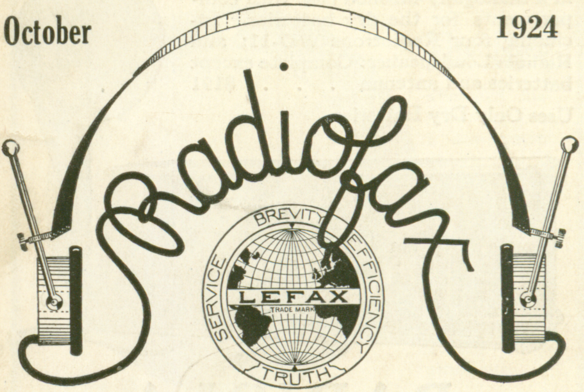
LEFAX—RADIO SECTION

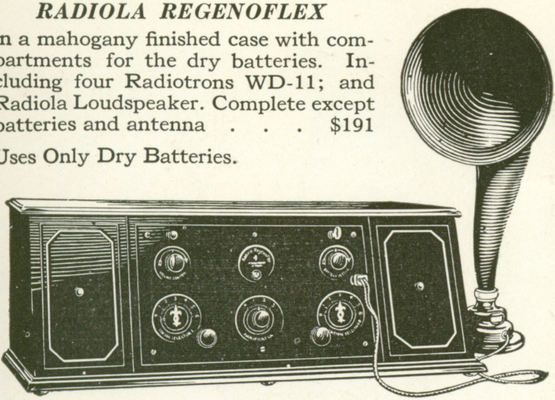
October 1924

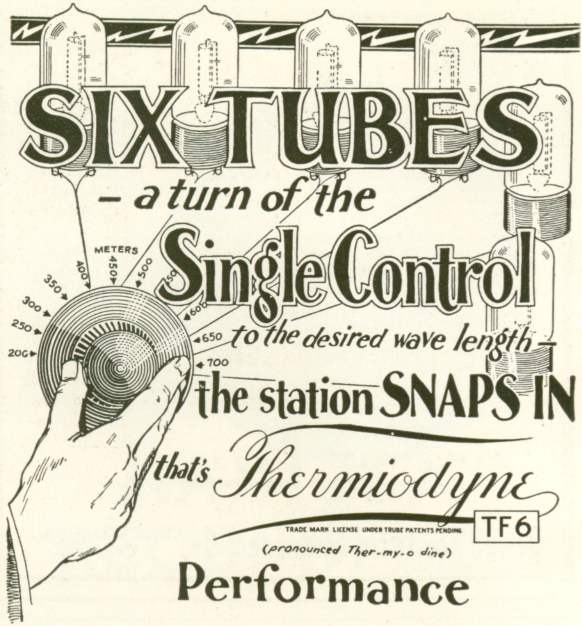


THE SUPPLEMENT
THAT KEEPS THE
LEFAX
RADIO HANDBOOK
PERPETUALLY UP-TO-DATE

A CONTRIBUTION TO RADIO SCIENCE

It is probable that many of our readers are not acquainted with the great excitement that has been created in the field of condensers by our tests. Many new features have been brought to light about condensers as a result, and it is probable that many criticisms may be directed toward us for some time until the hysteria created by the newness of the ideas shall have subsided. We caution our readers to be fair in their thoughts and to not draw too many conclusions before the whole story has been told. It is interesting to note that in this connection Lefax is the first publication to go out of its way to conduct *original* research for the benefit of its readers, and also the first to offer, as a commercial publication, an original contribution to the art of radio.





The ONLY six tube receiver to bring in any desired station by a *single* turn of a *single* control to a *single* pre-determined dial setting, with a purity of tone and clarity unmatched by any other receiver. Uses any type antenna or none, dry or storage batteries and any make tubes.

14 Points of Thermiodyne Supremacy

1—Single Control
2—No Outdoor Antenna Necessary
3—No Directional Loop
4—Meter or Kilocycle Pickup of Stations
5—CANNOT Squeal or Howl
6—CANNOT Radiate
7—CANNOT Distort
8—Newspapers give Time and Wavelength
9—Thermiodyne picks them at the Exact Setting Every Time
10—No Logging; Nothing to Remember
11—Stations of Different Wavelengths Cannot Interfere
12—Three Stages Thermionic Frequency, Detector, Two Stages Audio Frequency
13—Distance, Volume, Clear as a Bell, without fuss or excuses
14—A 180 degree turn of the Dial is Like a Tour of Dozens of Cities

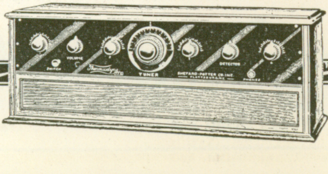
Beautifully built in exquisite genuine mahogany cabinet with space for all batteries for dry cell operation **List Price $140**

Insist that your dealer demonstrate Thermiodyne

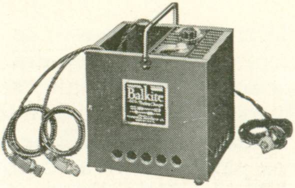
Made and Fully Guaranteed by

SHEPARD-POTTER COMPANY, Inc.

Dept. R.
35 So. River Street
Plattsburgh, N. Y.



FANSTEEL
Balkite
PATENTS APPLIED FOR *Battery Charger*



The Fansteel BALKITE Battery Charger, Model "A"

Characteristics

The Fansteel "Balkite" Battery Charger is designed to keep a six-volt storage battery charged, with a minimum of care and attention. It is automatic in operation, and once the leads from the charger are attached correctly to the battery, they may be forgotten and the charging started by turning on the electric light switch.

It is noiseless in operation.

It has no moving parts to adjust or wear out.

An ordinary six-ampere fuse is the only part which might possibly require replacement.

Its action as a rectifier of alternating current is independent of the frequency of the line, and it cannot therefore get out of adjustment and reverse its effect.

It does not require current from the storage battery to start it, and it will therefore charge a completely dead battery.

It can be operated while the radio set is in use without danger of burning out tubes. Without added attachments this charger may also be used to charge "B" storage batteries.

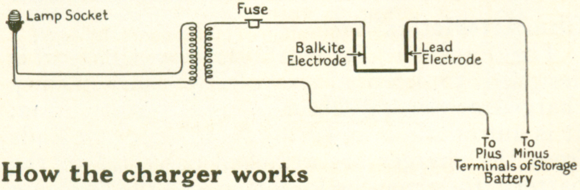
Charging rate

The "Balkite" charger delivers from two to three amperes to the battery, the rate depending on the condition of the battery at the time. As the battery gains energy the charging rate decreases. This effect is called a taper charge, and is recommended by battery engineers as prolonging the life of the battery.

Construction

Two electrodes, "Balkite"—the valve electrode which permits alternating current to pass in one direction but not in the other—and a lead electrode are housed in a lead cell containing electrolyte. A step-down transformer, having separate primary and secondary windings, delivers the alternating current to the cell at the correct voltage. These are housed in a wooden box painted with acid-proof enamel.

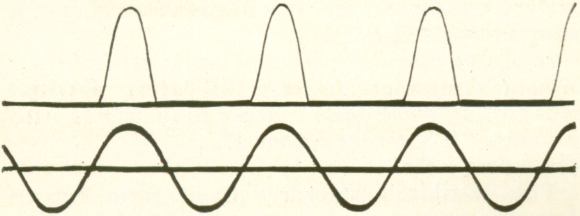
A schematic diagram of the charger is given below:



How the charger works

Alternating current, the current usually available for household use, carries impulses in both directions, and therefore would, if connected directly to a storage battery, take energy out of the battery as fast as it puts it in. "Balkite" allows impulses to go through it in one direction only and will produce a unidirectional current, suitable for charging.

The operation is shown in the following oscillogram:



Constants of the Model "A" "Balkite" charger are: Charging rate, 3 amperes; primary volts, 115; secondary volts, 19; cycles, 60; primary amperes, 1.4; watt efficiency, 22.5 to 33%; power factor, 56%; no load loss in watts, 3.

The "Balkite" charger is offered by all leading jobbers and dealers. Retail Price: $19.50. West of Rockies, $20.00. In Canada, $27.50.

Fansteel Products Company, Inc.

North Chicago, Illinois

RADIO FORMULAS

f, frequency, in kilocycles.
λ, wavelength, in meters.
C, capacity, in microfarads (μf.).
L, inductance, in microhenries (μh.).
R, resistance, in ohms.
X, reactance, in ohms.
Z, impedance, in ohms.
E, electromotive force, in volts.
V, potential difference or voltage, in volts.
I, current, in amperes.
P, power, in watts.
ψ, phase difference of condensers, in degrees.
φ, phase angle of alternating current circuit.

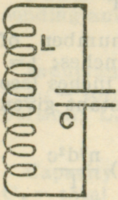


Fig. 1

Frequency of resonance in simple circuit.—

$$f = \frac{159.3}{\sqrt{LC}}, \quad \lambda = 1884\sqrt{LC}$$

Relation between wave length and frequency

$$f = 300{,}000/\lambda, \quad \lambda = 300{,}000/f$$

Capacity of parallel-plate air condenser (plates of any shape).—N = number of plates; S = area of plate in square inches; D = distance between plates in inches.

$$C = [224.6/10^9][(N-1)S/D]$$

The numerical value of 10^9 is 1,000,000,000.

Maximum capacity of variable condenser with semicular plates.—N and D as above; r_1 and r_2 = outside and inside radii respectively, of fixed plate, in inches.

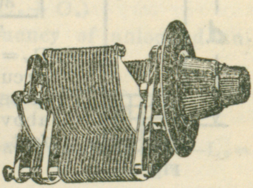


Fig. 2

$$C = \frac{353}{10^9}\,\frac{(N-1)\,(r_1^2 - r_2^2)}{D}$$

Apparent Inductance, L_a, of a Coil having capacity.—

$$L_a = L(1 + 0.0000394f^2CL), \quad L_a = L\left(1 + 3{,}550{,}000\frac{CL}{\lambda^2}\right)$$

Inductance of single-layer coil.— n = number of turns; d = diameter of coil, in inches; l = overall length = number of turns × distance between centers of adjacent wires.

$$L = 0.01\,kn^2\frac{d^2}{l}$$

where k, for various values of the ratio of diameter to length, has the values given in table.

$\frac{d}{l}$	k
0.01	2.50
0.1	2.40
0.5	2.05
0.75	1.87
1.00	1.72
2.	1.32
3.	1.08
10.	0.51
100.	0.09

Table 1

Frequency of resonance of coil.—For a single-layer coil as above with condenser of capacity C connected to it, (see Fig. 1).

$$f = \frac{1593}{nd}\sqrt{\frac{l}{kC}}, \quad \lambda = 188\, nd\sqrt{\frac{kC}{l}}$$

Inductance of multi-layer coil.—n = number of turns; d = average diameter of coil, in inches; l = length, in inches; c = depth of winding, in inches (see figure 3); k = constant in table 1; A = constant given below.

$$L = 0.01\, \frac{kn^2d^2}{l} \times 0.0064\, (0.693 + A)\, \frac{n^2d^2c}{l}$$

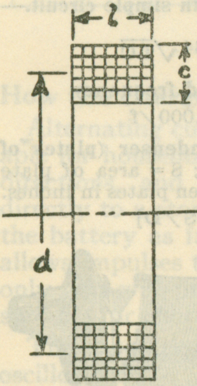


Fig. 3

$\frac{C}{l}$	A
1	0.000
2	0.120
3	0.175
5	0.229
10	0.279
20	0.310
30	0.322

Table 2

Current in receiving antenna (ordinary open type).— I_s = current in sending antenna of ordinary open type; d = distance between sending and receiving stations, in miles; R_r = resistance of receiving antenna circuit; h_s and h_r = average heights of sending and receiving antennas above ground or counterpoise, in feet.

$$I_{ra} = 3.63\, \frac{h_s h_r f I_s}{R_r d} \times 10^{-8} = 0.0109\, \frac{h_s h_r I_s}{R_r \lambda d}$$

Current in receiving coil antenna.—For plane of coil antenna parallel to line between sending and receiving stations, and for h_r = length of vertical side of coil antenna, in feet; l = length of horizontal side of coil antenna, in feet; N_r = number of turns of coil antenna; other symbols as in the two formulas just preceding.

$$I_{rc} = 2.32\, \frac{h_s h_r l_r N_r f^2 I_s}{R_r d} \times 10^{-13}$$

Correction factor for long distances. over about 50 miles.—Multiply any of the preceding four formulas by

$$2.718^{-0.00014d/\sqrt{f}} \quad \text{or } 2.718^{-0.076d/\sqrt{\lambda}}$$

Correction factor for angle α between plane of coil antenna and line between sending and receiving stations.—Multiply any of formulas for current in receiving antenna by cosine ω.

Voltage across antenna inductance.—

$$V = 0.00628fLI = 1884 \frac{LI}{\lambda}$$

Power input in sending antenna.—R_s = resistance of sending antenna circuit.

$$P_s = R_s I_s^2$$

Inductance of ordinary open type antenna (unloaded).—L_a = total inductance; L_h = inductance of horizontal portion; L_v = inductance of vertical portion.

$$L_a = (L_h + L_v)/3$$

Capacity of ordinary open type antenna (unloaded).—C_a = total capacity; C_h = capacity of horizontal portion; C_v = capacity of vertical portion.

$$C_a = C_h + C_v$$

Inductance of antenna loaded with inductance.—L_c = inductance of loading coils; other symbols as above; L = total inductance of antenna circuit.

$$L = L_a + L_c$$

Capacity of antenna with series condenser.—C_s = capacity of series condenser; C = total capacity of antenna circuit. Other symbols as above.

$$C = (C_a C_s)/(C_a + C_s)$$

Natural (fundamental) frequency of unloaded antenna.—

$$f = \frac{159.3}{\sqrt{L_a C_a}}, \ \lambda = 1884\sqrt{L_a C_a}$$

Frequency of antenna with loading inductance.—L_c = inductance of loading coils.

$$f = \frac{159.3}{\sqrt{(L_a + L_c)C_a}}, \ \lambda = 1884\sqrt{(L_a + L_c)C_a}$$

Frequency of antenna with series condenser.—C_s = capacity of series condenser.

$$f = \frac{159.3}{\sqrt{L_a \frac{C_a C_s}{C_a + C_s}}} \text{ and } \lambda = 1884\sqrt{L_a \frac{C_a C_s}{C_a + C_s}}$$

Radiation resistance of antenna.—h = height of antenna to center of capacity; h, in feet.

$$R = 16.3\ h^2 f^2 \times 10^{-10}, \ R = 147\ (h^2/\lambda^2)$$

Current in a series circuit.—

$$I = \frac{E}{Z} = \frac{E}{\sqrt{R^2 + \left(0.00628fL - \frac{159.3}{fC}\right)^2}}$$

Reactance of the capacity in a circuit.—

$$X_c = -\frac{159.3}{fC} = -0.000531\frac{\lambda}{C}$$

Reactance of the inductance in a circuit.—

$$X_L = 0.00628fL = 1884\ (L/\lambda)$$

Reactance of a series circuit.— $X = X_c + X_L$

Impedance of a series circuit.—$Z = \sqrt{R^2 + X^2}$

Capacities in parallel.—$C\ (\text{total}) = C_1 + C_2 + \ldots.$

Capacities in series.— $\frac{1}{C_1(\text{total})} = \frac{1}{C_1} + \frac{1}{C_2} + \ldots.$

Inductances in series.—$L(\text{total}) = L_1 + L_2 + \ldots.$

Inductances in parallel.— $\frac{1}{L\ (\text{total})} = \frac{1}{L_1} + \frac{1}{L_2} + \ldots.$

Resistances in series.—$R\ (\text{total}) = R_1 + R_2 + \ldots.$

Resistances in parallel.—$\frac{1}{R\ (\text{total})} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots.$

Ohm's law.—When the current flowing in a series circuit is not alternating or pulsating, or does not in any way vary in magnitude or direction, it is said to be direct-current and the reactance X is equal to zero. This is likewise the case when a circuit containing inductance capacity and resistance, is tuned or in resonance with an impressed alternating emf. The above formulas then reduce to Ohm's law, viz., $I = E/R$

Power loss in a circuit.—V = difference of potential or voltage drop between any two points in a circuit between which the power loss is to be determined.

$$P = RI^2 = V^2/R$$

Direct current resistance of a copper conductor.—A = cross section of conductor, in square inches; l = length of conductor, in inches. $(10^{-9} = 0.000\,000\,001)$

$$R_c = 62\ (l/A) \times 10^{-9}$$

Direct current resistance of round copper wire.—d = diameter of wire, in inches; l = length of wire, in feet

$$R = 85.2\ (l/d^2) \times 10^{-8}$$

Phase angle of circuit.—$\tan \varphi = X/R$

Power factor.—The power factor is defined as the cosine of the phase angle. power factor = $\cos \varphi = R/Z$

Condenser phase difference.—

$$\psi = 0.36rfC = 108{,}000\ rC/\lambda$$

Power input to a condenser.—$P = 0.0005\,fCE^2$

Power loss in condenser.—

$$P = EI\psi\ (\text{small air condensers}) = EI\cos\varphi$$

RADIO CONDENSERS

Sorting the Good From the Bad

(*Continued from the August issue of Radiofax*)

In this article we present a table giving the maximum capacities of these condensers, together with the equivalent series resistances and the corresponding phase differences. The capacities are given in micromicrofarads, the resistances in ohms, and the phase differences in minutes of arc.

As intimated in previous articles, dealing with condensers the values of resistance obtained for any condenser when **measured directly at 1,000,000 cycles,** will in general be very different from the value obtained when measured at 1,000 cycles and calculated for 1,000,000 cycles. It is believed that no one has the right to assume that the series resistance of a condenser varies inversely with the frequency. It may be well to repeat a little here. The phase difference of a condenser is given by

$$\psi = 0.36 \text{ frC}$$

in which ψ is the phase difference in degrees, f the frequency in kilocycles, r the resistance in ohms and C the capcity in mircofarads. We are considering a large change in the value of f. If everything else remained the same we would be justified in making the above assumption, but the fact remains that the value of the resistance varies somewhat, too, on account of the skin-effect at high frequencies. This would make the phase angle proportional to a power of the frequency greater than unity, and repudiate the above assumption, which calls for a constant value for ψ.

To illustrate this point, we happen to know of a condenser whose resistance as measured at 1,000 cycles is 125 ohms. Making the calculation for 1,000,000 cycles we obtain as the resistance at this frequency

$$125 \times \frac{1{,}000}{1{,}000{,}000} = 0.125 \text{ ohm}$$

The resistance of this same condenser was measured **directly at 1,000,000 Cycles,** and found it to be 0.8 ohm. The skin-effect, then, in this case, raises the resistance by 0.7 ohm.

It is not intimated in these articles that the measurements made at 1,000 cycles are not correct. They *are* correct—at 1,000 cycles. The error is made in computing the values for radio frequencies.

If a curve is plotted of resistance against frequency, we will obtain almost a straight line. The curvature is so slight that if plotted to a practical scale it will not be noticed. If we should double or triple the frequency we could calculate the effects at one frequency from knowing the effects at another frequency, but when it comes to calculating the effects at frequencies 1,000 times as great as those at which the effects are known, the effect of the slight curvature becomes appreciable.

All the measurements, the results of which are given in the table, were made **directly at radio frequencies and should not be compared with any measurements made at other than radio frequencies.**

The phase angle of a condenser may be regarded as a "figure of merit" of condensers regardless of the size. It is obvious from the formula that of two condensers having the same resistance, the larger one will have the larger phase angle.

TABLE OF CONDENSER CONSTANTS

Measured directly at 200 and 300 meters, and maximum condenser setting by an entirely new method.

Manufacturer	Type	No. of plates	Max Capacity $\mu\mu f$	Resistance (ohms)	Phase Difference (Minutes)	λ	Notes
Acme Apparatus Co.	....	29	478	0.7	11	200	3
Aerovox Wireless Corp.	.0005	Fixed	487	0.8	13	200	....
"	.001	"	999	0.8	18	300	....
"	.002	"	1842	0.4	24	200	....
"	.006	"	6020	0.4	74	200	....
Amplex Instrument Lab.	"Grid-	Denser"	392	0.7	9	200	1a
"	"	"	978	0.8	16	300	1a
Amsco Products Co., Inc.	....	23	377	1.0	13	200	....
"	....	23-3	406	0.9	12	200	....
"	....	43	691	0.9	13	300	....
"	....	43-3	756	1.4	23	300	....
Atwater-Kent Mfg. Co.	4270	19	347	1.2	14	200	2
"	....	16	282	1.5	14	200	2
Bruno Radio Corp.	....	22	520	0.8	13	200	11
Buell Mfg. Co. (Flewelling)	R	23	490	0.9	14	200	....
Caldbeck Tool & Mfg. Co.	....	23	353	1.2	13	200	6
Cardwell Mfg. Corp.	141B	11	250	1.5	12	200	....
"	152B	17	374	1.2	15	200	....
"	123B	21	476	0.9	13	200	....
"	137B	41	961	0.7	14	300	....
Carter Radio Co.	.01	Fixed	......	0.7	......	200	....
Chelten Electric Co.	820	11	253	1.5	12	200	....
"	815	17	388	1.0	12	200	....
"	810	23	517	0.8	13	200	....
"	800	23-9	559	0.8	14	200	....
"	805	45	1017	0.6	13	300	....
"	790	45-9	1043	0.5	12	300	....
Connecticut Tel. & Elec. Co.	D-10	3	850	1.3	24	300	5
Crosley Mfg. Co.	....	2	747	0.5	11	200	8
Dayton Fan & Motor Co.	5017	23-1	501	0.7	12	200	....
DeForest Radio Tel.&Tel. Co.	CV-600	25-1	560	0.9	17	200	....
"	CV-1503	31-2	1133	0.6	14	300	....
"	CV-1003	45-2	1575	0.6	19	300	....
Dubilier Condenser & Radio	.00025	Fixed	288	1.5	14	200	....
Corp.	.0003	"	300	1.0	10	200	....
" (Type 601)	.0005	"	480	0.8	12	200	....
"	.001	"	858	0.8	16	300	....
"	.0015	"	1900	0.4	23	200	....
"	.003	"	3095	0.4	36	200	....
"	.004	"	4100	0.1	13	200	....
"	.005	"	5020	0.4	60	200	....
"	.006	"	6240	0.3	61	200	....
"	.0075	"	7430	0.2	43	200	....
Duplex Engine Gov. Co.	DR-23	23	534	0.7	12	200	....
Electrical Research Lab.	.00025	Fixed	250	1.8	14	200	....
" (Erla)	.00035	"	310	1.7	17	200	....
"	.0005	"	500	1.0	11	300	....

Manufacturer	Type	No. of plates	Max. Capacity $\mu\mu f$	Resistance (ohms)	Phase Difference (Minutes)	λ	Notes
Electrical Research Lab.	.0008	"	750	0.9	14	300	....
"	.001	"	999	0.5	16	200	....
"	.0025	"	2500	0.4	32	200	....
"	.005	"	4900	0.4	64	200	....
"	.006	"	6000	0.4	78	200	....
Elgin Tool Works, Inc.	....	17	316	1.6	16	200	....
"	....	23-2	449	0.9	13	200	....
"	....	43-2	849	0.8	15	300	....
Fada (F. A. D. Andrea)	....	13	319	1.3	13	200	....
"	....	23	498	0.8	13	200	....
Federal Tel. & Tel. Co.	45	11	276	1.5	14	200	....
"	82	11	265	2.0	17	200	2
"	46	21	514	0.8	13	200	....
"	83	21	513	1.0	17	200	2
"	47	43	1054	0.7	15	300	....
"	85	43	1105	0.8	20	300	2
Framingham Co.	10	14	244	1.7	14	200	....
"	11	14-3	292	1.5	14	200	....
"	12	26-3	542	0.7	12	200	....
"	14	50	956	0.8	16	300	....
"	15	50-3	1011	0 7	15	300	....
Freed-Eisemann Corp.	258	13	288	1.0	9	200	....
Freshman & Co.	.0003	....	330	2.2	23	200	12
Gardiner & Hepburn	13	13	262	1.9	16	200	7
(Continental Lo-Loss)	18	18	347	1.0	11	200	7
"	25	25	500	0.8	12	200	7
"	45	45	1102	0.8	18	300	7
General Instrument Corp.	46A	13	307	1.2	12	200	10
"	46D	21	499	0.6	10	200	10
"	46F	43	1029	0.6	13	300	10
General Radio Co.	247H	26	506	0.7	11	200	gear
"	239G	33	1047	0.4	9	300	"
Gilfillan Bros., Inc.	R400	17	317	1.2	12	200	....
"	R375	23	404	0.9	12	200	....
"	R750	23-3	422	1.0	14	200	....
"	R350	43	737	0.9	14	300	....
"	R725	43-3	862	0.7	14	300	....
Hammarlund Mfg. Co.	.00025	11	221	1.8	13	200	4
"	.00038	17	383	1.0	12	200	4
"	.0005	23	501	0.8	13	200	4
"	.001	43	984	0.5	11	300	4
Hartford Instrument Co.	23SP	23	431	1.0	14	200	....
(Sexton)	23SD	21-3	432	0.8	12	200	....
Heath Radio & Elec. Co.	.0005	24-1	550	0.9	14	200	....
Horne Elect. & Mfg. Co.	355	18-3	447	1.0	14	200	....
Kellogg Swbd. & Supply Co.	601	11-3	454	0.8	12	200	....
"	603	23-3	884	0.7	14	300	....
"	605	43-3	1115	0.7	17	300	....
Kilbourne & Clarke Mfg. Co.	.0005	Fixed	287	1.4	13	200	....
"	.001	"	1156	0.8	21	300	....
"	.005	"	2890	0.4	34	200	....
"	43	43	712	1.1	16	300	....
"	45	45-2	......	0.7	......	300	....
Magnus Elect. Co.	916	13-3	207	1.6	11	200	....
"	917	17	255	1.5	13	200	....
Malone-Lemmon Lab.	A-44	20	481	0.7	11	200	....
Moretone Radio Co.	21	21	449	0.7	10	200	....
"	V-21	21-1	422	1.0	14	200	....
"	43	43	847	1.0	18	300	....
"	V-43	43-1	844	0.8	15	300	....
National Co., Inc.	....	12	246	1.8	15	200	gear
"	....	25	490	0.8	13	200	"
New York Coil Co.	.002	Fixed	2060	0.5	35	200	....
Pacent Elect. Co., Inc.	200C	15	306	1.6	16	200	....
"	200D	21	441	0.8	11	200	....

Manufacturers	Type	No. of plates	Max. Capacity $\mu\mu f$	Resistance (ohms)	Phase Difference (Minutes)	λ	Notes
Pacent Elect. Co., Inc......	200E	43	920	0.6	12	300	....
Perfection Mach. & Mfg. Co.	....	17	284	1.4	13	200	....
"	....	23-3	300	0.8	10	200	....
"	....	43-3	700	0.8	13	300	....
Radio Condenser Co........	....	23	500	0.8	......	200	11
("Certified")...........	....	45	......	0.7	......	300	....
Radio Dev. & Mfg. Co......	VC-99	13	261	0.8	7	200	9-10
"	VC-101	21	579	0.8	15	200	"
Radio Industries Corp......	423	"Rico"	222	0.7	3	300	1
	450	"	635	1.1	23	200	1
Radio Stores Corp.........	G	15	331	0.9	9	200	....
(Haig & Haig)..........	H	23	534	0.6	11	200	....
"	H	43	990	0.5	11	300	....
Rathbun Mfg. Co..........	....	13	246	1.1	9	200	....
"	....	15	307	1.1	11	200	....
"	....	23	475	0.9	13	200	....
"	....	23-3	480	0.7	......	200	....
"	....	43	935	0.8	16	300	....
Sherman Radio Distrib. Co...	....	46-2	983	0.7	15	300	....
(Kant-Short)..........	.0005	23-3	......	0.7	......	200	....
Signal Elect. Mfg. Co.......	R-77	21	371	1.2	14	200	....
"	132	21-2	387	1.3	16	200	....
Stand-bi Radio Mfg. Co.....	.0025	Fixed	2460	2.4	195	200	....
"	.005	"	3140	1.8	189	200	....
"	.006	"	3680	1.5	177	200	....
Stern & Co. (Fesco)..........	....	23	456	0.8	12	200	....
"	....	43	938	0.8	17	300	....
Thordarson Elect. Mfg. Co...	R-171	23-1	474	0.8	12	200	....
" ...	R-161	23	460	0.9	13	200	....
United Mfg. & Dist. Co......	....	23	494	0.7	12	200	....
United Scientific Lab.(U.S.L.)	....	23	431	0.7	9	200	....
Walnart Elect. Mfg. Co.....	....	13	269	1.2	10	200	....
"	....	17	333	1.0	11	200	....
"	....	19-3	359	1.0	12	200	....
"	....	23	389	1.0	14	200	....
"	....	39-3	711	0.8	13	300	....
"	....	43	767	0.8	13	300	....
Westwyre Co..............	F	17	323	1.1	12	200	....
"	E	23	461	0.8	13	200	....
"	D	43	859	0.7	13	300	....
"	117	17	335	1.3	15	200	....
"	110	23	467	1.2	18	200	....
Wireless Shop..............	130T	13	245	1.4	11	200	....
"	130MV	13-2	249	1.7	13	200	....
"	170T	17	322	2.0	21	200	....
"	170MV	17-2	326	1.0	11	200	....
"	230T	23	451	0.9	14	200	....
"	230MV	23-2	429	0.9	12	200	....
"	310T	31	584	0.8	15	200	....
"	430T	43	856	0.6	12	300	....
"	630T	63	1271	0.7	19	300	....

1. Special type, variable, mica dielectric. 1a, "Adjustable fixed" type, i.e., adjustable to proper value, and allowed to remain as set.
2. Enclosed in metal case. 3. Enclosed in celluloid case.
4. Vernier consists of eccentric driving plates by forked arm on shaft.
5. No vernier; connections on back of instrument according to letters indicated (marked on case); enclosed.
6. Straight line type; 7. Special vernier construction.
8. Book type, mica dielectric, variable; capacity increases as dial rotates to 150 (270°). Values at 125 and 150 on the dial are given on second line.
9. Die-Cast Plates. 10. Cut-back plates to reduce minimum capacity and facilitate tuning at lower end of scale.
11. Double range secured by means of 2 sets of plates, either or both of which may be connected in circuit at the same time.
12. Mercury type.

SUPPLEMENTAL LIST OF BROADCASTING STATIONS TO SEPTEMBER 1, 1924

Call Signal	Owner of Station	Location of Station	Frequency Kilocycles	Wave Length Meters	Rating Oscill. Watts
KFAN	The Electric Shop........	Moscow, Idaho.....	833	360	50
KFRA	Marvin S. Olson..........	Carver, Minn.......	1250	240	100
KFRB	Hall Brothers............	Beeville, Tex.......	1210	248	250
KFRC	Radioart Studio..........	San Francisco, Calif.	1070	280	5
WBBA	Plymouth Congregational Church................	Newark, Ohio......	1250	240	20
WEBL	Radio Corp. of America...	United States (portable)............	1330	226	100
WEBO	Radio Company..........	Hamilton, Ohio....	1200	250	5
WFBI	Galvin Radio Supply Co...	Camden, N. J......	1270	236	100

Changes

KFDY—1100 kilocycles, 273 meters, 100 watts.
KFGD—power decreased to 100 watts.
KFLV—Swedish Evangelical Mission Church.
WABP—power increased to 200 watts.
WCAG—power decreased to 50 watts.
WDBJ—power increased to 50 watts.
WEAA—power increased to 50 watts.
WEB—power decreased to 100 watts.
WGAZ—1090 kilocycles, 275 meters.
WGR—Federal Telephone Mfg. Co.
WHAV—power increased to 100 watts.
WJY—power increased to 750 watts.
WMAK—Lockport Board of Com'rce.
WQAN—power increased to 100 watts.
WQJ—Calumet Rainbo Broadcasting Co.

Licenses Recently Cancelled

KFID KFPB WDBA WLAW

ARGENTINE BROADCASTING STATIONS

Captain Luis F. Orlandini, Chief Naval Communication Service has reported the following stations now in operation.

Call Signal	Owner of Station	Location of Station	Frequency Kilocycles	Wave Length Meters	Rating Oscill. Watts
LOR	Radio Argentina.........	Buenos Aires.......	750	400	1500
LOV	F. Brusa................	Buenos Aires.......	857	350	500
LOW	Grand Splendid..........	Buenos Aires.......	923	325	1000
LOX	Radio Cultura...........	Buenos Aires.......	800	375	500
LOY	Radio Nacional..........	Buenos Aires.......	923	325	1000
LOZ	Radio South America.....	Monte Grande.....	706	425	500

Foreign Stations

Radio broadcasting is now receiving the sanction and assistance of the government in almost all important countries. It is expected that because of the differences in national traits many unique and interesting plans will be put into effect.

We are in touch with the official sources of information in all countries and will describe anything of interest that comes to our attention through this channel.

If any of our distant readers can supplement our official reports with comments on the public's viewpoint we will indeed be glad to hear from them.

FADS IN RADIO

The era of circuits is closing and we are now entering upon one of low-loss design, and short waves. The two go hand in hand. We cannot hope to accomplish any improvements in transmission on short waves unless we design our circuits to have less resistance than they used to have.

It seems that necessity is the mother of invention, in this case as well as in any other. The great necessity for low-loss circuits was not noticed until experiments were started with the short waves. When it was found that good radiation could not be obtained on these short wave lengths in the ordinary circuits on account of the abnormal increase of resistance attending the enormous increase in frequency, we found that it would be worth while to reduce the circuit resistance.

The advantage of low-loss circuits in the broadcasting range of wave lengths should not be left unnoticed, however. It is obvious that the circuit resistances do not climb to such heights at these lower frequencies,but it still climbs high enough to cause considerable lowering of efficiency of reception.

We have tried several circuits whose design was directed mainly toward lowering the resistance of the oscillating circuits, and the results obtained fell hardly short of remarkable. In these circuits, the most serious offender of all the apparatus used were the coils. We wish to emphasize the great need for low-resistance coils. We have our low-loss condensers—very good ones at that. We also urge experimenters to investigate the relative importance of coil capacity, skin-effect, and ordinary ohmic resistance. It is our opinion that the most serious cause of coil resistance is the skin-effect, rather than the coil capacity especially in single-layer coils.

The skin-effect, however, is that of a mere multiplication of the ohmic resistance. There is reason to believe that by proper design the ohmic resistance of a coil might be so reduced that this reduction would far overbalance the attendent increase in the skin-effect. For example, if the ohmic resistance of the coil be reduced to one-fourth what it was, and the skin-effect should happen to be doubled at the same time, the final resistance of the coil would still be one-half what it was.

These remarks are made with the idea of giving our readers, many of them whom are experimenters, some ideas to work upon. The field is big and many opportunities are offered for exercising the ingenuity. The need is great also. We urge our readers to let us have their ideas on the subject, so that together we may so improve coil design that their resistances are brought down as low as the resistances of condensers.

DEFINITION OF RADIO TERMS

(Continued from the September Radiofax)

Harmonics: Multiples of the fundamental frequency which are often set up in a circuit; the introduction of these introduces elements into speech sounds which cause distortion. Part of the electrical energy is lost in setting up these harmonics. Harmonics which are present in the original speech sounds however must be preserved so that the quality is not altered.

Henry: The unit of inductance. One millionth of a henry, called the microhenry, is commonly used in radio calculations.

Heterodyne Reception: A method of radio reception for continuous waves, employing the principle of reaction between locally generated oscillations and incoming oscillations. See Beat Frequency.

Heterodyne, Self: See Self-Heterodyne.

Hot Wire Ammeter, Expansion Type: An ammeter dependent for its indications on the change in dimensions of an element heated by a current through it.

Hydrometer: An instrument for measuring the specific gravity of electrolytes in batteries.

Inductance: A property of conductors and circuits by virtue of which opposing emf's are induced in them or in other nearby circuits, due to the magnetic fields set up by the current cutting across these circuits.

Impact Transmitter: A radio transmitting set in which the transfer of energy from the exciting to an oscillatory circuit is effected during one pulse of the exciting circuit current.

Impedance: Ratio of voltage to current in an alternating-current circuit. Impedance is a factor determining the magnitude of current flow in a circuit. The greater the impedance for a given voltage the smaller the current. For series resistance and reactance it is equal to $\sqrt{(\text{Resistance})^2+(\text{Reactance})^2}$

Impulse Emf.: An emf. the maximum value of which is large compared with its average value, the average value being taken over a time equal to the time-constant of the circuit in which the emf. is impressed.

Impulse Excitation: A method of producing free oscillations in a circuit in which the duration of the impressed voltage is short compared with the duration of the current produced.

Inductive Coupling: The association of one circuit with another by means of inductance common or mutual to both. (This term when used without modifying words is commonly used for coupling by means of mutual inductance, whereas coupling by means of self-inductance common to both circuits is called "direct inductive coupling.")

Inductive Reactance: That part of the impedance which is due to the presence of inductance in the circuit, and which is equal to 6.28 × frequency × inductance.

Input Reactance of a Three-Electrode Tube: The reactance of an electron tube to its input circuit, due to its electrode capacities. (See reactance.) The ratio of an alternating sine-wave input voltage to the portion of the resulting input current which is an alternating sine-wave current of the same frequency as the input voltage and ninety degrees out of phase with it.

Inductance: That property of an electric circuit by virtue of which a varing current induces an emf in that circuit or in a neighboring circuit. Ratio of the magnetic flux to the current producing it.

Inductor: A conductor having inductance, usually a coil of wire.

Input Resistance of a Three-Electrode Tube; That part of the resistance of the input circuit of an electron tube which is due to the presence of the tube in the circuit. The ratio of an alternating sine-wave input voltage to that portion of the resulting input current which is an alternating sine-wave current of the same frequency as the input voltage and in phase with it.

Interrupted Continuous Waves: Interrupted continuous waves (I C W) are waves obtained by the modulation at audio frequency, during signaling, of an otherwise continuous wave.

Inverted L Antenna: A flat-top antenna in which the down lead is taken from one end of the horizontal portion.

Key: A device for closing and opening transmitting circuits in the act of transmitting signals.

Kenotron: A two element electron tube highly evacuated, generally used for rectifying alternating currents.

Lead-In: See Down Lead.

Lightning Arrester: An instrument placed in antenna circuits to furnish an easy path to ground for lightning or other extremely high voltage discharges.

Loading Coil: An inductor used to decrease the resonance frequency of an antenna or other circuit.

Logarithmic Decrement: The Napierian logarithm of the ratio of two successive current amplitudes in the same direction, for an exponentially damped alternating current. The logarithmic decrement can also be considered as a constant of a simple radio circuit, being π times the product of the resistance by the square root of the ratio of the capacity to the inductance of the circuit.

Loop Antenna: See Coil Antenna. Commonly used for a coil antenna of a single turn.

Loud Speaker: A device with or without special amplifying circuits, by means of which received sounds are made audible without the use of telephone receivers held to the ears.

Megohm: One million ohms. The unit of high resistance.

Meter: A unit of length, 39.37 inches.

Meter-Amperes: The product of the antenna current in amperes at the point of maximum current and the antenna height in meters for any radio transmitting station. It constitutes a factor for indicating the radiating strength of radio transmitting stations.

Microampere: One millionth of an ampere.

Microfarad: One millionth of a farad, a unit of capacity.

Microhm: One-millionth of an ohm.

Micromicrofarad: One millionth of a microfarad, a convenient unit of capacity.

Microhenry: One millionth of a henry.

Milliampere: One-thousandth of an ampere; a convenient unit in measuring small currents.

Modulation: Variation of amplitude of a radio-frequency current.

Modulation, Double: See Double Modulation.

Modulation Frequency Ratio: The ratio of modulation frequency to wave frequency.

Multiple-Tuned Antenna: An antenna with connections to ground through inductances at more than one point, the inductances being so determined that their reactances in parallel present a total reactance equal to that necessary to give the antenna the desired natural frequency.

Mutual Inductance: The inductive effect due to the proximity of two separate electrical circuits.

Ohm: The unit of resistance. The resistance of a d-c. circuit when a current of one ampere flows under a difference of potential of one volt is one ohm.

Open-Antenna: See Condenser Antenna.

Oscillations: (In Radio Work.) See Damped Alternating Current.

Output Resistance of Three-Electrode Tube: That part of the impedance of the output circuit of the tube which is due to the presence of the tube in the circuit.

Parallel Resonance: When a single lumped capacity and a single lumped inductance are connected in parallel between terminals to which an alternating emf. is applied, and the inductance or capacity or frequency is varied, the condition of parallel resonance exists when the current supplied by the source is a minimum.

Every part of every actual circuit possesses a certain amount of distributed capacity and inductance, and in practice complex arrangements of a considerable number of inductances and capacities are often used. For this reason the assumption as to a single lumped capacity and a single lumped inductance made in the above two definitions are not strictly realized in practice, and the resonance conditions attained are a combination of series resonance and parallel resonance. This is particularly true in circuits of radio frequency in which the reactances due to leads and other parts of the circuit may be appreciable factors. (See Series Resonance.)

Period: The time of a complete cycle of alternating current or voltage; equal to 2 alternations.

Phase Difference: A quantity proportional to the power loss in a condenser or insulating material. Phase difference in degrees =0.57×power factor in per cent.

Plate Condenser Antenna: A condenser antenna in which the capacity areas consist of wires or metal plates, both elevated well away from the ground.

Plate Current: The current passing between the plate and the heated cathode in a three-electrode tube.

Pliotron: A kenotron with an additional electrode called the grid, for controlling the output current.

Potentiometer: Known also as a "voltage divider." A resistance used for obtaining adjustable voltages by utilizing the voltage drop in the resistance.

Power Factor: In a-c. circuits, the ratio of the power in watts to the volt-amperes, often expressed in percent.

Pulsating Current: A periodic current (that is, current passing through the successive equal cycles of values), the average value of which is not zero. A pulsating current is the sum of an alternating and a direct current.

Radiation Efficiency: The radiation efficiency of an antenna at a given wave length is the ratio of power radiated to the total power delivered to the antenna.

Radiation Resistance: The ratio of the total power radiated by an antenna to the square of the effective current at the point of maximum current.

Radio Channel: A band of wave lengths or frequencies of a width sufficient to permit of its use for radio communication without the radiation of subsidiary waves of more than a certain intensity at wave lengths or frequencies outside of such band.

Radio Frequencies: (See also Audio Frequencies.) The frequencies higher than those corresponding to normally audible sound waves.

Note.—It is not implied that radiation cannot be secured at lower frequencies, nor that radio frequencies are necessarily above the limit of audibility.

Radiogoniometer: See Direction Finder.

Reactance: That part of the impedance of a circuit due to the inductance and capacity in it. (See Impedance. Inductive reactance = 0.00628 × frequency × inductance. Capacitive reactance = —159.3 ÷(frequency × capacity.) Frequency in kilocycles.

Rectification: Changing an alternating current into direct or pulsating current.

Rectifier: A device for rectifying alternating currents.

Regenerative Coupling: (See Feed-Back Coupling.) A receiving system designed to increase amplification in a three-electrode tube.

Resistance: The opposition offered to the flow of current in a circuit which manifests itself in the evolution of heat in the conductors.

Resistor: A device having resistance, used to introduce resistance into a circuit.

Resistive Coupling: The association of one circuit with another by means of resistance common to both.

Resonance: That condition of an a-c. circuit under which maximum current flows for a given voltage. In a series circuit there is resonance when the inductive reactance is equal to the capacitive reactance.

Rheostat: A resistor with a means for varying the resistance, to control the flow of current in the circuit in which the rheostat is connected.

Self-inductance: A property of wires and coils, due to the magnetic lines of force created by the current in the wire, cutting back on the wires and inducing an opposing emf in them.

Self-Heterodyne: A system of reception of continuous wave signals by the production of audio-frequency beats through the use of a device which is both a radio-frequency generator and a detector of the audio-frequency beat currents produced.

Series Resonance: When a single lumped capacity and a single lumped inductance are connected in series between terminals to which an alternating emf. is applied, and the inductance or capacity or frequency is varied, the condition of series resonance (maximum current) exists when the inductive reactance equals the capacitive reactance. (See parallel resonance.)

Signal Stray Ratio: See Strays.

Static: Static is conduction or charging current in the antenna system resulting from physical contact between the antenna and charged bodies (e. g., snowflakes) or masses of gas.

Stopping Condenser: A condenser used to provide direct-current insulation, but which permits alternating current to flow in a circuit.

Strays: Electromagnetic field causing disturbances in radio reception other than those produced by radio transmitting systems or by alternating current induction from wire circuits. The term "strays" includes atmospheric disturbances and disturbances caused by electrical apparatus such as sparking commutators; sparking contacts in fire alarm apparatus, Tirrell regulators or elevator controllers; sudden current changes through arc lamps; transient or sparking grounds on power systems; electric ignition systems of internal combustion engines, or sparking at third-rail or trolley contactors. (A reduction of the effect of strays on radio reception increases the signal-stray ratio.)

T-Antenna: A flat-top antenna in which the down lead is taken from the center of the horizontal portion.

Three-Electrode Tube: A combination of a heated cathode, a relatively cold anode, and a third electrode for controlling the current flowing between the other two electrodes, the whole contained within an enclosure evacuated to a low pressure.

This device is variously known as an Audion, Audiotron, Aerotron, Electron Relay, Electron Tube, Pliotron, Triode, Oscillion, Radiotron, etc.

Tickler: See Feed-Back Coil.

Transformer: A device consisting of one coil of wire placed in proximity with another, for the purpose of coupling two circuits together by virtue of the mutual inductance between the two coils. Also used for raising or lowering alternating voltages and currents. When the voltage of a line is increased by a transformer the current is correspondingly decreased and vice-versa. The power remains the same except for losses in the transformer. In this case one coil is wound directly upon the other. The coil connected to the source of power is called the **primary** and the other coil the **secondary.**

Umbrella Antenna: An antenna the conductors of which form elements of a cone with the apex at the top to which the down lead is connected.

Undamped Alternating Current: A periodic current (i.e., current passing through successive equal cycles of values) with constant amplitude whose average value is zero.

Volt: See electromotive force.

Volt-Ampere: The product of the current and voltage in a circuit.

Watt: A unit of power; $^1/_{746}$th of a horsepower 1000th of a kilowatt. A d.c. circuit carrying a current of one ampere with an emf. of one volt can deliver one watt of power.

Wave Antenna: A horizontal antenna the physical length of which is approximately equal to the length of signaling waves to be received, and which is so used as to be strongly directional.

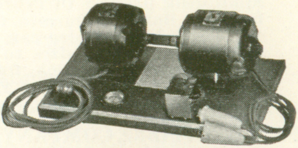
Wave-Length: The ratio of the velocity of propagation of electric waves to the frequency.

Wavemeter: An instrument for measuring frequency and wavelength.

Waves, Continuous, Key Modulated: See Continuous Waves, Key Modulated.

Waves, Continuous, Modulated at Audio Frequency: See Continuous Waves at Audio Frequency.

Wave-Trap: A device used with a receiving set to improve its selectivity. A commonly used type is a parallel combination of a condenser and an inductor connected in series with the antenna. (See parallel resonance).



IMPROVING THE AUDIO AMPLIFIER

Part 3

In the construction of a two-step audio frequency amplifier the importance of choosing only the best parts has been frequently emphasized. Next in importance is the location and mounting of these parts in such a way that all of the grid connections between tubes and transformers will be as short and direct as possible. If AmerTran audio transformers are mounted on the baseboard, the terminals will be approximately 2½ inches above the baseboard. The sockets can be elevated so that the terminals are about on the same level and the grid connections can then be very short and direct. The filament and B battery connections should be made with insulated wire (not bus bar) and brought downward from the sockets and bunched or twisted together. These bunched leads from all the rheostats and sockets should then be brought together and bunched or twisted into the form of a cable extending along the baseboard to the rear and only at this point fan out the individual leads to their proper battery connections. The battery leads so bunched and twisted together form a cable which may be passed through a grounded metal tube. The object in bunching all battery leads is to prevent the formation of inductive loops where they should not exist. Bus bar wiring invariably introduces inductive loops due to the required separation and lack of flexibility.

Any sort of coupling between the grid connections and other parts of the circuit should be prevented, but a certain amount of capacity coupling between A and B battery leads should be encouraged by grouping them together as close as the insulation will permit. This automatically diminishes the inductive loop effect, and it is not uncommon in good sets to see 1 mfd or 2 mfd fixed condensers connected across the B batteries as a radio frequency bypass. Strange as it may seem, these precautions are more necessary with efficient parts than otherwise. For example, an audio transformer may be so weak that the grid voltage amplification is insufficient to make apparent the necessity of proper wiring, but to use poor transformers and improper wiring is like gunning for bear with a popgun. Audio frequency currents should pass through the audio frequency amplifier without interference, but radio frequency currents should be kept out wherever possible, because the combination of two frequencies is productive of most of the disagreeable howls. Circular 1005A will be sent free upon request by the AMERICAN TRANSFORMER COMPANY, 182 Emmet Street, Newark, N. J.

(*Advertisement*)