "class program."

Gracious me! Time flies, and it's still hot. Into another cab and over to WABC. There's Eddie Wolf, in the lobby. . . Eddie is the erstwhile manager of Arthur Tracey and recently won a suit against him for breach of contract. . . He tells me that he is expecting to close a big commercial contract for Vaughn de Leath. Vaughn is playing vaudeville and is pulling them into theatres by putting on radio auditions for young local talent; that sort of thing is always good for the box-office. . . The Bourjois program, "Evening in Paris," is going dramatic on September 12th, for a period of thirteen weeks. If the program meets with the approval of listeners, it will stay dramatic, if not, well—the old program will go on again. . . There's Norman Brokenshire, he has a sleek, well-contented look these days—and why not, with a long-term Chesterfield contract in his pocket! There are the Pebeco Playboys and the charming Helen Leighton, who writes the Pebeco continuity and works with the boys. Very clever little lady. . . By the way, this program is changing its time and will go on Tuesday and Thursday evenings, instead of mornings, seven-thirty p.m.; try and catch it, you'll not be sorry. . . Well, time to depart for home and Octavia's nice apple pie as a fitting ending to a busy day.

* * *

Biographical Brevity

AS TO LOWELL THOMAS

This breezy news commentator first saw the light of day in Cripple Creek, Colorado, and was reared in the rarified at-

(Continued on next page)

Station Sparks

(*Continued from preceding page*)

mosphere of this world-famous Rocky Mountain mining camp. . . He went to work underground in the gold mines when he was eleven years old. Before that he had sold newspapers on the streets and in gambling halls and saloons. In those days he associated with adventurous men which filled him with a desire to travel and see the world.

He worked his way through college by various means. . . When barely of legal age, he outfitted and headed two private expeditions into the sub-Arctic. . . His inseparable companions were a camera and a notebook. Soon he became known as an authority on remote regions. During the World War he was assigned by the President to record its history. It was during this time that he kept hearing fantastic stories of a man who had united the hostile Arab tribes in a fierce war against the Turks. He eventually met this half-man, half-myth and soon after Thomas joined the romantic figure of Colonel T. E. Lawrence in the Arabian desert which enabled him to give the world the first account of this wonderful man.

Lowell Thomas is only forty years old, but he has done some marvelous things in that short time. . . He has written more than seventeen best-selling books, and from the platform has probably addressed more people than any man who ever lived. . . He is a Fellow of the Royal Geographical Society and of the American Geographical Society, an honorary life member of the English Speaking Union and of the Chicago Press Club, a member of the Explorers Club, the Princeton Club and the New York Advertising Club.

BANKRUPTCY PROCEEDINGS

Eastern District, N. Y.

Petition Filed—Against

Greenpoint Electric Equipment Co., Inc., electrical contractor, 136 Greenpoint Ave., Brooklyn, N. Y., By Henry Jurgens, $250; Lexington Electric Products Co., Inc., $820; and Bangert Electric Co., Inc., $850.

CORPORATION REPORTS

Radio-Keith-Orpheum Corporation and Subsidiaries—Six months ended June 30: Net loss after depreciation, amortization, adjustments and other charges, $3,843,534, contrasted with net profit of $969,732, equal, after preferred dividend requirements, to 24 cents a share on Class A stock last year. Quarter ended June 30: Net loss after same charges, $2,195,155, against $2,166,713 loss in preceding quarter and $429,554 loss for second quarter last year.

Universal Pipe and Radio Company and subsidiaries—Six months ended June 30: Net loss after depreciation, interest and other charges, $484,893, against $89,243 loss for corresponding period last year. Quarter ended June 30: Net loss after same charges, $231,708, against $253,184 loss in preceding quarter and $16,297 loss in second quarter of 1931.

Western Electric Makes New Phone for 'Plane

A complete new line of radio telephone equipment for aircraft use is announced by the Western Electric Company. This new equipment is the result of the experience gained from many million miles of flying of radio telephone on the principal air lines in this country for the past three years. It has been developed to incorporate the refinements which extensive use has shown desirable. The various air lines have cooperated by making many practical suggestions and recommendations.

The new system as a whole will enable the pilot to change from one frequency to another while in flight by simply pulling a lever in the cockpit. It will no longer be necessary for radio mechanic to readjust the transmitter and receiver on the ground when a frequency shift is desirable. This will further improve the already efficient operation being obtained.

The new radio transmitter is arranged to transmit on any of three pre-arranged frequencies. The stability of the transmission is maintained by an improved type of quartz crystal oscillator. Circuit changes and the improved types of tubes used do away with the necessity of neutralizing the transmitter. The coupling unit for the antenna is included as part of the transmitter unit, eliminating the separate tuning unit was formerly employed and was installed at the base of the transmitting antenna. This improvement results in a higher output efficiency. The transmitter is capable of substantially complete modulation.

New Incorporations

Polymet Manufacturing Corp., Bronx, New York City, electrical communication business—Attys., Oppenheimer, Heiblum Kupfer, 30 Broad St., New York City.
Rale Electrical Supply Co., Inc., Asbury Park, N. J., electrical supplies—Atty., Lillian Broder-Levington, Asbury Park, N. J.
Peer Electric Co., Brooklyn, N. Y.—Atty., N. Bloom, 302 Broadway, New York City.
Fein Electric Supply Co., New York City—Attys., Katz & Spector, 29 Broadway, New York City.

CORPORATE CHANGES

Capital Increase

Radio Productions Corporation, New York, N. Y., $300,000 to $500,000, and from 10,000 to 15,000 shares common.

Name Change

Argo Tube & Television Corporation to Electronic Research Corporation, New York, N. Y.

Surrender of Authority

Polymet Manufacturing Corp., Delaware.

SHORT WAVE CLUB

J. V. Fernandez, Hotel Cosmos, San Juan de Latran No. 12, Mexico, D. F.

Tradiograms

By J. Murray Barron

A photoelectric spectrophotometer developed by the American Photoelectric Corporation and built by Eimer and Amend, of New York City, is designed for the accurate analysis of emitted, transmitted or reflected radiation. Its sensitivity is such that it may be employed to measure accurately the relative intensity of individual lines in the spectrum. All measurements are made electrically, so that errors resulting from visual observations are eliminated.

To make a reading on any material at any desired wave length, it is necessary only to balance an electrical circuit by turning a dial similar to that on a radio set, and then after interposing the material under examination, again to balance the circuit by turning another dial on which is read directly in percentage the proportion of the total light of that particular wavelength which is transmitted or reduced by the material.

This instrument already has found employment in many industries. It is beginning to find applications in other industries. Servicemen in many communities from time to time will find excellent opportunities to capitalize on the device where industries of large size are accessible and where much merchandise is produced. It might be well to study the situation, for here may be a real addition to regular work that might pay handsome returns. More information in addition to the above will be found in a circular of the American Photoelectric Corporation, obtainable through Trade Editor, RADIO WORLD, 145 West 145th Street, N. Y. City.

* * *

P. R. Fredericks Radio Studio, manufacturer of the Fredericks Safety Protector for electric receivers, announces removal to 341 West Twenty-third Street, N. Y. City. This is in the same neighborhood as before. The studio has been on the same block for nearly ten years.

* * *

Radio Chassis, Inc., is the new name as announced by D. Kasson of the concern formerly known as Marquette Radion Co.

Literature Wanted

Readers desiring radio literature from manufacturers and jobbers should send a request for publication of their name and address. Address Literature Editor, RADIO WORLD, 145 *West 45th Street, New York, N. Y.*

J. V. Fernandez, Hotel Cosmos, San Juan de Letran No. 12, Mexico, D. F.
E. Lintner, General Radio Service, 2115 Mound St., Davenport, Iowa.
Morris L. Montgomery, Short wave radio and standard parts, 700 S. Lake St., Okmulgee, Okla.
C. E. Cox, 1112 So. Harvard Blvd., Los Angeles, Calif.
C. Jos. Shannon, 104 S. Arlington Ave., Baltimore, Md.
H. E. Howell, Radio Service, 231 Robinwood Ave., Columbus, Ohio.
George W. Matters, 265 Wembly Rd., Upper Darby, Penna.
John K. Hopkins (diagrams of sets of last three years), 238 Bowman St., W., Hamilton, Ont., Canada.
L. Mitchell Barcus, R.F.D. No. 1, Box 561, Torrance, Calif.
Wm. F. Beyer, care Postal Telegraph Cable, Fort Wayne, Ind.
Whaley Brothers, Augusta, Ga.
Radio Service Co., 506 West 9th St., Coffeyville, Kans.
Geo. B. Gish, Fox Lake, Ills.
Henry A. Haley, 41 South Main St., Mechanicsville, N. Y.
Paul C. Meyer, 227 N. Center St., Grove City, Penna.
Miles Moravec, Box 117, Peakville, N. Y.
Gail A. Eaton, 659 W. Elmira, San Antonio, Texas.
B. M. Weissenfels, 525 N. Dewey St., Eau Claire, Wisc.
L. A. Jungst, Radiotrician, 507 No. Ruby St., Ellensburg, Wash.
Mack Johnson, West Point, Miss.

STATIONS BY FREQUENCIES

The list of U. S., Canadian, Newfoundland, Cuban and Mexican stations, 540 to 1210 kc, was published last week, issue of August 27th. The list is completed this week, the listing corrected to August 23rd.

1210 KILOCYCLES—247.8 METERS (Cont.)

WSIX—Springfield, Tenn.; Jack M. and Louis R. Draughon, doing business as 638 Tire and Vulcanizing Co.; 100 W.
WSOC—Gastonia, N. C.; WSOC (Inc.); 100 W.
WJBY—Gadsden, Ala.; Gadsden Broadcasting Co. (Inc.); 100 W.
WQDX—Thomasville, Ga.; Stevens Luke; 50 W.
WRBQ—Greenville, Miss.; J. Pat Scully; 250 W.*
KWEA—Shreveport, La.; Hello World Broadcasting Corporation; 100 W.
KDLR—Devils Lake, N. Dak.; KDLR (Inc.); 100 W.
KGCR—Watertown, S. Dak.; Greater Kampeska Radio Corp.; 100 W.
KFOR—Lincoln, Nebr.; Howard A. Shuman; 250 W.*
WHBU—Anderson, Ind.; Anderson Broadcasting Corp.; 100 W.
WEBQ—Harrisburg, Ill.; First Trust & Savings Bank of Harrisburg, Ill.; 100 W.
—Troy, Ala.; Troy Bdcg. Co.; 100 W.
WSBC—Chicago, Ill.; World Battery Co. (Inc.); 100 W.
WCRW—Chicago, Ill.; Clinton R. White; 100 W.
WEDC—Chicago, Ill.; Emil Denemark (Inc.); 100 W.
WCBS—Springfield, Ill.; Chas. H. Messter and Harold L. Dewing; 100 W.
WTAX—Springfield, Ill.; WTAX (Inc.); 100 W.
WHBF—Rock Island, Ill.; Beardsley Specialty Co.; 100 W.
WOMT—Manitowoc, Wis.; Francis M. Kadow; 100 W.
WIBU—Poynette, Wis.; William C. Forrest; 100 W.
KGNO—Dodge City, Kans.; Dodge City Broadcasting Co. (Inc.); 100 W.
KGRS—Amarillo, Tex.; E. B. Gish; 1 KW.
KMJ—Fresno, Calif.; James McClatchy Co.; 100 W.
KFXM—San Bernardino, Calif.; J. C. & E. W. Lee (Lee Bros. Broadcasting Co.); 100 W.
KFVS—Cape Girardeau, Mo.; Oscar C. Hirsch, trading as Hirsch Battery & Radio Co.; 100 W.
KPPC—Pasadena, Calif.; Pasadena Presbyterian Church; 50 W.
KFJI—Klamath Falls, Ore.; KFJI Broadcasters, Inc.; 100 W.
WPRO—Providence, R. I.; Cherry & Webb Broadcasting Co.; 100 W.
KGMP—Elk City, Okla.; Bryant Radio & Electric Co.; 100 W.
KGY—Olympia, Wash.; KGY, Inc.; 100 W.
CFCO—Chatham, Ontario, Can.; John Beardall; 100 W.
CFNB—Fredericton, New Brunswick, Can.; Jas. S. Neill & Sons, Ltd.; 50 W.
CJOR—Vancouver, British Columbia, Can.; T—Sea Island, British Columbia, Can.; G. C. Chandler; 500 W.
CKMC—Cobalt, Ontario, Can.; R. L. MacAdam; 100 W.
XEX—Mexico City, Mex.; Excelsior; 500 W.

1220 KILOCYCLES—245.8 METERS

WCAD—Canton, N. Y.; St. Lawrence University; 500 W.
WCAE—Pittsburgh, Pa.; WCAE, Inc.; 1 KW.
WDAE—Tampa, Fla.; Tampa Publishing Co.; 1 KW.
WREN—Tanganoxie, Kans.; Jenny Wren Co.; 1 KW.
KFKU—Lawrence, Kans.; University of Kansas; 500 W.
KWSC—Pullman, Wash.; State College of Washington; 2 KW.*
KTW—Seattle, Wash.; First Presbyterian Church; 1 KW.

1225 KILOCYCLES—244.8 METERS

CMBY—Havana, Cuba; Callejas-Cosculluela; 350 W.

1230 KILOCYCLES—243.8 METERS

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

1235 KILOCYCLES—242.8 METERS

CMCA—Havana, Cuba; Manuel Cruz; 150 W.

1240 KILOCYCLES—241-8 METERS

WXYZ—Detroit, Mich.; Kunsky-Trendle Broadcasting Corporation; 1 KW.
KTAT—Fort Worth, Tex.; T—Birdville, Tex.; S. A. T. Broadcast Co.; 1 KW.
WACO—Waco, Tex.; Central Texas Broadcasting Co. (Inc.); 1 KW.
KGCU—Mandan, N. Dak.; Mandan Radio Assn.; 250 W.
KLPM—Minot, N. Dak.; John B. Cooley; 250 W.
KTFI—Twin Falls, Idaho; Radio Bdcg. Corp.; 500 W.

1249 KILOCYCLES—240 METERS

CMAB—Pinar del Rio, Cuba; Francisco Martinez; 20 W.

1250 KILOCYCLES—239.9 METERS

WGCP—Newark, N. J.; May Radio Broadcast Corporation; 250 W.
WODA—Paterson, N. J.; Richard E. O'Dea; 1 KW.
WAAM—Newark, N. J.; WAAM (Inc.); 2 KW.*
WDSU—New Orleans, La.; T—Gretna, La.; Joseph H. Uhalt; 1 KW.
WLB—Minneapolis, Minn.; T—St. Paul, Minn.; University of Minnesota; 1 KW.
WRHM—Minneapolis, Minn.; T—Fridley, Minn.; Minnesota Broadcasting Corporation; 1 KW.
KFMX—Northfield, Minn.; Carlton College; 1 KW.
WCAL—Northfield, Minn.; St. Olaf College; 1 KW.
WFOX—Long Beach, Calif.; Nichols and Warriner (Inc.); 1 KW.
XEFA—Mexico City, Mex.; Manuel F. Murguia; 250 W.

1260 KILOCYCLES—238.0 METERS

WLBW—Oil City, Pa.; Broadcasters of Pennsylvania, Inc.; 1 K.*
KWWG—Brownsville, Tex.; Frank P. Jackson; 500 W.
WTOC—Savannah, Ga.; Savannah Broadcasting Co., (Inc.); 500 W.
KRGV—Harlingen, Tex.; KRGV (Inc.); 500 W
KOIL—Council Bluffs, Iowa; Mona Motor Oil Co.; 1 KW.
KVOA—Tuscon, Ariz.; Robert M. Riculfi; 500 W.

1270 KILOCYCLES—236.1 METERS

WEAI—Ithaca, N. Y.; Cornell University; 1 KW.
WFBR—Baltimore, Md.; Baltimore Radio Show (Inc.); 500 W.
WASH—Grand Rapids, Mich. (Uses transmitter of WOOD); WASH Broadcasting Corporation; 500 W. (1 KW.—C.P.).
WOOD—Grand Rapids, Mich.; T—Furn-Kunsky-Trendle Broadcasting Corp.; 500 W.
WJDX—Jackson, Miss.; Lamar Life Insurance Co.; 1 KW.
KWLC—Decorah, Iowa; Luther College; 100 W.
KGCA—Decorah, Iowa; Charles W. Greenley; 100 W.
KOL—Seattle, Wash.; Seattle Broadcasting Co. (Inc.); 1 KW.
KVOR—Colorado Springs, Colo.; Reynolds Radio Co., Inc.; 1 KW.
CMCU—Havana, Cuba; Jorge Garcia Serra; 150 W.

1280 KILOCYCLES—234.2 METERS

WCAM—Camden, N. J.; City of Camden; 500 W.
WCAP—Asbury Park, N. J.; Radio Industries Broadcast Co.; 500 W.
WOAX—Trenton, N. J.; WOAX (Inc.); 500 W.
WDOD—Chattanooga, Tenn.; T—Brainerd, Tenn.; WDOD Broadcasting Corporation; 1 KW. (5 KW.—C.P.).
WRR—Dallas, Tex.; City of Dallas, Tex.; 500 W.
WIBA—Madison, Wis.; Badger Broadcasting Co.; 500 W.
KFBB—Great Falls, Mont.; Buttrey Broadcast (Inc.); 2½ KW.*

1285 KILOCYCLES—233.4 METERS

CMCW—Havana, Cuba; Jose Lorenzo; 150 W.

1290 KILOCYCLES—232.4 METERS

WNBZ—Saranac Lake, N. Y.; Earl J. Smith and William Mace, doing business as Smith & Mace; 50 W.
WJAS—Pittsburgh, Pa.; T—North Fayette Township, Pa.; Pittsburgh Radio Supply House; 2½ KW.*
KTSA—San Antonio, Tex.; Lone Star Broadcasting Co. (Inc.); 2 KW.*
KFUL—Galveston, Tex.; News Publishing Co.; 500 W.
KLCN—Blytheville, Ark.; Charles Leo Lintzenich; 50 W.
WEBC—Superior, Wisc.; Head of the Lakes Broadcasting Co.; 2½ KC.*
KDYL—Salt Lake City, Utah; Intermountain Broadcasting Corporation; 1 KW.

1300 KILOCYCLES—230.6 METERS

WBBR—Brooklyn, N. Y.; T—Rossville, N. Y. (Staten Island); Peoples Pulpit Association; 1 KW.
WFAB—New York, N. Y.; T—Carlstadt, N. J.; Defenders of Truth Society (Inc.); 1 KW.
WEVD—New York, N. Y.; T—Forest Hills, N. Y.; Debs Memorial Radio Fund (Inc.); 500 W.
WHAZ—Troy, N. Y.; Rensselaer Polytechnic Institute; 500 W.
WIOD—WMBF—Miami, Fla.; T—Miami Beach, Fla.; Isle of Dreams Broadcasting Corporation; 1 KW.
Corporation; 1KW.
KFH—Wichita, Kans.; Radio Station KFH Co.; 1 KW.
WOQ—Kansas City, Mo.; Unity School of Christianity; 1 KW.
KFJR—Portland, Ore.; Ashley C. Dixon, trading as Ashley C. Dixon & Son; 500 W.
KTBR—Portland, Ore.; M. E. Brown; 500 W.
KFAC—Los Angeles, Calif.; Los Angeles Broadcasting Co.; 1 KW.
XEM—Mexico City, Mex.; Maria T. de Gutierez; 250 W.

1310 KILOCYCLES—228.9 METERS

—Galesburg, Ill.; S. E. Yaste and Burrell Banash; 100 W.; C. P. only.
WKAV—Laconia, N. H.; Laconia Radio Club; 100 W.
WEBR—Buffalo, N. Y.; Howell Broadcasting Co. (Inc.); 250 W.*
WMBO—Auburn, N. Y.; WMBO, Inc.; 100 W.
WNBH—New Bedford, Mass.; T—Fairhaven, Mass.; Irving Vermilya, trading as New Bedford Broadcasting Co.; 100 W.
WOL—Washington, D. C.; American Broadcasting Co.; 100 W.
WGH—Newport News, Va.; Hampton Roads Broadcasting Corporation; 100 W.
WEXL—Royal Oak, Mich.; Royal Oak Broadcasting Co.; 50 W.
WFDF—Flint, Mich.; Frank D. Fallain; 100 W.
WBEO—Marquette, Mich.; Lake Superior Broadcasting Co.; 100 W.
WHAT—Philadelphia, Pa.; Independence Broadcasting Co.; 100 W.
WTEL—Philadelphia, Pa.; Foulkrod Radio Engineering Co.; 100 W.
WJAC—Johnstown, Pa.; Johnstown Automobile Co.; 100 W.
WFBG—Altoona, Pa.; William F. Gable Co.; 100 W.
WRAW—Reading, Pa.; Reading Broadcasting Co.; 100 W.
WGAL—Lancaster, Pa.; WGAL, Incorporated; 100 W.
WSAJ—Grove City, Pa.; Grove City College; 100 W.
WBRE—Wilkes-Barre, Pa.; Louis G. Baltimore; 100 W.
WKBC—Birmingham, Ala.; R. B. Broyles, trading as R. B. Broyles Furniture Co.; 100 W.
WTJS—Jackson, Tenn.; Sun Pub. Co.; 100 W.
WTSL—Laurel, Miss.; G. H. Houseman; 100 W.
WROL—Knoxville, Tenn.; Stuart Broadcasting Corporation; 100 W.
KRMD—Shreveport, La.; Radio Station KRMD, Inc.; 50 W.
WSJS—Winston-Salem, N. C.; Winston-Salem Journal Co.; 100 W.
KTLC—Houston, Tex.; Houston Broadcasting Co.; 100 W.
KFPM—Greenville, Tex.; Dave Ablowich, trading as The New Furniture Co.; 15 W.
KTSM—El Paso, Tex.; W. S. Bledsoe and W. T. Blackwell; 100 W.
WDAH—El Paso, Tex.; W. S. Bledsoe and W. T. Blackwell; 100 W.
KFPL—Dublin, Tex.; C. C. Baxter; 100 W.
KFXR—Oklahoma City, Okla.; Exchange Avenue Baptist Church; 250 W.*
WKBS—Galesburg, Ill.; Permil N. Nelson; 100 W.
WCLS—Joliet, Ill.; WCLS (Inc.); 100 W.
WKBB—Joliet, Ill.; Sanders Brothers Radio Station; 100 W.
KFGQ—Boone, Iowa; Boone Biblical College; 100 W.
KGFW—Ravenna, Nebr.; Central Nebraska Broadcasting Corporation; 100 W.
WBOW—Terre Haute, Ind.; Banks of Wabash (Inc.); 100 W.
WJAK—Marion, Ind.; Marion Broadcast Co.; 50 W.
WLBC—Muncie, Ind.; Donald H. Burton; 50 W.
KGBX—St. Joseph, Mo.; KGBX (Inc.); 100 W.
KFBK—Sacramento, Calif.; James McClatchy Co.; 100 W.
KCRJ—Jerome, Ariz.; Charles C. Robinson; 100 W.
KGCX—Wolf Point, Mont.; First State Bank of Vida; 250 W.*
KGEZ—Kalispell, Mont.; Donald C. Treloar; 100 W.
KFXJ—Grand Junction, Colo.; R. G. Howell and Charles Howell, doing business as Western Slope Broadcasting Co.; 100 W.
KMED—Medford, Ore.; Mrs. W. J. Virgin; 100 W.
KXRO—Aberdeen, Wash.; KXRO (Inc.); 100 W.
KIT—Yakima, Wash.; Carl E. Haymond; 100 W.
KFYO—Lubbock, Tex.; Kirksey Bros.; 250 W.

1320 KILOCYCLES—227.1 METERS

WADC—Akron, Ga.; Allen T. Simmons; 1 KW.
WSMB—New Orleans, La.; Saenger Theatres (Inc.) and Maison Blanche Co.; 500 W.
KID—Idaho Falls, Idaho; KID Broadcasting Co.; 500 W.*
KGHF—Pueblo, Colo.; Curtis P. Ritchie and Joe E. Finch; 500 W.*
KGMB—Honolulu, Hawaii; Honolulu Broadcasting Co. (Ltd.); 250 W.

1330 KILOCYCLES—225.4 METERS

KMO—Tacoma, Wash.; KMO, Inc.; 250 W.
WDRC—Hartford, Conn.; T—Bloomfield, Conn.; WDRC (Inc.); 500 W.
WSAI—Cincinnati, O.; T—Mason, Ohio; Crosley Radio Corporation (lessee); 1 KW.*
WTAQ—Eau Claire, Wis.; T—Township of Washington, Wis.; Gillette Rubber Co.; 1 KW.
KSCJ—Sioux City, Iowa; Perkins Brothers Co.; 2½ KW.*
KGB—San Diego, Calif.; Don Lee, Inc.; 500 W.

1340 KILOCYCLES—223.7 METERS

KGIR—Butte, Mont.; KGIR (Inc.); 500 W.
WSPD—Toledo, Ohio; Toledo Broadcasting Co.; 1 KW.
KFPW—Fort Smith, Ark.; Southwestern Hotel Co.; 50 W.

(*Continued on next page*)

(Continued from preceding page)

WCOA—Pensacola, Fla.; Pensacola Bdcg. Co.; 500 W.
KFPY—Spokane, Wash.; Symons Broadcasting Co.; 1 KW.

1345 KILOCYCLES—223 METERS

CMCR—Havana, Cuba; Aurelio Hernandez; 150 W.
CMCY—Havana, Cuba; M. D. Autran; 250 W.

1350 KILOCYCLES—222.1 METERS

WAWZ—Zarephath, N. J.; Pillar of Fire; 250 W.
WMSG—New York, N. Y.; Madison Square Garden Broadcast Corporation; 250 W.
WCDA—New York, N. Y.; T—Cliffside Park, N. J.; Italian Educational Broadcasting Co. (Inc.); 250 W.
WBNX—New York, N. Y.; Standard Cahill Co. (Inc.); 250 W.
KWKK—St. Louis, Mo.; T—Kirkwood, Mo.; Greater St. Louis Broadcasting Corporation; 1 KW.

1350 KILOCYCLES—222.1 METERS (Cont.)

WEHC—Emory, Va.; Emory & Henry College; 500 W.
KIDO—Boise, Idaho; Boise Broadcasting Station; 1 KW.

1360 KILOCYCLES—220.4 METERS

WFBL—Syracuse, N. Y.; Onondaga Radio Broadcasting Corporation; 1 KW.
WQBC—Vicksburg, Miss.; Delta Broadcasting Co. (Inc.); 500 W.
WCSC—Charleston, S. C.; South Carolina Broadcasting Co., Inc.; 500 W.
WJKS—Gary, Ill.; Johnson-Kennedy Radio Corporation; 1¼ KW.*
WGES—Chicago, Ill.; Oak Leaves Broadcasting Station (Inc.); 1 KW.*
KGER—Long Beach, Calif.; Consolidated Broadcasting Corp.; 1 KW.

1370 KILOCYCLES—218.7 METERS

WRDO—Augusta, Me.; WRDO, Inc.; 100 W.
WQDM—St. Albans, Vt.; A. J. St. Antoine and E. J. Regan; 100 W.
WLEY—Lexington, Mass.; Carl S. Wheeler, trading as Lexington Air Stations; 250 W.*
WSVS—Buffalo, N. Y.; Elmer S. Pierce, principal, Seneca Vocational High School; 50 W.
WBGF—Glens Falls, N. Y.; W. Neal Parker and Herbert H. Metcalfe; 50W.
WCBM—Baltimore, Md.; Baltimore Broadcasting Corporation; 250 W.*
WBTM—Danville, Va.; L. H., R. G. and A. S. Clarke, doing business as Clarke Electric Co.; 100 W.
WLVA—Lynchburg, Va.; Lynchburg Broadcasting Corporation; 100 W.
WHBD—Mount Orab, Ohio; F. P. Moler; 100 W.
WHDF—Calumet, Mich.; Upper Michigan Broadcasting Co.; 250 W.*
WJBK—Highland Park, Mich.; James F. Hopkins (Inc.); 50 W.
WIBM—Jackson, Mich.; WIBM (Inc.); 100 W.
WRAK—Williamsport, Pa.; Clarence R. Cummins; 100 W.
WHBQ—Memphis, Tenn.; Broadcasting Station WHBQ (Inc.); 100 W.
KGFG—Oklahoma City, Okla.; Oklahoma Broadcasting Co. (Inc.); 100 W.
KCRC—Enid, Okla.; Enid Radiphone Co.; 250 W.*
WMBR—Tampa, Fla.; F. J. Reynolds; 100 W.
KMAC—San Antonio, Tex.; W. W. McAllister; 100 W.
KFJZ—Fort Worth, Tex.; Ralph S. Bishop; 100 W.
KONO—San Antonio, Tex.; Mission Broadcasting Co.; 100 W.
KGKL—San Angelo, Tex.; KGKL (Inc.), 100 W.
KFLX—Galveston, Tex.; George Roy Clough; 100 W.
WGL—Fort Wayne, Ind.; Fred C. Zeig (Allen-Wayne Co.); 100 W.
KGDA—Mitchell, S. Dak.; Mitchell Broadcasting Corporation; 100 W.
KFJM—Great Forks, N. Dak.; University of North Dakota; 100 W.
KWKC—Kansas City, Mo.; Wilson Duncan, trading as Wilson Duncan Broadcasting Co.; 100 W.
WRJN—Racine, Wis.; Racine Broadcasting Corporation; 100 W.
KGAR—Tucson, Ariz.; Tucson Motor Service; 250 W.*
KRE—Berkeley, Calif.; First Congregational Church of Berkeley; 100 W.
KOOS—Marshfield, Ore.; H. H. Hansetly (Inc.); 100 W.
KFBL—Everett, Wash.; Otto Leese and Robert Leese, doing business as Leese Bros.; 50 W.
KVL—Seattle, Wash.; KVL, Incorporated; 100 W.
KGFL—Raton, N. Mex.; KGFL, Inc.; 50 W.
KUJ—Walla Walla, Wash.; KUJ, Inc.; 100 W.
WRAM—Wilmington, N. C.; Wilmington Radio Asso.; 100 W.
WJTL—Tifton, Ga.; Oglethorpe University; 100 W.
WPFB—Hattiesburg, Miss.; Hattiesburg Bdcg. Corp.; 100 W.
CMGH—Matanzas, Cuba; Alberto Alvarez; 150 W.

1375 KILOYCLES—218 METERS

CMAC—Pinar del Rio, Cuba; Oscar S. Mechoso; 30 W.
CMGE—Cardenas, Cuba; Genaro Sebater; 30 W.

1380 KILOCYCLES—217.3 METERS

WSMK—Dayton, Ohio; Stanley M. Krohn, Jr.; 200 W.
KQV—Pittsburgh, Pa.; KQV, Inc.; 500 W.
KSO—Clarinda, Iowa; Iowa Broadcasting Co.; 500 W.
WKBH—LaCrosse, Wis.; WKBH (Inc.); 1 KW.
KOH—Reno, Nev.; The Bee, Inc.; 500 W.
KQV—Pittsburgh, Pa.; KQV Broadcasting Co.; 500 W.
XETB—Torreon Coah., Mex.; Jose A. Berumen; 125 W.

1382 KILOCYCLES—217.25 METERS

CMJC—Camaguey, Cuba; Feliciano Isaac; 75 W.

1390 KILOCYCLES—215.7 METERS

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

1395 KILOCYCLES—215 METERS

CMCG—Havana, Cuba; Jose Justo Moran; 30 W.

1400 KILOCYCLES—214.2 METERS

CMCH—Havana, Cuba; Hernani Torralbas; 20 W.
CMCM—Havana, Cuba; Martinez-Madicu; 15 W.
WCGU—Brooklyn, N. Y.; United States Broadcasting Corporation; 500 W.
WFOX—Brooklyn, N. Y.; Paramount Broadcasting Corporation; 500 W.
WLTH—Brooklyn, N. Y.; Voice of Brooklyn (Inc.); 500 W.
WBBC—Brooklyn, N. Y.; Brooklyn Broadcasting Corporation; 500 W.
KOCW—Chickasha, Okla.; Oklahoma College for Women; 500 W.*
WCMA—Culver, Ind.; General Broadcasting Corporation; 500 W.
WKBF—Indianapolis, Ind.; T—Clermont, Ind.; Indianapolis Broadcasting (Inc.); 500 W.
WBAA—West Lafayette, Ind.; Purdue University; 1 KW.*
KLO—Ogden, Utah; Peery Building Co.; 500 W.
XEP—N. Laredo, Tams., Mex.; Asociacion Radiodifusora Latino-Americana, S. A.; 200 W.

1410 KILOCYCLES—212.6 METERS

WRBX—Roanoke, Va.; Richmond Development Corporation; 250 W.
WBCM—Bay City, Mich.; T—Hampton Township, Mich.; James E. Davidson; 500 W.
KGRS—Amarillo, Tex.; E. B. Gish (Gish Radio Service); 1 KW.
WDAG—Amarillo, Tex.; National Radio and Broadcasting Corporation; 1 KW.
WODX—Mobile, Ala.; T—Springhill, Ala.; Mobile Broadcasting Corporation; 500 W.
WSFA—Montgomery, Ala.; Montgomery Broadcasting Co. (Inc.); 500 W.
KFLV—Rockford, Ill.; Rockford Broadcasters (Inc.); 500 W.
WHBL—Sheboygan, Wis.; Press Publishing Co.; 500 W.
WAAB—Boston, Mass.; Bay State Broadcasting Corp.; 500 W.
WHIS—Bluefield, W. Va.; Daily Telegraph; 250 W.

1420 KILOCYCLES—211.1 METERS

WTBO—Cumberland, Md.; Associated Broadcasting Corporation; 210 W.*
WILM—Wilmington, Del.; T—Edge Moor, Del.; Delaware Broadcasting Co. (Inc.); 100 W.
—Springfield, Mass.; Albert S. Moffat; 100 W.
WPAD—Paducah, Ky.; Paducah Broadcasting Co., Inc.; 100 W.

1420 KILOCYCLES—211.1 METERS (Cont.)

WERE—Erie, Pa.; Erie Dispatch-Herald Broadcasting Corporation; 100 W.
WMBC—Detroit, Mich.; Michigan Broadcasting Co.; 210 W.*
WELL—Battle Creek, Mich.; Enquirer-News Co.; 50 W.
WFDW—Anniston, Ala. T—Talladega, Ala.; Raymond C. Hammett; 100 W.
WJBO—New Orleans, La.; Valdemar Jensen; 100 W.
KGFF—Shawnee, Okla.; D. R. Wallace (owner KGFF Broadcasting. Co.); 100 W.
KABC—San Antonio, Tex.; Alamo Broadcasting Co. (Inc.); 100 W.
WSPA—Spartanburg, S. C.; Virgil V. Evans, trading as The Voice of South Carolina; 250 W.*
KICK—Red Oak, Iowa; Red Oak Radio Corporation; 100 W.
WIAS—Ottumwa, Iowa; Iowa Broadcasting Co.; 100 W.
WLBF—Kansas City, Kans.; The WLBF Broadcasting Co.; 100 W.
WMBH—Joplin, Mo.; Edwin Dudley Aber; 250 W.*
WEHS—Evanston, Ill.; WEHS (Inc.); 100 W.
WHFC—Cicero, Ill.; WHFC, Inc.; 100 W.
WKBI—Chicago, Ill.; WKBI, Inc.; 100 W.
KFIZ—Fond du Lac, Wis.; The Reporter Printing Co.; 100 W.
KFXY—Flagstaff, Ariz.; Albert H. Scherman; 100 W.
KGIX—Los Vegas, Nev.; Los Vegas Radio Corp.; 100 W.
KGIW—Trinidad, Colo.; Leonard E. Wilson; 100 W.
KGKX—Sandpoint, Idaho; Sandpoint Broadcasting Co., 100 W.
KGGC—San Francisco, Calif.; The Golden Gate Broadcasting Co.; 100 W.
KXL—Portland, Ore.; KXL Broadcasters, Inc.; 100 W.
KBPS—Portland, Ore.; Benson Polytechnic School; 100 W.
KORE—Eugene, Ore.; Frank L. Hill and C. G. Phillips, doing business as Eugene Broadcast Station; 100 W.
WJMS—Ironwood, Mich.; Morris Johnson; 100 W.
WDEV—Waterbury, Vermont; Harry C. Whitehall; 50 W.
WENC—Americus, Ga.; Americus Broadcasting Co.; 100 W.
WAGM—Presque Isle, Me.; Aroostook Broadcasting Corp.; 100 W.
WHDL—Tupper Lake, N. Y., Tupper Lake Bdcg. Co., Inc.; 100 W.

1430 KILOCYCLES—209.7 METERS

WHP—Harrisburg, Pa.; T—Lemoyne, Pa.; WHP (Inc.); 1 KW.*
WBAK—Harrisburg, Pa.; Pennsylvania State Police, Commonwealth of Pennsylvania; 1 KW.*
WCAH—Columbus, Ohio; Commercial Radio Service Co.; 500 W.
WNBR—Memphis, Tenn.; Memphis Broadcasting Co.; 500 W.
KGNF—North Platte, Nebr.; Great Plains Broadcasting Co.; 500 W.
KECA—Los Angeles, Calif.; Earle C. Anthony, Inc.; 1 KW.
WFEA—Manchester, N. H.; New Hampshire Broadcasting Co.; 500 W.
WHEC—Rochester, N. Y.; WHEC, Inc.; 500 W.
WOKO-WABO—Albany, N. Y.; T—Mount Beacon, N. Y.; WOKO (Inc.); 500 W.

1440 KILOCYCLES—208.2 METERS

WCBA—Allentown, Pa.; B. Bryan Musselman; 250 W.
WSAN—Allentown, Pa.; Allentown Call Publishing Co. (Inc.); 250 W.
WBIG—Greensboro, N. C.; North Carolina Broadcasting Co. (Inc.); 1 KW Daytime.
WTAD—Quincy, Ill.; Illinois Broadcasting Corporation; 500 W.
WMBD—Peoria Heights, Ill.; E. M. Kahler (owner Peoria Heights Radio Laboratory); 1 KW.*
KXYZ—Houston, Tex.; Harris County Broadcast Co.; 250 W.
KLS—Oakland, Calif.; E. N. and S. W. Warner, doing business as Warner Bros.; 250 W.
WMBD—Peoria Heights, Ill.; Peoria Bdcg. Co.; 1 KW.
WTAD—Quincy, Ill.; Ill. Bdcg. Corp.; 500 W.
KDFN—Casper, Wyo.; Donald L. Hathaway; 500 W.
CMBI—Havana, Cuba; Francisco Mayorquim; 30 W.
CMBN—Havana, Cuba; Armado Romeu; 30 W.
CMBL—Havana, Cuba; Julio C. Hidalgo; 20 W.

1450 KILOCYCLES—206.8 METERS

WSAR—Fall River, Mass.; Doughty & Welch Elec. Co., Inc.; 250 W.
WBMS—Hackensack, N. J.; WBMS Broadcasting Corporation; 250 W.
WNJ—Newark, N. J.; Radio Investment Co. (Inc.); 250 W.
WHOM—Jersey City, N. J.; New Jersey Broadcasting Corporation; 250 W.
WSAR—Fall River, Mass.; Doughty & Welch Electric Co. (Inc.); 250 W.
WGAR—Cleveland, Ohio; WGAR Broadcasting Co.; 500 W.
WTFI—Athens, Ga.; Liberty Broadcasting Co.; 500 W.
KTBS—Shreveport, La.; Tri State Broadcasting System (Inc.); 1 KW.

1460 KILOCYCLES—205.4 METERS

WJSV—Alexandria, Va.; T—Mt. Vernon Hills, Va.; Old Dominion Broadcasting Co.; 10 KW.
KSTP—St. Paul, Minn.; T—Westcott, Minn.; National Battery Broadcasting Co.; 10 KW.

1470 KILOCYCLES—204.0 METERS

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

1480 KILOCYCLES—202.6 METERS

WKBW—Buffalo, N. Y.; T—Amherst, N. Y.; Buffalo Broadcasting Co.; 5 KW.
KFJF—Oklahoma City, Okla.; National Radio Manufacturing Co.; 5 KW.

1490 KILOCYCLES—201.2 METERS

WCKY—Covington, Ky.; T—Crescent Springs, Ky.; L. B. Wilson (Inc.); 5 KW.
WCHI—Chicago, Ill.; T—Batavia, Ill.; Midland Broadcasting Co.; 5 KW.

1500 KILOCYCLES—199.9 METERS

WFDV—Rome, Ga.; Rome Broadcasting Corp.; 100 W.
WMBA—Newport, R. I.; LeRoy Joseph Beebe; 100 W.
WLOE—Boston, Mass. T—Chelsea, Mass.; Boston Broadcasting Co. 250 W.
WNBF—Binghamton, N. Y.; Howitt-Wood Radio Co. (Inc.); 100 W.
WMBQ—Brooklyn, N. Y.; Paul J. Gollhofer; 100 W.
WLBX—Long Island City, N. Y.; John N. Brahy; 100 W.
WWRL—Woodside, N. Y.; Long Island Broadcasting Corporation; 100 W.
WSYB—Rutland, Vt.; H. E. Seward, Jr., and Philip Weiss, doing business as Seward & Weiss Music Co.; 250 W.
WKBZ—Ludington, Mich.; Karl L. Ashbacker; 50 W.
WMPC—Lapeer, Mich.; First Methodist Protestant Church of Lapeer; 100 W.
WPEN—Philadelphia, Pa.; Wm. Penn Broadcasting Co.; 250 W*.
WWSW—Pittsburgh, Pa.; Walker & Downing Radio Corp.; 250 W Daytime.
WOPI—Bristol, Tenn.; Radiophone Broadcasting Station WOPI (Inc.) 100 W.
KNOW—Austin, Tex.; A. P. Miller; 100 W.
WRDW—Augusta, Ga.; Musicove (Inc.); 100 W.
KGFI—Corpus Christi, Tex.; Eagle Broadcasting Co. (Inc.); 250 W*.
KGKB—Tyler, Tex.; East Texas Bldg. Co.; 100 W.
KGIZ—Grant City, Mo.; Grant City Park Corporation; 100 W.
KGKY—Scottsbluff, Nebr.; Hillard Co. (Inc.); 100 W.
WKBV—Connersville, Ind.; William O. Knox, trading as Knox Battery & Electric Co.; 150 W*.
KGFK—Moorehead, Minn.; Red River Broadcasting Co. (Inc.); 50 W.
KPJM—Prescott, Ariz.; Scott and Sturm; 100 W.
KXO—El Centro, Calif.; E. R. Irey and F. M. Bowles; 100 W.
KDB—Santa Barbara, Calif.; Santa Barbara Broadcasters, Ltd.; 100 W.
KREG—Santa Ana, Calif.; J. S. Edwards; 100 W.
KPQ—Wenatchee, Wash.; Wescoast Broadcasting Co.; 50 W.
WMIL—Brooklyn, N. Y.; Arthur Faske; 100 W.
XETZ—Coyoacan, D. F., Mex.; Manuel Zetina; 100 W.
CMBQ—Havana, Cuba; Gali-Sardinas; 50 W.
CMBR—Havana. Cuba; Tomas Basail; 15 W.

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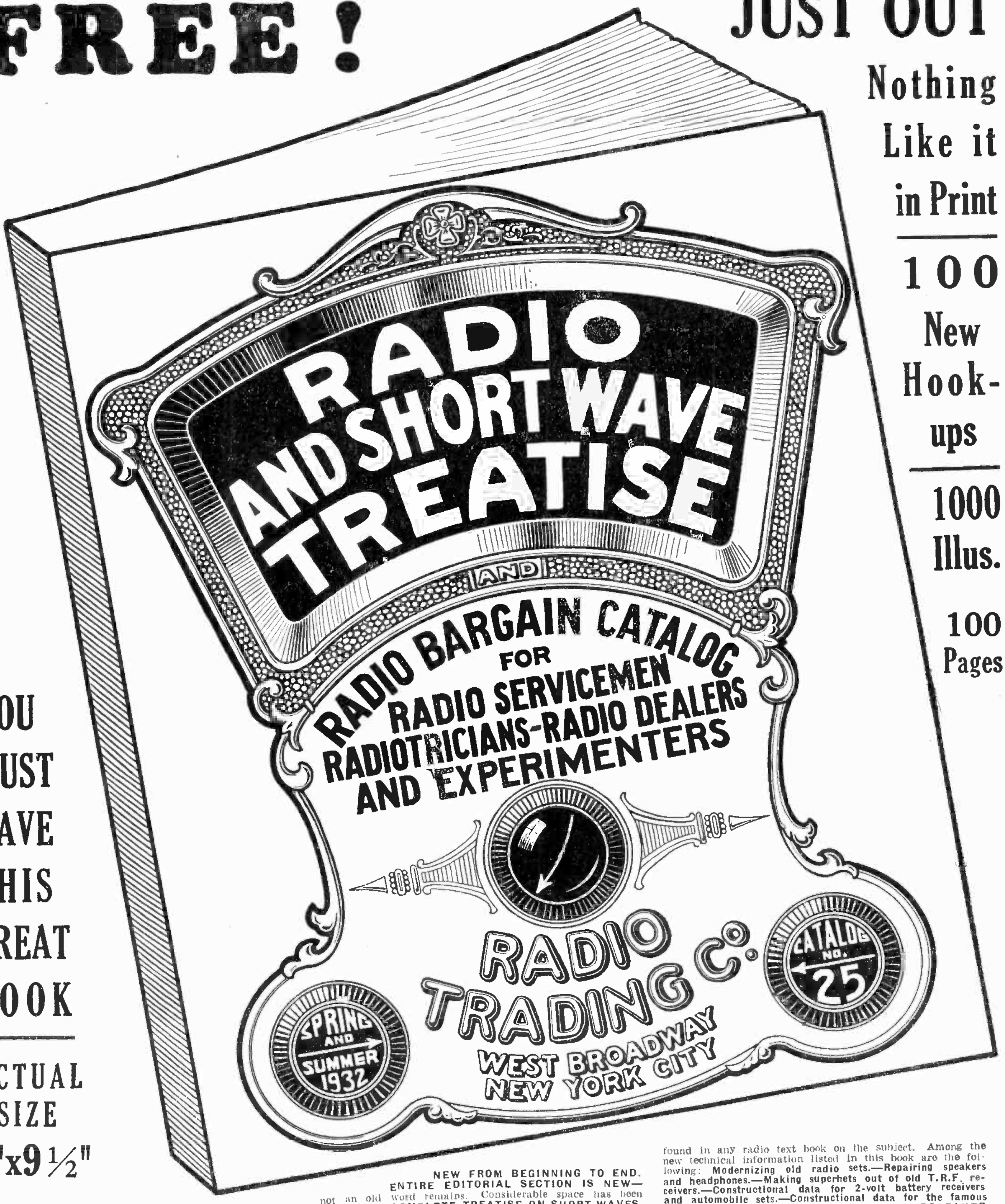

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