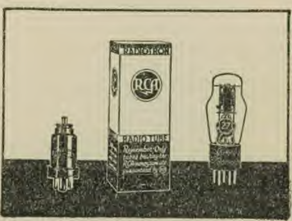
Radiotron

REFERENCE BOOK 1937

RADIO TUBE REFERENCE BOOK

1937



Price $1.00

RCA RADIOTRON DIVISION

RCA Manufacturing Co., Inc.

CAMDEN NEW JERSEY

A Service of the Radio Corporation of America

Form No. 1400

Personal

Name ______________________________

Residence ______________________________

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Business Address ______________________________

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In case of accident, please notify

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Telephone ______________________________

Accident Ins. Policy No. ______________________________

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THIS BOOK IS VALUABLE
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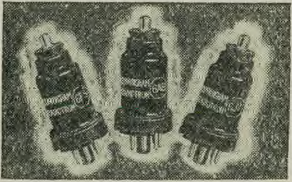
Metal Tubes a Boon to Radio Industry

Typical of the leadership maintained by RCA in all branches of the radio art was the ntroduction in the Spring of 1935 of the All-Metal Radio Tube, the most radical advance in tube design since RCA developed the a-c tube.



Metal Tubes were an immediate success. The public quickly realized that RCA Metal Tubes were *modern* tubes. They demanded Metal Tube radios. The radio trade recognized Metal Tubes as a powerful stimulant to sales —and they were not disappointed. Within a ew months Metal Tubes had definitely stamped themselves as the new order in tube lesign. Today, an overwhelming majority of ll American radio manufacturers use Metal Tubes—a tribute to the pioneering vision and perseverance of RCA in developing radio for the best interests of the public.

Glass has been used as the envelope of radio tubes because of its ability to retain a vacuum and because some of the manufacturing blems of radio tubes were similar to those amp bulbs. Radio tubes, however, did not uire a transparent envelope as did lamp bs but did require far greater precision in spacing of elements.

'he Metal Tube awaited only the solv- by the engineers of certain problems lved in quickly making vacuum-tight ds where the shell and base of tubes join, in designing a vacuum-tight seal at the point where the leads from the internal electrodes pass through the metal base to the pins.

The welding problem was solved by the use of electronic tubes to provide accurate control to a fraction of a second of a welding current as high as 75,000 amperes. An alloy possessing the same coefficient of expansion as glass is used with a small amount of glass to create a tight seal for the leads.

Metal, of course, can be worked with far greater precision than glass, permitting smaller tubes and better shielding. While most of the metal types are less than half the size of their glass counterparts, the reduction in size is a result of compact design and a close-fitting envelope rather than of miniature parts or decreased electrode clearances. Lead wires are much shorter, making a better tube both electrically and mechanically. The metal shell provides almost perfect shielding and is positively grounded to a base pin. Finally, the new Octal base, with its keyed center pin, makes it far easier to insert a Metal Tube in its socket.

It is worthy of note that the manner in which the interests of both the radio trade and the public were protected in the introduction of the new tubes was also typical of RCA's acceptance of its responsibility as leader of the industry. The world's greatest tube laboratories and factories at the RCA Radiotron plant worked for months before the new tubes were announced so that a thoroughly reliable product might be offered right from the start. The tube characteristics were carefully standardized so that the number of types of RC[illegible] Metal Tubes would be kept at the lo[illegible] figure consistent with progress in radio des[illegible] Thus the interests of manufacturers, dea[illegible] and the public were safeguarded. Today, [illegible] almost two full years of production and [illegible] behind them, Metal Tubes stand as ano[illegible] major contribution of RCA to the progre[illegible] radio and to the prosperity of radio de[illegible] and service engineers.

U. S. POPULATION—RADIO SETS

City and State	Population U. S. Census 1930	No. of Families U. S. Census 1930	Estimated No. of Radio Sets Jan. 1, 1936	Est. % of* Families Having Radio Sets
ALABAMA	2,646,248	592,530	258,000	44
Birmingham	259,678	64,443	71,518	100
Mobile	68,202	16,909	14,642	73
Montgomery	66,079	17,195	13,524	79
ARIZONA	435,573	106,630	62,500	59
Douglas	9,828	2,397	1,527	64
Phoenix	48,118	12,666	13,869	100
Tucson	32,506	8,266	8,647	100
ARKANSAS	1,854,482	439,408	187,300	43
Fort Smith	31,429	8,200	11,636	100
Little Rock	81,679	20,123	19,757	98
Pine Bluff	20,760	5,549	5,639	100
CALIFORNIA	5,677,251	1,618,533	1,398,900	86
Berkeley	82,109	24,440	24,309	99
Fresno	52,513	14,556	14,131	97
Glendale	62,736	19,324	22,380	100
Long Beach	142,032	47,153	45,556	97
Los Angeles	1,238,048	370,462	358,094	97
Oakland	284,063	83,350	83,916	100
Pasadena	76,086	23,068	22,612	98
Sacramento	93,750	24,886	24,686	99
San Diego	147,995	45,454	44,311	97
San Francisco	634,394	180,346	170,000	94
San Jose	57,651	16,872	17,894	100
COLORADO	1,035,791	268,531	206,600	77
Colo. Springs	33,237	10,048	10,353	100
Denver	287,861	79,879	73,800	92
Pueblo	50,096	12,360	11,824	96
CONNECTICUT	1,606,903	389,596	372,200	96
Bridgeport	146,716	35,902	35,480	99
Hartford	164,072	40,796	40,922	100
New Britain	68,124	15,568	15,595	100
New Haven	162,655	39,647	38,664	98
Waterbury	99,902	23,125	22,447	97
DELAWARE	238,380	59,295	47,100	79
Dover	4,800	1,200	821	68
New Castle	4,131	1,033	750	73
Wilmington	106,597	25,694	25,835	100
D. COLUMBIA				
Washington	486,869	126,014	125,800	99
FLORIDA	1,468,211	377,823	233,900	62
Jacksonville	129,549	32,555	33,552	100
Miami	110,637	30,902	31,065	100
St. Petersburg	40,425	12,749	12,094	95
Tampa	101,161	25,111	23,188	92
GEORGIA	2,908,506	654,009	334,500	51
Atlanta	270,366	68,021	65,957	97
Augusta	60,342	15,421	11,367	74
Macon	53,829	13,938	11,295	81
Savannah	85,024	22,495	16,936	75

City and State	Population U. S. Census 1930	No. of Families U. S. Census 1930	Estimated No. of Radio Sets Jan. 1, 1936	Est. % of* Families Having Radio Sets
IDAHO	445,032	108,515	75,800	70
Boise	21,544	5,931	6,114	100
Idaho Falls	9,429	2,300	2,096	91
Pocatello	16,471	4,164	4,055	97
ILLINOIS	7,630,654	1,934,445	1,674,300	87
Chicago	3,376,438	845,868	819,201	97
Cicero	66,602	16,276	16,609	100
Decatur	57,510	15,421	16,846	100
E. St. Louis	74,347	19,122	15,941	83
Evanston	63,338	16,472	19,578	100
Oak Park	63,982	17,021	20,828	100
Peoria	104,969	26,627	25,357	95
Rockford	85,864	22,187	22,518	100
Springfield	71,864	18,799	15,290	81
INDIANA	3,238,503	844,463	616,800	73
Evansville	102,249	25,769	22,854	89
Ft. Wayne	114,946	29,199	30,125	100
Gary	100,426	23,232	20,414	88
Hammond	64,560	15,513	16,661	100
Indianapolis	364,161	98,841	93,071	94
South Bend	104,193	25,682	22,579	88
Terre Haute	62,810	17,612	12,726	72
IOWA	2,470,939	636,905	503,100	79
Cedar Rapids	56,097	15,350	16,216	100
Davenport	60,751	16,706	15,399	92
Des Moines	142,559	38,190	38,588	100
Sioux City	79,183	20,051	20,026	99
Waterloo	46,191	11,957	11,469	96
KANSAS	1,880,999	488,055	348,000	71
Kansas City	121,857	31,657	31,987	100
Topeka	64,120	17,468	18,586	100
Wichita	111,110	30,021	30,819	100
KENTUCKY	2,614,589	610,288	313,800	51
Covington	65,252	17,271	14,380	83
Lexington	45,736	12,060	13,102	100
Louisville	307,745	80,297	78,181	97
LOUISIANA	2,101,593	486,424	260,000	53
Baton Rouge	30,720	7,600	7,454	98
New Orleans	458,762	112,329	101,123	90
Shreveport	76,655	20,087	21,834	100
MAINE	797,423	198,372	163,600	82
Bangor	28,749	6,906	7,812	100
Lewiston	34,948	7,998	5,154	64
Portland	70,810	17,582	17,566	99
MARYLAND	1,631,526	386,087	320,000	83
Baltimore	804,874	194,491	211,300	100
Cumberland	37,747	8,909	7,553	85
Hagerstown	30,861	7,701	5,667	74
MAS'ACHUS'TS	4,249,614	1,024,527	946,900	92
Boston	781,188	180,451	170,220	94
Brockton	63,797	16,724	16,517	99

City and State	Population U. S. Census 1930	No. of Families U. S. Census 1930	Estimated No. of Radio Sets Jan. 1, 1936	Est. % of* Families Having Radio Sets
MASS.—Cont.				
Cambridge	113,643	27,524	25,268	92
Fall River	115,274	27,077	25,466	94
Haverhill	48,710	12,764	10,858	85
Holyoke	56,537	14,010	12,687	91
Lawrence	85,068	20,097	12,879	64
Lowell	100,234	23,805	21,841	92
Lynn	102,320	26,001	25,048	96
Malden	58,036	14,187	15,550	100
Medford	59,714	14,413	17,473	100
New Bedford	112,597	27,982	26,336	94
Newton	65,276	15,350	18,588	100
Pittsfield	49,677	12,093	11,540	95
Quincy	71,983	18,343	23,242	100
Somerville	103,908	25,552	23,509	92
Springfield	149,900	38,188	38,029	99
Worcester	195,311	46,020	43,045	94
MICHIGAN	4,842,325	1,183,157	936,600	79
Bay City	47,355	11,457	8,540	75
Dearborn	50,358	11,476	10,821	94
Detroit	1,568,662	371,344	345,672	93
Flint	156,492	37,757	36,139	96
Grand Rapids	168,592	43,567	41,657	96
Hamtramck	56,268	11,303	4,703	42
Highland Park	52,959	13,038	13,173	100
Jackson	55,187	14,335	12,725	89
Kalamazoo	54,786	13,867	13,349	96
Lansing	78,397	20,182	18,355	91
Pontiac	64,928	15,189	12,236	81
MINNESOTA	2,563,953	608,398	535,600	88
Duluth	101,463	23,984	23,522	98
Minneapolis	464,356	117,777	113,291	96
St. Paul	271,606	67,999	76,810	100
MISSISSIPPI	2,009,821	472,354	166,400	35
Jackson	48,282	11,130	11,787	100
Meridian	31,954	8,128	8,666	100
Vicksburg	22,943	6,861	5,573	81
MISSOURI	3,629,367	941,821	708,500	75
Kansas City	399,746	109,242	108,795	99
St. Joseph	80,935	21,065	21,164	100
St. Louis	821,960	215,680	240,200	100
Springfield	57,527	15,667	9,471	
				60
MONTANA	537,606	137,010	91,700	67
Butte	39,532	10,352	9,850	95
Great Falls	28,822	7,374	6,439	87
Missoula	14,657	3,924	5,548	100
NEBRASKA	1,377,963	343,781	266,800	78
Grand Island	18,041	4,555	4,258	93
Lincoln	75,933	20,229	20,893	100
Omaha	214,006	54,845	50,431	92

City and State	Population U. S. Census 1930	No. of Families U. S. Census 1930	Estimated No. of Radio Sets Jan. 1, 1936	Est. % of* Families Having Radio Sets
NEVADA	91,058	25,730	21,700	84
Las Vegas	5,165	1,476	1,429	97
Reno	18,529	5,093	5,220	100
Sparks	4,508	1,288	1,118	87
N. HAMPSHIRE	465,293	119,660	99,700	83
Concord	25,228	6,181	6,289	100
Manchester	76,834	18,832	18,332	97
Nashua	31,463	7,612	6,383	84
NEW JERSEY	4,041,334	987,616	897,500	91
Atlantic City	66,198	16,986	16,876	99
Bayonne	88,979	18,564	15,065	81
Camden	118,700	27,874	26,967	97
E. Orange	68,020	19,077	21,609	100
Elizabeth	114,589	26,772	27,323	100
Hoboken	59,261	13,655	10,010	73
Irvington	56,733	15,106	15,892	100
Jersey City	316,715	76,436	74,054	97
Newark	442,337	105,398	106,935	100
Passaic	62,959	14,847	11,221	76
Paterson	138,513	35,556	34,404	97
Trenton	123,356	27,183	26,286	97
Union City	58,659	16,127	14,464	90
NEW MEXICO	423,317	98,820	48,300	49
Albuquerque	26,570	6,821	7,143	100
Roswell	11,173	2,860	3,012	100
Sante Fe	11,176	2,625	2,748	100
NEW YORK	12,588,066	3,162,118	2,993,100	95
Albany	127,412	34,186	33,894	99
Binghamton	76,662	18,880	19,222	100
Buffalo	573,076	140,215	139,725	99
Mt. Vernon	61,499	15,361	18,959	100
New Rochelle	54,000	12,542	15,754	100
New York	6,930,446	1,728,695	1,730,595	100
Niagara Falls	75,460	17,626	17,969	100
Rochester	328,132	82,205	82,185	99
Schenectady	95,692	24,281	24,091	97
Syracuse	209,326	53,203	53,372	100
Troy	72,763	19,034	17,060	90
Utica	101,740	24,935	24,633	99
Yonkers	134,646	32,582	32,929	100
N. CAROLINA	3,170,276	645,245	341,800	53
Asheville	50,193	11,762	10,884	93
Charlotte	82,675	19,319	20,289	100
Durham	52,037	11,508	10,728	93
Greensboro	53,569	11,528	11,778	100
Winston-Salem	75,274	17,210	16,461	96
N. DAKOTA	680,845	145,382	100,500	69
Fargo	28,619	6,679	6,428	96
Grand Forks	17,112	4,032	3,567	88
Minot	16,099	3,639	3,948	100

U. S. POPULATION—RADIO SETS

City and State	Population U. S. Census 1930	No. of Families U. S. Census 1930	Estimated No. of Radio Sets Jan. 1, 1936	Est. % of* Families Having Radio Sets
TENNESSEE	2,616,556	601,578	328,900	55
Chattanooga	119,798	29,252	27,005	92
Knoxville	105,802	24,381	22,502	92
Memphis	253,143	68,452	62,268	91
Nashville	153,866	39,501	39,558	100
TEXAS	5,824,716	1,383,280	862,100	62
Austin	53,120	12,815	11,089	87
Beaumont	57,732	14,512	11,186	77
Dallas	260,475	67,376	72,421	100
El Paso	102,421	24,564	25,968	100
Ft. Worth	163,447	43,167	45,825	100
Galveston	52,938	13,635	15,200	100
Houston	292,352	75,681	80,123	100
Port Arthur	50,902	12,522	10,528	84
San Antonio	231,542	55,898	52,520	94
Waco	52,848	13,329	12,622	95
UTAH	507,847	116,254	85,000	73
Ogden	40,272	9,971	9,032	91
Provo	14,766	3,204	2,923	91
Salt Lake City	140,267	34,548	33,931	98
VERMONT	359,611	89,439	72,400	81
Burlington	24,789	6,028	6,521	100
Montpelier	7,837	1,959	1,850	94
Rutland	17,315	4,374	4,415	100
VIRGINIA	2,421,851	530,092	336,900	64
Lynchburg	40,661	9,357	10,416	100
Norfolk	129,710	31,991	34,331	100
Richmond	182,929	44,929	42,229	94
Roanoke	69,206	15,944	17,246	100
WASHINGTON	1,563,396	426,019	346,900	81
Seattle	365,583	101,794	101,419	99
Spokane	115,514	32,116	31,877	99
Tacoma	106,817	30,686	28,107	92
W. VIRGINIA	1,729,205	374,646	240,000	64
Charleston	60,408	14,128	14,236	100
Huntington	75,572	17,975	18,787	100
Wheeling	61,659	15,595	15,419	99
WISCONSIN	2,939,006	713,576	576,600	81
Kenosha	50,262	12,088	11,770	97
Madison	57,899	15,097	18,153	100
Milwaukee	578,249	143,879	145,760	100
Racine	67,542	16,845	15,104	90
WYOMING	225,565	57,218	44,600	78
Casper	16,619	4,663	4,965	100
Cheyenne	17,361	4,590	5,174	100
Sheridan	8,536	2,189	2,171	99
U. S.	122,775,047	29,980,146	22,869,000	76

*Based upon number of radio homes as at Jan. 1, 1936 and number of families per 1930 U. S. census, the latest authentic figures available. This accounts for the large number of cities showing 100% (or better) in this column.

City and State	Population U. S. Census 1930	No. of Families U. S. Census 1930	Estimated No. of Radio Sets Jan. 1, 1936	Est. % of* Families Having Radio Sets
OHIO	6,646,697	1,700,877	1,396,900	82
Akron	225,040	62,689	60,974	97
Canton	104,906	26,365	25,836	98
Cincinnati	451,160	122,832	123,540	100
Cleveland	900,429	222,131	218,969	99
Cleveland Hts.	50,945	13,271	15,926	100
Columbus	290,564	75,806	76,983	100
Dayton	200,982	52,839	52,459	99
Hamilton	52,176	13,219	11,346	86
Lakewood	70,509	19,656	23,774	100
Springfield	68,743	18,237	16,459	90
Toledo	290,718	74,205	74,603	100
Youngstown	170,002	39,101	39,658	100
OKLAHOMA	2,396,040	565,348	335,000	59
Muskogee	32,026	8,391	7,443	89
Oklahoma City	185,389	47,394	45,918	97
Tulsa	141,258	37,156	36,889	99
OREGON	953,786	267,690	216,400	81
Eugene	18,901	5,358	4,299	80
Portland	301,815	87,375	83,800	96
Salem	26,266	6,788	6,774	99
PEN'SYLVANIA	9,631,350	2,239,179	1,938,400	87
Allentown	92,563	22,838	32,718	100
Altoona	82,054	20,005	17,028	85
Bethlehem	57,892	13,570	15,443	100
Chester	59,164	13,579	13,024	96
Erie	115 967	28,252	25,828	91
Harrisburg	80,339	21,652	22,393	100
Johnstown	66,993	15,076	13,060	87
Lancaster	59,949	15,433	15,609	100
McKeesport	54,632	12,484	10,990	88
Philadelphia	1,950,961	459,629	430,300	94
Pittsburgh	669,817	155,519	159,623	100
Reading	111,171	27,706	29,146	100
Scranton	143,433	32,988	33,168	100
Wilkes-Barre	86,626	18,752	16,815	90
RHODE ISLA'D	687,497	165,811	150,000	90
Pawtucket	77,149	19,121	19,304	100
Providence	252,981	61,628	57,470	93
Woonsocket	49,376	11,253	9,971	89
S. CAROLINA	1,738,765	366,265	174,600	48
Charleston	62,265	16,746	11,936	71
Columbia	51,581	11,239	10,867	97
Greenville	20,154	7,223	11,168	100
S. DAKOTA	692,849	161,332	107,000	66
Aberdeen	16,465	4,058	3,382	83
Pierre	3,659	851	876	100
Sioux Falls	33,362	8,248	7,442	90

Technical Definitions*

"A" Power Supply A power supply device providing heating current for the cathode of a vacuum tube.

Alternating Current A current, the direction of which reverses at regularly recurring intervals, the algebraic average value being zero.

Amplification Factor A measure of the effectiveness of the grid voltage relative to that of the plate voltage in affecting the plate current.

Amplifier A device for increasing the amplitude of electric current, voltage or power, through the control by the input power of a larger amount of power supplied by a local source to the output circuit.

Anode An electrode to which an electron stream flows.

Antenna A conductor or a system of conductors for radiating or receiving radio waves.

Atmospherics Strays produced by atmospheric conditions.

Attenuation The reduction in power of a wave or a current with increasing distance from the source of transmission.

Audio Frequency A frequency corresponding to a normally audible sound wave. The upper limit ordinarily lies between 10,000 and 20,000 cycles.

Audio-Frequency Transformer A transformer for use with audio-frequency currents.

Autodyne Reception A system of heterodyne reception through the use of a device which is both an oscillator and a detector.

Automatic Volume Control A self-acting device which maintains the output constant within relatively narrow limits while the input voltage varies over a wide range.

"B" Power Supply A power supply device connected in the plate circuit of a vacuum tube.

Baffle A partition which may be used with an acoustic radiator to impede circulation between front and back.

Band-Pass Filter A filter designed to pass currents of frequencies within a continuous band limited by an upper and a lower critical or cut-off frequency and substantially reduce the amplitude of currents of all frequencies outside of that band.

Beat A complete cycle of pulsations in the phenomenon of beating.

Beat Frequency The number of beats per second. This frequency is equal to the difference between the frequencies of the combining waves.

Beating A phenomenon in which two or more periodic quantities of different frequencies react to produce a resultant having pulsations of amplitude.

Broadcasting Radio transmission intended for general reception.

By-Pass Condenser A condenser used to provide an alternating-current path of comparatively low impedance around some circuit element.

"C" Power Supply A power supply device connected in the circuit between the cathode and grid of a vacuum tube so as to apply a grid bias.

Capacitive Coupling The association of one circuit with another by means of capacity common or mutual to both.

Carbon Microphone A microphone which depends for its operation upon the variation in resistance of carbon contacts.

Carrier A term broadly used to designate carrier wave, carrier current, or carrier voltage.

Carrier Frequency The frequency of a carrier wave.

Carrier Suppression That method of operation in which the carrier wave is not transmitted.

Carrier Wave A wave which is modulated by a signal and which enables the signal to be transmitted through a specific physical system.

Cathode The electrode from which the electron stream flows. (See Filament.)

Choke Coil An inductor inserted in a circuit to offer relatively large impedance to alternating current.

Class A Amplifier A class A amplifier is an amplifier in which the grid bias and alternating grid voltages are such that plate current in a specific tube flows at all times.

Class AB Amplifier A class AB amplifier is an amplifier in which the grid bias and alternating grid voltages are such that plate current in a specific tube flows for appreciably more than half but less than the entire electrical cycle.

Class B Amplifier A class B amplifier is an amplifier in which the grid bias is approximately equal to the cut-off value so that the plate current is approximately zero when no exciting grid voltage is applied, and so that plate current in a specific tube flows for approximately one-half of each cycle when an alternating grid voltage is applied.

Class C Amplifier A class C amplifier is an amplifier in which the grid bias is appreciably greater than the cut-off value so that the plate current in each tube is zero when no alternating grid voltage is applied, and so that plate current flows in a specific tube for appreciably less than one-half of each cycle when an alternating grid voltage is applied.

Note:—To denote that grid current does not flow during any part of the input cycle, the suffix 1 may be added to the letter or letters of the class identification. The suffix 2 may be used to denote that grid current flows during some part of the cycle.

Condenser Loud Speaker A loud speaker in which the mechanical forces result from electrostatic reactions.

Condenser Microphone A microphone which depends for its operation upon variations in capacitance.

Continuous Waves Continuous waves are waves in which successive cycles are identical under steady state conditions.

Conversion Transconductance is the ratio of the magnitude of a single beat-frequency component ($f_1 + f_2$) or ($f_1 - f_2$) of the output current to the magnitude of the input voltage of frequency f_1 under the conditions that all direct voltages and the magnitude of the second input alternating voltage f_2 must remain constant. As most precisely used, it refers to an infinitesimal magnitude of the voltage of frequency f_1.

Converter (generally, in superheterodyne receivers.) A converter is a vacuum-tube which performs simultaneously the functions of oscillation and mixing (first detection) in a radio receiver.

Coupling The association of two circuits in such a way that energy may be transferred from one to the other.

Cross Modulation A type of intermodulation due to modulation of the carrier of the desired signal in a radio apparatus by an undesired signal.

Current Amplification The ratio of the alternating current produced in the output circuit of an amplifier to the alternating current supplied to the input circuit for specific circuit conditions.

Cycle One complete set of the recurrent values of a periodic phenomenon.

Damped Waves Waves of which the amplitude of successive cycles, at the source, progressively diminishes.

Decibel The common transmission unit of the decimal system, equal to $1/_{10}$ bel.

$$1 \text{ bel}=2 \log_{10} \frac{E_1}{E_2}=2 \log_{10} \frac{I_1}{I_2}$$

(See Transmission Unit)

Detection is any process of operation on a modulated signal wave to obtain the signal imparted to it in the modulation process.

Detector A detector is a device which is used for operation on a signal wave to obtain the signal imparted to it in the modulation process.

Diaphragm A diaphragm is a vibrating surface which produces sound vibrations.

Diode A type of thermionic tube containing two electrodes which passes current wholly or predominantly in one direction.

Direct Capacitance (C) between two conductors—The ratio of the charge produced on one conductor by the voltage between it and the other conductor, divided by this voltage, all other conductors in the neighborhood being at the potential of the first conductor.

Direct Coupling The association of two circuits by having an inductor, a condenser, or a resistor common to both circuits.

Direct Current A unidirectional current. As ordinarily used, the term designates a practically non-pulsating current.

Distortion A change in wave form occurring in a transducer or transmission medium when the output wave form is not a faithful reproduction of the input wave form.

Double Modulation The process of modulation in which a carrier wave of one frequency is first modulated by the signal wave and is then made to modulate a second carrier wave of another frequency.

Dynamic Amplifier The RCA Dynamic Amplifier is a variable gain audio amplifier, the gain of which is proportional to the average intensity of the audio signal. Such an amplifier compensates for the contraction of volume range required because of recording or transmission line limitations.

Dynamic Sensitivity of a Phototube The alternating-current response of a phototube to a pulsating light flux at specified values of mean light flux, frequency of pulsation, degree of pulsation, and steady tube voltage.

Electro-Acoustic Transducer A transducer which is actuated by power from an electrical system and supplies power to an acoustic system or vice versa.

Electron Emission The liberation of electrons from an electrode into the surrounding space. In a vacuum tube it is the rate at which the electrons are emitted from a cathode. This is ordinarily measured as the current carried by the electrons under the influence of a voltage sufficient to draw away all the electrons.

Electron Tube A vacuum tube evacuated to such a degree that its electrical characteristics are due essentially to electron emission.

Emission Characteristic A graph plotted between a factor controlling the emission (such as the temperature, voltage, or current of the cathode) as abscissas, and the emission from the cathode as ordinates.

Facsimile Transmission The electrical transmission of a copy or reproduction of a picture, drawing or document. (This is also called picture transmission.)

Fading The variation of the signal intensity received at a given location from a radio transmitting station as a result of changes occurring in the transmission path. (See Distortion.)

Fidelity The degree to which a system, or a portion of a system, accurately reproduces at its output the signal which is impressed upon it.

Filament A cathode in which the heat is supplied by current passing through the cathode.

Filter A selective circuit network, designed to pass currents within a continuous band or bands of frequencies or direct current, and substantially reduce the amplitude of currents of undesired frequencies.

Frequency The number of cycles per second.

Full-Wave Rectifier A double element rectifier arranged so that current is allowed to pass in the same direction to the load circuit during each half cycle of the alternating-current supply, one element functioning during one-half cycle and the other during the next half cycle, and so on.

Fundamental Frequency The lowest component frequency of a periodic wave or quantity.

Fundamental or Natural Frequency (of an antenna). The lowest resonant frequency of an antenna, without added inductance or capacity.

Gas Phototube A type of phototube in which a quantity of gas has been introduced, usually for the purpose of increasing its sensitivity.

Grid An electrode having openings through which electrons or ions may pass.

Grid Bias The direct component of the grid voltage.

Grid Condenser A series condenser in the grid or control circuit of a vacuum tube.

Grid Leak A resistor in a grid circuit, through which the grid current flows, to affect or determine a grid bias.

Grid-Plate Transconductance The name for the plate current to grid voltage transconductance. (This has also been called mutual conductance.)

Ground System (of an antenna) That portion of the antenna system below the antenna loading devices or generating apparatus most closely associated with the ground and including the ground itself.

Ground Wire A conductive connection to the earth.

Half-Wave Rectifier A rectifier which changes alternating current into pulsating current, utilizing only one-half of each cycle.

Harmonic A component of a periodic quantity having a frequency which is an integral multiple of the fundamental frequency. For example, a component the frequency of which is twice the fundamental frequency is called the second harmonic.

Heater An electrical heating element for supplying heat to an indirectly heated cathode.

Heterodyne Reception The process of receiving radio waves by combining in a detector a received voltage with a locally generated alternating voltage. The frequency of the locally generated voltage is commonly different from that of the received voltage. (Heterodyne reception is sometimes called beat reception.)

Homodyne Reception A system of reception by the aid of a locally generated voltage of carrier frequency. (Homodyne reception is sometimes called zero-beat reception.)

Hot-Wire Ammeter, Expansion Type An ammeter dependent for its indications on a change in dimensions of an element which is heated by the current to be measured.

Indirectly Heated Cathode A cathode of a thermionic tube, in which heat is supplied from a source other than the cathode itself.

Induction Loud Speaker is a moving coil loud speaker in which the current which reacts with the polarizing field is induced in the moving member.

Inductive Coupling The association of one circuit with another by means of inductance common or mutual to both.

Interelectrode Capacitance The direct capacitance between two electrodes.

Interference Disturbance of reception due to strays, undesired signals, or other causes; also, that which produces the disturbance.

Intermediate Frequency, in Superheterodyne Reception A frequency between that of the carrier and the signal, which results from the combination of the carrier frequency and the locally generated frequency.

Intermodulation The production, in a non-linear circuit element, of frequencies corresponding to the sums and differences of the fundamentals and harmonics of two or more frequencies which are transmitted to that element.

Interrupted Continuous Waves Interrupted continuous waves are waves obtained by interruption at audio frequency in a substantially periodic manner of otherwise continuous waves.

Kilocycle When used as a unit of frequency, is a thousand cycles per second.

Lead-In That portion of an antenna system which completes the electrical connection between the elevated outdoor portion and the instruments or disconnecting switches inside the building.

Linear Detection That form of detection in which the audio output voltage under consideration is substantially proportional to the modulation envelope throughout the useful range of the detecting device.

Loading Coil An inductor inserted in a circuit to increase its inductance but not to provide coupling with any other circuit.

Loud Speaker A telephone receiver designed to radiate acoustic power into a room or open air.

Magnetic Loud Speaker One in which the mechanical forces result from magnetic reactions.

Magnetic Microphone A microphone whose electrical output results from the motion of a coil or conductor in a magnetic field.

Master Oscillator An oscillator of comparatively low power so arranged as to establish the carrier frequency of the output of an amplifier.

Megacycle When used as a unit of frequency, is a million cycles per second.

Mercury-Vapor Rectifier. A mercury-vapor rectifier is a two electrode, vacuum-tube rectifier which contains a small amount of mercury. During operation, the mercury is vaporized. A characteristic of mercury-vapor rectifiers is the low-voltage drop in the tube.

Microphone A microphone is an electro-acoustic transducer actuated by power in an acoustic system and delivering power to an electric system, the wave form in the electric system corresponding to the wave form in the acoustic system. This is also called a telephone transmitter.

Mixer Tube (generally, in superheterodyne receivers.) A mixer tube is one in which a locally generated frequency is combined with the carrier-signal frequency to obtain a desired beat frequency.

Modulated Wave A modulated wave is a wave of which either the amplitude, frequency, or phase is varied in accordance with a signal.

Power Detection That form of detection in which the power output of the detecting device is used to supply a substantial amount of power directly to a device such as a loud speaker or recorder.

Pulsating Current A periodic current, that is, current passing through successive cycles, the algebraic average value of which is not zero. A pulsating current is equivalent to the sum of an alternating and a direct current.

Push-Pull Microphone One which makes use of two functioning elements 180 degrees out of phase.

Radio Channel A band of frequencies or wavelengths of a width sufficient to permit of its use for radio communication. The width of a channel depends upon the type of transmission. (See Band of Frequencies.)

Radio Compass A direction finder used for navigational purposes.

Radio Frequency A frequency higher than those corresponding to normally audible sound waves. (See Audio Frequency.)

Radio-Frequency Transformer A transformer for use with radio-frequency currents.

Radio Receiver A device for converting radio waves into perceptible signals.

Radio Transmission The transmission of signals by means of radiated electromagnetic waves originating in a constructed circuit.

Radio Transmitter A device for producing radio-frequency power, with means for producing a signal.

Rectifier A device having an asymmetrical conduction characteristic which is used for the conversion of an alternating current into a pulsating current. Such devices include vacuum-tube rectifiers, gas rectifiers, oxide rectifiers, electrolytic rectifiers, etc.

Reflex Circuit Arrangement A circuit arrangement in which the signal is amplified, both before and after detection, in the same amplifier tube or tubes.

Regeneration The process by which a part of the output power of an amplifying device reacts upon the input circuit in such a manner as to reinforce the initial power, thereby increasing the amplification. (Sometimes called "feedback" or "reaction.")

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

Resonance Frequency (of a reactive circuit)—The frequency at which the supply current and supply voltage of the circuit are in phase.

Rheostat A resistor which is provided with means for readily adjusting its resistance.

Screen Grid A screen grid is a grid placed between a control grid and an anode, and maintained at a fixed positive potential, for the purpose of reducing the electrostatic influence of the anode in the space between the screen grid and the cathode.

Secondary Emission Electron emission under the influence of electron or ion bombardment.

Modulation is the process in which the amplitude, frequency, or phase of a wave is varied in accordance with a signal, or the result of that process.

Modulator A device which performs the process of modulation.

Monochromatic Sensitivity The response of a phototube to light of a given color, or narrow frequency range.

Moving-Armature Speaker A magnetic speaker whose operation involves the vibration of a portion of the ferromagnetic circuit. (This is sometimes called an electromagnetic or a magnetic speaker.)

Moving Coil Loud Speaker A moving coil loud speaker is a magnetic loud speaker in which the mechanical forces are developed by the interaction of currents in a conductor and the polarizing field in which it is located. This is sometimes called an Electro-Dynamic or a Dynamic Loud Speaker.

Mu-Factor A measure of the relative effect of the voltages on two electrodes upon the current in the circuit of any specified electrode. It is the ratio of the change in one electrode voltage to a change in the other electrode voltage, under the condition that a specified current remains unchanged.

Mutual Conductance (See Grid-Plate Transconductance.)

Oscillator A non-rotating device for producing alternating current, the output frequency of which is determined by the characteristics of the device.

Oscillatory Circuit A circuit containing inductance and capacitance, such that a voltage impulse will produce a current which periodically reverses.

Pentode A type of thermionic tube containing a plate, [illegible]athode, and three additional electrodes. (Ordi[illegible]ly the three additional electrodes are of the [illegible]e of grids.)

P[illegible]age Modulation The ratio of half the differ[illegible] between the maximum and minimum amplit[illegible] of a modulated wave to the average amplitude, e[illegible]essed in per cent.

Phonograph Pickup An electromechanical transducer actuated by a phonograph record and delivering power to an electrical system, the wave form in the electrical system corresponding to the wave form in the phonograph record.

Phototube A vacuum tube in which electron emission is produced by the illumination of an electrode. (This has also been called photo-electric tube.)

Plate A common name for the principal anode in a vacuum tube.

Power Amplification (of an amplifier)—The ratio of the alternating-current power produced in the output circuit to the alternating-current power supplied to the input circuit.

Selectivity The degree to which a radio receiver is capable of differentiating between signals of different carrier frequencies.

Sensitivity The degree to which a radio receiver responds to signals of the frequency to which it is tuned.

Sensitivity of a Phototube The electrical current response of a phototube, with no impedance in its external circuit, to a specified amount and kind of light. It is usually expressed in terms of the current for a given radiant flux, or for a given luminous flux. In general the sensitivity depends upon the tube voltage, flux intensity, and spectral distribution of the flux.

Service Band A band of frequencies allocated to a given class of radio communication service.

Side Bands The bands of frequencies, one on either side of the carrier frequency, produced by the process of modulation.

Signal The intelligence, message or effect conveyed in communication.

Single-Side-Band Transmission That method of operation in which one side band is transmitted, and the other side band is suppressed. The carrier wave may be either transmitted or suppressed.

Static Strays produced by atmospheric conditions.

Static Sensitivity of a Phototube The direct current response of a phototube to a light flux of specified value.

Stopping Condenser A condenser used to introduce a comparatively high impedance in some branch of a circuit for the purpose of limiting the flow of low-frequency alternating current or direct current without materially affecting the flow of high frequency alternating current.

Strays Electromagnetic disturbances in radio reception other than those produced by radio transmitting systems.

Superheterodyne Reception—Superheterodyne reception is a method of reception in which the received voltage is combined with the voltage from a local oscillator and converted into voltage of an intermediate frequency which is usually amplified and then detected to reproduce the original signal wave. (This is sometimes called double detection or supersonic reception.)

Swinging The momentary variation in frequency of a received wave.

Telephone Receiver An electro-acoustic transducer actuated by power from an electrical system and supplying power to an acoustic system, the wave form in the acoustic system corresponding to the wave form in the electrical system.

Television The electrical transmission of a succession of images and their reception in such a way as to give a substantially continuous reproduction of the object or scene before the eye of a distant observer.

Tetrode A type of thermionic tube containing a plate, a cathode, and two additional electrodes. (Ordinarily the two additional electrodes are of the nature of grids.)

Thermionic Relating to electron emission under the influence of heat.

Thermionic Emission Electron or ion emission under the influence of heat.

Thermionic Tube An electron tube in which the electron emission is produced by the heating of an electrode.

Thermocouple Ammeter An ammeter dependent for its indications on the change in thermo-electromotive force set up in a thermo-electric couple which is heated by the current to be measured.

Total Emission The value of the current carried by electrons emitted from a cathode under the influence of a voltage such as will draw away all the electrons emitted.

Transconductance The ratio of the change in the current in the circuit of an electrode to the change in the voltage on another electrode, under the condition that all other voltages remain unchanged.

Transducer A device actuated by power from one system and supplying power to another system. These systems may be electrical, mechanical, or acoustic.

Transmission Unit A unit expressing the logarithmic ratios of powers, voltages, or currents in a transmission system. (See Decibel.)

Triode A type of thermionic tube containing an anode, a cathode, and a third electrode, in which the current flowing between the anode and the cathode may be controlled by the voltage between the third electrode and the cathode.

Tuned Transformer A transformer whose associated circuit elements are adjusted as a whole to be resonant at the frequency of the alternating current supplied to the primary, thereby causing the secondary voltage to build up to higher values than would otherwise be obtained.

Tuning The adjustment of a circuit or system to secure optimum performance in relation to a frequency; commonly, the adjustment of a circuit or circuits to resonance.

Vacuum Phototube A type of phototube which is evacuated to such a degree that the residual gas plays a negligible part in its operation.

Vacuum Tube A device consisting of a number of electrodes contained within an evacuated enclosure.

Vacuum-Tube Transmitter A radio transmitter in which vacuum tubes are utilized to convert the applied electric power into radio-frequency power.

Vacuum-Tube Volt-Meter A device utilizing the characteristics of a vacuum tube for measuring alternating voltages.

Voltage Amplification The ratio of the alternating voltage produced at the output terminals of an amplifier to the alternating voltage impressed at the input terminals.

Voltage Divider A resistor provided with fixed or movable contacts and with two fixed terminal contacts;

current is passed between the terminal contacts, and a desired voltage is obtained across a portion of the resistor. (The term potentiometer is often erroneously used for this device.)

Wave a. A propagated disturbance, usually periodic, as an electric wave or sound wave,
b. A single cycle of such a disturbance, or,
c. A periodic variation as represented by a graph.

Wavelength The distance traveled in one period or cycle by a periodic disturbance.

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*Most of these definitions are based on I.R.E. Standards.

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New RCA Check-Up

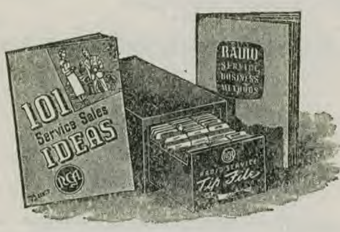
A wealth of brand new sales helps—a new 10-point offer and new window displays are but a few of the many new features of the RCA Check-Up for 1937. Not only does the new Check-Up have greater customer appeal, but it enables the service engineer to make attractive combination offers which build up a greater dollar volume for him.

The RCA Check-Up, which now enters its third year of highly successful operation, is a simple means by which a service engineer or radio dealer may get in touch with customers who ordinarily would not call for a radio service engineer. It features a special 10-point job at a flat price. The job, which has obvious benefits for the customer, nevertheless costs little to perform and opens the way for the sale of tubes, parts or accessories. The service engineer is assured the flat price which more than covers any actual expense. Experience has shown that practically always additional merchandise is sold, all of which makes the RCA Check-Up a valuable, business-building program.

RCA Radio Tube Distributors are now featuring the 1937 RCA Check-Up on a number of attractive plans. They will be glad to show you the many unusual mailing pieces, the new window displays and many other important sales helps. See your distributor at once.

RCA Three-Point Service System

The RCA Three-Point Service System offers the service engineer or radio dealer help in the three fundamental phases of his business—the technical, the promotional and the accounting. These aids are based on actual experience and reach the basic needs of everyone engaged in the radio or service retail field.



The RCA Service Tip File is a collection of service tips, indexed both as to symptoms and set manufacture. Two hundred cards are included with the initial equipment and additional packets of twenty tips each are available for supplementing the file.

"101 Service Sales Ideas" is a unique booklet containing 101 actual selling ideas that have been used successfully in the radio service and retail business. While all the ideas will not apply to all organizations, nevertheless there are many that everyone can use.

"Radio Service Business Methods," by John F. Rider and J. Van Newenhizen, is a 220-page book that covers every phase of operating a radio business. It shows how to properly arrive at the cost of operation, how to compute overhead, and many other items of selling and service expense. Supplementing this book is a complete series of forms, supplied at low prices and imprinted with your name.

RCA Radio Tube Distributors are now featuring each unit of the RCA Three-Point Service System on unusually liberal terms. See your distributor at once.

Receiver Circuit Analysis

All receivers are built around the vacuum tube used as amplifier, detector, rectifier or oscillator. Whenever an open or short occurs in the filament, plate, grid or screen-grid circuit of a vacuum tube, it will have a definite effect upon the voltage and current readings obtained at these different tube elements with an analyzer.

The analyzer is designed to indicate the variations caused by such opens or shorts, and thus enables the service man to determine in which tube circuit the abnormal condition exists. Having done this the analyzer has done all that it is possible for an instrument to do. It now remains for the service man to decide (by analytic reasoning based on previous experience and thought on trouble shooting problems) in which portion of that particular tube's circuits the trouble is.

On the following pages will be found 4 fundamental, schematic diagrams of the complete filament, grid and screen-grid circuits for:

1. Filament type triodes and screen-grid tubes.
2. Heater-cathode type triodes and screen-grid tubes.
3. Filament type pentodes (voltage or power amplifiers.)
4. Heater-cathode type pentodes (voltage or power amplifiers.)

The various circuits are numbered as:

Example:

1 = grid return from grid of tubes to negative C in grid circuit.

2 = plate circuit from positive B on voltage divider to plate of tube.

On a following page will be found a chart listing the effects noted (as compared to the normal readings) when the various circuits or parts are open or shorted. By the use of this chart, knowing what normal conditions are, and how the abnormal conditions compare with them, it is possible for a service man to narrow his tracing of the suspected tube circuit, down to the testing of one or two of the parts of that circuit.

Diagrams No. 1 and No. 2 apply equally as well to triodes of the filament and cathode-heater types by omitting circuit No. 13 and condenser No. 7 which apply to screen-grid types only.

It will be noted that circuit No. 14 in diagrams No. 3 and No. 4 applies only to a pentode. It represents the connection between the suppressor grid (located between the space charge or screen-grid and plate) and the cathode, or to a point in the circuit whose potential is more negative than the cathode. Since the suppressor grid serves the same purpose (i. e., to practically eliminate the effects of secondary emission) whether the tube be a radio-frequency pentode, such as the 57, or whether it be a power-output pentode, such as the 47, diagrams No. 3 and No. 4 apply equally as well to both types of tubes. The effects upon normal voltage readings when this circuit opens are listed under circuit No. 14 on the following chart. In certain tube types, such as the 47, circuit No. 14 is made within the tube, as indicated by the dotted lines in Fig. 3. An open in this internal connection will cause the same analyzer readings as those noted under circuit No. 14 in the accompanying chart.

Diagram No. 4 applies to triple-grid amplifiers, such as the 89, when used as a pentode power amplifier. When this tube is used as a class A or B amplifier, it would then be classified as a triode, and in this case diagram No. 2 would apply. For information on the operation and connections of the grids of a triple-grid amplifier when used in class A or B amplifier circuits, refer to the set manufacturer's service notes.

Example:

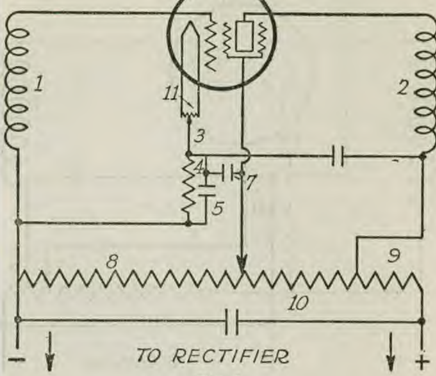
If it is found that the readings at one tube socket show E_{c1} = above normal, I_b = o, E_b = o, E_{kf} = above normal; referring to the chart we see that when this condition exists it indicates a short in No. 6—(the plate by-pass condenser)—when its return is connected to positive side of grid-bias resistor No. 4, or it indicates an open in the cathode circuit through conductor No. 3 or grid-bias resistor No. 4.

The meaning of the symbols used in the reference chart are as follows:—

E_{c1} = Grid voltage or control grid on S. G. tubes.
E_{kf} = Cathode voltage on cathode heater tube.
E_b = Plate voltage.
E_{c2} = Screen grid voltage.
E_{c3} = Suppressor grid voltage.
I_b = Plate current.

S = Shorted.
L = Leaking.
Op = Open.
O = Zero voltage or current.
Lo = Below normal.
Hi = Above normal.
Nor = Normal.
F = Fluctuating.

Note: In servicing modern receivers it is extremely desirable that the service man use the set manufacturer's service notes. These will be found to be of great assistance in locating troubles and applying the correct remedy. Most radio set manufacturers will gladly furnish responsible service men with service notes on any model of their receivers upon a written request to the manufacturer's service department.


1
11
2
3
4
7
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8
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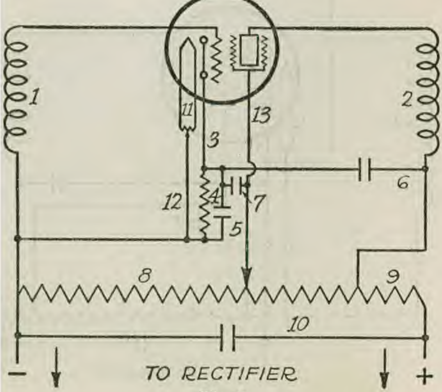
10
TO RECTIFIER
−
+

Fig. 1


1
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13
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6
12
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7
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8
9
10
TO RECTIFIER
−
+

Fig. 2

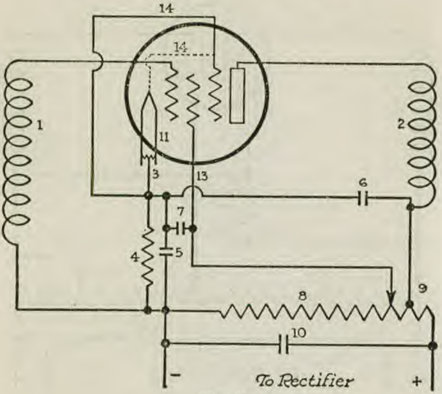

14
14
1
2
11
3
13
6
7
4
5
8
9
10
-
To Rectifier
+

Fig. 3

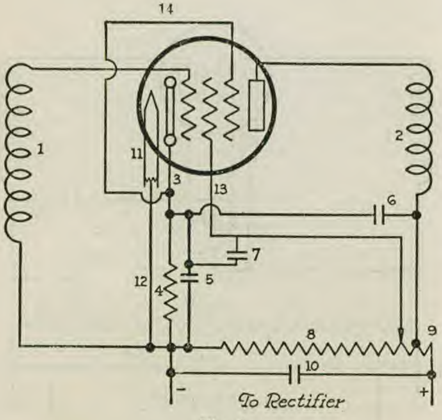

14
1
2
11
3
13
6
7
12
4
5
8
9
10
-
To Rectifier
+

Fig. 4

Receiver Circuit Analysis

Circuit No.	Condition	E_{c1}	E_{c2}	I_{c2}	I_b	E_b	E_{kf}	E_{c3}
1	Op	0	Lo	Hi	Hi	Lo	Hi	
* 2	Op	0	Nor	Hi	0	0	0	
† 3	Op	Hi	0	0	0	0	Hi	
4	Op	Hi	0	0	0	0	Hi	
5	S	0	Lo	Hi	Hi	Lo	0	
5	L	F or Lo	Nor	Nor	F or Hi	F or Lo	F or Lo	
5	Op	Nor	Nor	Nor	Nor	Nor	Nor	
‡ 6	S	Hi	0	0	0	0	Hi	
6	L	F or Hi	F or Lo	F or Lo	F or Lo	F or Lo	F or Hi	
6	Op	Nor	Nor	Nor	Nor	Nor	Nor	
‡ 7	S	Hi	0	0	0	Lo	Hi	
7	L	F or Hi	F or Lo	F or Lo	F or Lo	F or Lo	F or Hi	
7	Op	Nor	Nor	Nor	Nor	Nor	Nor	
8	Op	Hi	Hi	Hi	Hi	Hi	Hi	
9	Op	0	0	0	0	0	0	
10	S	0	0	0	0	0	0	
11	Op	Nor	Nor	Nor	Nor	Nor	Nor	Hum
12	Op	Nor	Nor	Nor	Nor	Nor	0	Hum
13	Op	0	0	0	0	Hi	0	
14	Op	Nor	Nor	Hi	Lo	Nor	Nor	Hi

Exceptions:

*E_{c1} = 0 when Individual Bias Resistor.

E_{c1} = Lo when Common Bias Resistor, or S. G. Tube.

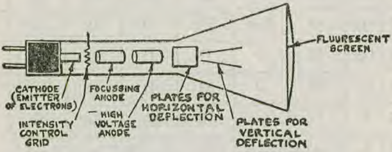
†E_{c1} & E_{kf} = Hi when Individual Bias Resistor.

E_{c1} & E_{kf} = Lo when Common Bias Resistor.

‡E_{c1} and E_{kf} = 0 when condenser return is to neg. end No. 4 o[r]
Neg. Rectifier.

How The Cathode-Ray Tube Works

Since the cathode-ray tube is comparatively new in he field of electronic devices, information concerning ts functioning may be of interest. The schematic liagram shows the essential parts of a typical cathode-ay tube of the electrostatic-deflection type.



RCA Cathode-Ray Tube

Electrons emitted by the cathode are attracted by the positive voltages on the focusing anode and on the high-voltage anode. Some of these electrons pass through the two anodes, which are hollow cylinders, and flowing down the length of the tube, form a concentrated electron beam. The inner surface of the large end of the bulb is coated with a layer (called the screen) of a material which fluoresces wherever electrons strike it. Hence the beam of electrons flowing down the tube produces a spot of light on the screen at the end of the tube. Focusing of the spot is accomplished by adjusting the ratio of the anode voltages. The brightness of the spot is controlled by the negative voltage applied to the control grid, which regulates the amount of current in the electron beam. The voltages on the focusing anode and on the control grid are usually adjusted simultaneously so that the spot is sufficiently bright and of small size.

The position of the spot on the fluorescent screen is controlled by the voltages on the deflecting plates. When a voltage is connected across one of the sets of deflecting plates so that one plate is positive with respect to the other, the electrons in the beam are attracted toward the positive plate. Hence, the electrons in the beam are deflected and the position of the spot on the screen changes. One set of plates provides horizontal deflection of the beam; the other provides vertical deflection.

When the cathode-ray tube is used to observe an alternating voltage, the voltage under observation is applied to give vertical displacement of the light spot. A "linear sweep" voltage is applied to give horizontal displacement. With this arrangement, the spot traces on the screen a curve which shows the waveform of the voltage being observed.

The Cathode-Ray Oscillograph

A cathode-ray oscillograph consists of a cathode-ray tube and its associated apparatus, conveniently assembled with all necessary controls and switches. Thi associated apparatus usually consists of a "saw-tooth oscillator, which provides the linear sweep voltag vertical and horizontal amplifiers for increasing th image size on low input voltages, and the necessar power supply equipment. The RCA Oscillograph is a example of the better types of oscillographs now on th market.

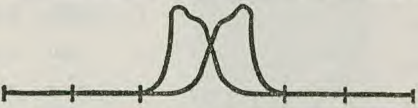
Applications of the Oscillograph

For quickly disclosing the source of trouble in a radi receiver, the cathode-ray oscillograph is ideal. How ever, the service engineer must have an understandin of the use of the oscillograph to be able to take fu advantage of its capabilities.

First, the oscillograph should be recognized as an ir strument that shows effect, rather than cause. Fo example, numerous troubles can be identified an isolated in a particular section of the circuit with th oscillograph, but the actual testing of the parts mus be done with other equipment.

Distortion and Hum. In a receiver having objec tionable distortion, the cause of the distortion can easil be located with the aid of an oscillograph. One way t do this is to apply the output of a signal generator t the input of the receiver and observe on the oscillograp the output of successive stages. If, for instance, th waveform appears undistorted at the input of the firs audio stage but is distorted at the output of this stag distortion obviously is being produced in this stag Similarly, a method of locating the source of hum in set is to examine the waveform of the output of suc cessive filter sections.

Aligning Receivers. Perhaps one of the most spec tacular uses of the cathode-ray oscillograph is the visua alignment of receivers. In this application, a tes oscillator is controlled by a frequency modulator so tha the output voltage of the oscillator varies in frequency This voltage of varying frequency is applied to th input of the stage being checked. The cathode-ray tub is connected to show the curve of gain-vs.-frequency fo

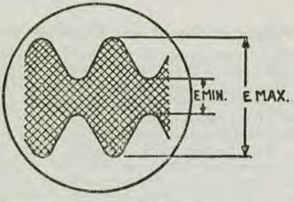


I. F. Curve Showing Double Image Method of Alignment

the stage. With this curve in view, the operator ca easily adjust the trimmers to give peak gain at the cor rect frequency in each stage as it is checked. In th more advanced instruments, the r-f frequency is swep in both directions and a double curve is shown on th screen, adjustment being made with the trimme capacitors until the curves coincide.

Measuring Percentage Modulation.

Modulation may be quickly checked with the oscillograph, either for percentage or for distortion. This is done by impressing the modulated r-f signal on the vertical plates and the linear timing voltage on the horizontal



R. F. Modulated at 1000 Cycles
Timing Axis Supply: 500-Cycle Saw-Tooth

$$\text{Per cent Modulation} = \frac{\text{EMax.} - \text{EMin.}}{\text{EMax.} + \text{EMin.}} \times 100$$

plates. The true wave shape of the r-f envelope will appear and an appreciable lack of symmetry or other irregularities will be immediately apparent, indicating distortion. The percentage modulation is determined as shown in the illustration.

Type	RCA CATHODE-RAY TUBES	Electrodes	Max. Anode No. 2 Volts	Cathode Volts
904	5 in., Electrostatic-Magnetic Deflection, High-Vacuum	5	4,600	2.5
905	5 in., Electrostatic-Deflection, High-Vacuum	4	2,000	2.5
906	3 in., Electrostatic Deflection, High-Vacuum	4	1,200	2.5
907	5 in., Electrostatic Deflection, High-Vacuum, Short Persistence Screen	4	2,000	2.5
908	3 in., Electrostatic Deflection, High-Vacuum, Short Persistence Screen	4	1,200	2.5
909	5 in., Electrostatic Deflection, High-Vacuum, Long Persistence Screen	4	2,000	2.5
910	3 in., Electrostatic Deflection, High-Vacuum, Long Persistance Screen	4	1,200	2.5
911	3 in., Electrostatic Deflection, High-Vacuum, Medium Persistence Screen, with Gun Unusually Free from Magnetization Effects	4	1,200	2.5
912	5 in., Electrostatic Deflection, High-Vacuum, Medium Persistence Screen	4	15,000	2.5

Calculation and Use of Shunts and Multipliers

Primarily, all electric meters of the indicating type having only two terminals are essentially current measuring devices and in fact are ammeters or milliammeters, as it is only the current flowing through the meter that causes mechanical motion and deflection of the needle.

However, we may calibrate the meter scale so that the needle deflection will accurately read ohms, volts, microfarads, etc., or any one of the electrical factors which if varied would create a change in current flow provided the other characteristics of the circuit would remain constant.

Let us consider a DC milliammeter (0-1) which gives full scale deflection when 1 milliampere flows through the meter. We desire to use this meter as a multirange voltmeter having scales (0-10) (0-100) (0-500) and (0-1000) volts respectively. The resistance of many such meters in commercial use ranges from 20 to 50 ohms. In the extreme case considering a meter of 50 ohms resistance the voltage drop across the meter at full scale current would be, according to Ohms Law, $E_m = R_m \times I_m$, R_m = resistance of meter = 50 ohms I_m = full scale current = 1 milliampere = .001 ampere E_m = 50 x .001 = 0.05 volts.

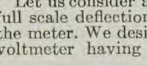


FIG. 1

As the maximum voltage drop across the meter is only 1/20 volt under extreme conditions we can disregard this in our calculations as the error will be negligible.

Referring to Figure 1 we see that the meter can be used as a 0-10 voltmeter if a resistance or multiplier is connected in series with it. The resistance must be of such value that if 1 milliampere of current (which is full scale deflection of the meter) flows through it the voltage across the resistance will be 10 volts. Figure 1.

$$\text{The multiplier, } R_1 = \frac{E}{I} = \frac{10}{.001} = 10{,}000 \text{ ohms.}$$

Half scale deflection means that ½ milliampere is flowing through the meter, therefore half scale deflection indicates

$$E = R\,I = 10{,}000 \times .0005 = 5 \text{ volts.}$$

Accordingly any fractional indication on the 0-1 mil scale will read the corresponding fraction of 10 volts which means the milliammeter scale is multiplied by 10 to get the actual reading in volts.

Similarly the multiplier for the (0-100) volt scale

$$R_2 = \frac{E}{I} = \frac{100}{.001} = 100{,}000 \text{ ohms.}$$

and the milliammeter scale readings are multiplied by 100.

Likewise the multipliers for the (0-500) and (0-1000) volt scales would be 500,000 and 1,000,000 ohms respectively and the scale multiples would be correspondingly 500 and 1000.

If a 0-10 milliammeter was used in place of the 0-1 the multipliers in each case would of course be only 1/10 of their respective values in the previous example. This would also apply to the scale multiples. However, the 10 milliammeter would consume appreciable current in itself and may in certain circuits introduce a considerable error particularly where the resistance of the multiplier is not considerably higher than the voltage supply system. Moreover, the regulation of the voltage supply system may be seriously affected when it is called upon to supply an additional 10 milliamperes to operate the voltmeter which would perhaps introduce a large error.

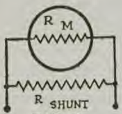


FIG. 2

This emphasizes the importance of a high resistance voltmeter; in the first example the resistance was 1000 ohms per volt while in the second instance it was only 100 ohms per volt. For the proper degree of accuracy in radio work a 1000 ohm per volt voltmeter will be quite suitable.

To use the 0-1 milliammeter as a higher scale milliammeter, it is necessary to provide a shunt as in Figure 2. In this case it is essential to know accurately the resistance of the meter. Assuming that it has a resistance of 27 ohms and that we want to have a scale reading of 0-10 mil (0-50) (0-100) (0-500) milliampere.

Referring to Figure 2 it is evident that to use the meter for 0-10 mil measurements the meter would carry 1/10 of the total current and the shunt 9/10 or the shunt resistance would be 1/9 of the meter resistance. If the meter resistance was 27 ohms the shunt resistance would be 3 ohms; correspondingly the shunt resistance for use as an 0-50 milliammeter would be 1/49 x 27 = .551 ohms. For 0-100 and 0-500 scales the shunt resistance must be 0.2727 ohms and 0.0541 ohms respectively.

The general formula is

$$R = \frac{R_m \times I_m}{I - I_m}$$

where R = resistance of shunt in ohms
R_m = resistance of meter in ohms
I_m = full scale current for meter
I = full scale current for new calibration

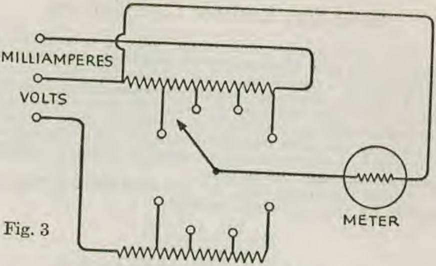


Fig. 3

By having a star or multipole switch as shown in Figure 3, one meter can be used as well as a voltmeter or milliammeter at any desired range. The accompanying chart shows the resistance of the shunt or multiplier as the case may be.

Shunt and Multiplier Values

27 Ohm (0-1) Milliammeter

Scale	Use as	Ohms of Resistance in Series or in Shunt with Meter	Multiply old scale by
0-10	Voltmeter	10,000	10
0-50	"	50,000	50
0-100	"	100,000	100
0-250	"	250,000	250
0-500	"	500,000	500
0-1000	"	1,000,000	1000
0-10	Milliammeter	3	10
0-50	"	0.551	50
0-100	"	0.272	100
0-500	"	0.0541	500

35 Ohm (0-1.5) Milliammeter

0-15	Voltmeter	10,000	10
0-150	"	100,000	100
0-750	"	500,000	500
0-15	Milliammeter	3.89	10
0-75	"	0.714	50
0-150	"	0.354	100
0-750	"	0.0701	500

Grid Bias Resistor Calculations

The radio service man often finds it necessary to replace the grid bias resistor in receivers employing a self-biasing arrangement for obtaining the proper grid voltage. When the resistance value is not known, it may be calculated by dividing the grid voltage required at the plate voltage at which the tube is operating, by the plate current in amperes plus the screen current in amperes times the number of tubes passing current through the resistor.

Under the above rule, the grid bias resistor value is given by the following formula:

$$R = \frac{E_{C1} \times 1{,}000}{(I_B + I_{C2})\, n}$$

where: R = Grid bias resistor value in ohms.

E_{C1} = The grid bias required in volts.

I_B = The plate current of a single tube in *milliamperes*.

I_{C2} = The screen-grid current of a single tube in *milliamperes*.

n = The number of tubes passing current through the resistor.

Example:

It is desired to determine the value of bias resistor used to obtain the proper value of grid bias on three type '35 tubes working in the radio frequency stages of a receiver. First determine the plate and screen voltages employed in this set. Suppose, in this case, it is found that the plate supply voltage is 250 and the screen voltage is 90. Looking in the characteristics chart, it is found that the proper grid bias for the '35 under these conditions is —3.0 volts. In addition, the plate current is 6.5 milliamperes and the screen current is 2.5 milliamperes. Substituting in the formula,

$$R = \frac{3.0 \times 1{,}000}{(6.5 + 2.5)\, 3} = 111 \text{ ohms.}$$

The value of grid bias resistors can be calculated in this manner for any type and any number of tubes. In the case of triodes, the screen current term drops out entirely.

Be sure to determine the plate voltage at which the tubes are working, the number of tubes being supplied from the bias resistor, the screen voltage, (if a tetrode or pentode), the correct value of grid bias voltage required (whether the tube cathode is operated from A.C. or D.C. will affect the value of bias voltage), and the plate and screen current for the given plate voltage.

In the case of resistance-coupled amplifiers which employ high resistance in the plate circuit, it must be remembered that the plate voltage is equal to the plate supply voltage minus the voltage drop in the plate load resistance caused by the plate current. The net plate voltage alone determines the correct value of grid bias.

The foregoing methods of calculations cannot be used in connection with receivers employing a bleeder circuit to obtain grid bias.

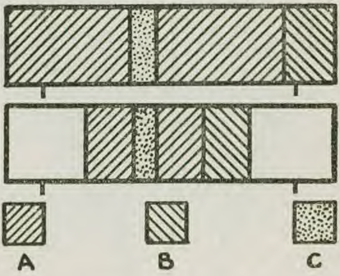
RMA Standard Color Coding for Resistors

The Radio Manufacturers Association has standardized on the following color coding for resistance value identification:

Ten colors are assigned to the figures as shown in the following table:

Figure	Color	Figure	Color	Figure	Color
0	Black	4	Yellow	7	Violet
1	Brown	5	Green	8	Gray
2	Red	6	Blue	9	White
3	Orange				

The body (A) of the resistor is colored to represent the first figure of the resistance value. One end (B) of the resistor is colored to represent the second figure. A band, or dot (C) of color, representing the number of ciphers following the first two figures, is located within the body color. The two diagrams illustrate two interpretations of this standard method of coding resistance value.



NOTE: The problem of coding two resistors of the same nominal value when tolerances are different is solved in a practical manner by using the next higher or lower coded value for the unit with the larger tolerance. For example: if the nominal values of two resistors are 2,500 ohms, one with 10% tolerance and the other with 20%. The unit with 10% tolerance will be 2,500 ohms and be coded as such. The unit with 20% tolerance will be assigned a nominal value of either 2,400 ohms or 2,600 ohms and be so coded. A similar system for coding fixed condensers is in general use. Three colored dots are employed to show the capacity in micromicrofarads. The dots are read from left to right with the condenser held so that the brand name is upright. The correspondence between colors and digits is the same as in the resistance coding.

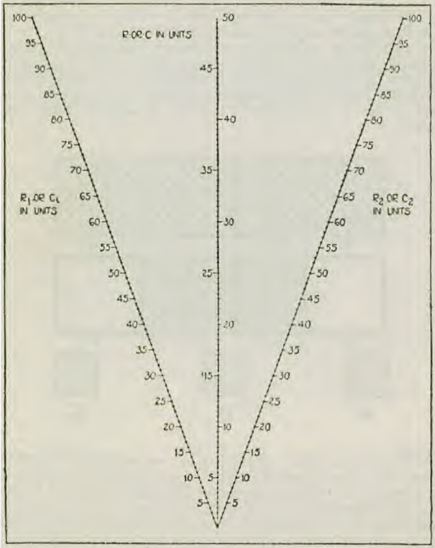
Series Resistances, Parallel Capacities

$$R = R_1 + R_2 + R_3 \text{ etc.}$$

$$C = C_1 + C_2 + C_3 \text{ etc.}$$

Where: R and C equal the total resistance or capacity.

Parallel Resistances, Series Capacities Chart



This chart suffices for both resistances in parallel and capacities in series since the formula for each is the same.

Lay a straightedge from unit desired on the left oblique line to unit desired on right oblique line. Point at which straightedge intersects the vertical line is the resultant value in units.

To increase range of the scale multiply or divide all values by the factor desired, such as one thousandth, one hundredth, one tenth; ten, one hundred or one thousand, etc.

DIAMETER, WEIGHTS AND RESISTANCE OF COPPER WIRE

No. AWG.	Diameter Mils	Area, Circular Mils	Weight, Bare Wire		Resistance at 25°C. (77°F.)		
			Pounds per 1000 Ft.	Pounds per Mile	Ohms per 1000 Ft.	Ohms per Mile	Feet per Ohm
0000	460.	211,600.	641.	3385.	0.0499	0.2638	20,040.
000	410.	167,800.	508.	2683.	0.0630	0.3325	15,870.
00	364.8	133,100.	403.	2126.	0.0794	0.419	12,590.
0	324.9	105,500.	319.5	1687.	0.1003	0.529	9,980.
1	289.3	83,700.	253.3	1337.	0.1262	0.666	7,930.
2	257.6	66,400.	200.9	1061.	0.1591	0.840	6,290.
3	229.4	52,600.	159.3	841.	0.2008	1.062	4,980.
4	204.3	41,700.	126.4	668.	0.2533	1.338	3,950.
5	181.9	33,100.	100.2	529.	0.3193	1.685	3,134.
6	162.0	26,250.	79.5	419.	0.403	2.127	2,485.
7	144.3	20,820.	63.0	332.6	0.507	2.682	1,971.
8	128.5	16,510.	50.0	264.0	0.640	3.382	1,562.
9	114.4	13,090.	39.63	208.3	0.807	4.26	1,238.
10	101.9	10,380.	31.43	165.9	1.017	5.37	983.
11	90.7	8,230.	24.92	131.6	1.284	6.78	779.
12	80.8	6,530.	19.77	104.3	1.618	8.55	618.
13	72.0	5,180.	15.68	82.8	2.040	10.77	490.
14	64.1	4,110.	12.43	65.6	2.575	13.60	388.2
15	57.1	3,257.	9.86	52.1	3.244	17.13	308.4
16	50.8	2,583.	7.82	41.3	4.09	21.62	244.3
17	45.3	2,048.	6.20	32.73	5.16	27.24	193.9
18	40.3	1,624.	4.92	26.00	6.51	34.34	153.7
19	35.89	1,288.	3.899	20.57	8.20	43.3	121.9
20	31.96	1,022.	3.092	16.33	10.34	54.6	96.6
21	28.46	810.	2.452	12.93	13.04	68.9	76.6
22	25.35	642.	1.945	10.27	16.44	86.9	60.8
23	22.57	509.	1.542	8.14	20.75	109.5	48.2
24	20.10	404.	1.223	6.46	26.15	138.1	38.2
25	17.90	320.4	0.970	5.12	33.00	174.3	30.3
26	15.94	254.1	0.769	4.06	41.6	219.5	24.0
27	14.20	201.5	0.610	3.220	52.4	276.8	19.0
28	12.64	159.8	0.484	2.556	66.01	349.2	15.1

DIAMETER, WEIGHTS AND RESISTANCE OF COPPER WIRE

No. AWG	Diameter Mils	Area, Circular Mils	Weight, Bare Wire		Resistance at 25°C. (77°F.)		
			Pounds per 1000 Ft.	Pounds per Mile	Ohms per 1000 Ft.	Ohms per Mile	Feet per Ohm
29	11.26	126.7	0.3836	2.025	83.4	441.	11.98
30	10.03	100.5	0.3042	1.606	105.4	556.	9.48
31	8.93	79.7	0.2413	1.273	132.6	700.	7.55
32	7.95	63.2	0.1913	1.011	167.2	883.	5.98
33	7.08	50.1	0.1517	0.807	210.8	1113.	4.74
34	6.30	39.75	0.1203	0.636	265.8	1403.	3.762
35	5.61	31.52	0.0954	0.504	335.5	1772.	2.980
36	5.00	25.00	0.0757	0.400	423.0	2232.	2.366
37	4.45	19.83	0.0600	0.3168	533.	2814.	1.877
38	3.965	15.72	0.0476	0.2514	673.	3553.	1.487
39	3.531	12.47	0.03774	0.1991	847.	4470.	1.180
40	3.145	9.89	0.02993	0.1579	1068.	5640.	0.936

ALLOWABLE CARRYING CAPACITIES OF COPPER WIRE AND CABLE

(Regulations of the National Board of Fire Underwriters)

No. AWG	Circular Mils	Amperes		Circular Mils	Amperes	
		Rubber Insulation	Other Insulation		Rubber Insulation	Other Insulation
18	1,624	3	5	250,000	250	350
16	2,583	6	10	300,000	275	400
14	4,107	15	20	350,000	300	450
12	6,530	20	25	400,000	325	500
10	10,380	25	30	450,000	362	550
8	16,510	35	50	500,000	400	600
6	26,250	50	70	600,000	450	680
4	41,740	70	90	700,000	500	760
2	66,370	90	125	800,000	550	840
1	83,690	100	150	1,000,000	650	1000
0	105,500	125	200	1,250,000	750	1180
00	133,100	150	225	1,500,000	850	1360
000	167,800	175	275	1,750,000	950	1520
0000	211,600	225	325	2,000,000	1050	1670

TEMPERATURE CORRECTIONS FOR COPPER WIRE

(Based on A.I.E.E. Standards)

Temperature Coefficient of Resistance. At a temperature of 25 degrees Centigrade the "constant mass" temperature coefficient of resistance of standard annealed copper, measured between potential points rigidly fixed to the wire is 0.00385 or 1/259.5 per Centigrade degree.

Resistance values of copper wire given in table on preceding pages may be corrected for any temperature by means of the formula given below.

Correction for Change in Temperature

$Rt = R_{25} [1 + 0.00385 (t - 25)]$, where
Rt = the resistance in ohms at a temperature, t.
R_{25} = the resistance in ohms at 25 degrees, Centigrade
t = the temperature of wire in degrees, Centigrade

Temp. C.=5/9 (Temp. F.−32)
Temp. F.=9/5 (Temp. C.)+32.

SPECIFIC RESISTANCE OF METALS AND ALLOYS AT ORDINARY TEMPERATURES

SUBSTANCE	Specific Resistance Microhms per Cm. Cube	Relative Conductance	SUBSTANCE	Specific Resistance Microhms per Cm. Cube	Relative Conductance
Aluminum . .	2.94	54.	Lead . . .	20.8	6.64
Brass	6–9	26–17	Manganin .	43.	3.7
Climax	87.	1.83	Mercury . .	95.7	1.66
Cobalt	9.7	16.3	Molybdenum	4.8	33.2
Constantan . .	49.	3.24	Nickel . .	10.5	11.8
Copper, U.S. std.	1.78	89.5	Nichrome .	110.	1.45
Copper, annealed	1.59	100.	Platinum .	10.8	14.6
Ger. Silver (18X)	30–40	5.3–4	Silver . . .	1.5	106.
Iron, pure . .	9.	17.7	Superior 23.	86.	1.85
Iron, wrought .	13.9	11.4	Tungsten .	5.4	28.9

USEFUL CONVERSION RATIOS

Multiply	by	to obtain
Diam. Circle	3.1416	Circumference Circle
Diam. Circle	0.886	Side Equal Square
U. S. Gallons	0.8333	Imperial Gallons
U. S. Gallons	0.1337	Cubic Feet
Inches Mercury	0.4912	Pounds per Sq. In.
Feet of Water	0.4335	Pounds per Sq. In.
Cubic Feet	62.4	Pounds of Water
U. S. Gallons	8.343	Pounds of Water
U. S. Gallons	3.785	Liters
Knots	1.152	Miles
Inches	2.540	Centimeters
Yards	0.9144	Meters
Miles	1.609	Kilometers
Cubic Inches	16.39	Cubic Centimeters
Ounces	28.35	Grams
Pounds	0.4536	Kilograms

Winding Turns per Linear Inch

Gauge No. B & S	Enamel	S. S. C.	D. S. C. or S. C. C.	D. C. C.
8	7.6	——	7.4	7.1
9	8.6	——	8.2	7.8
10	9.6	——	9.3	8.9
11	10.7	——	10.3	9.8
12	12.0	——	11.5	10.9
13	13.5	——	12.8	12.0
14	15.0	——	14.2	13.3
15	16.8	——	15.8	14.7
16	18.9	18.9	17.9	16.4
17	21.2	21.2	19.9	18.1
18	23.6	23.6	22.0	19.8
19	26.4	26.4	24.4	21.8
20	29.4	29.4	27.0	23.8
21	33.1	32.7	29.8	26.0
22	37.0	36.5	34.1	30.0
23	41.3	40.6	37.6	31.6
24	46.3	45.3	41.5	35.6
25	51.7	50.4	45.6	38.6
26	58.0	55.6	50.2	41.8
27	64.9	61.5	55.0	45.0
28	72.7	68.6	60.2	48.5
29	81.6	74.8	65.4	51.8
30	90.5	83.3	71.5	55.5
31	101.	92.0	77.5	59.2
32	113.	101.	83.6	62.6
33	127.	110.	90.3	66.3
34	143.	120.	97.0	70.0
35	158.	132.	104.	73.5
36	175.	143.	111.	77.0
37	198.	154.	118.	80.3
38	224.	166.	126.	83.6
39	248.	181.	133.	86.6
40	282.	194.	140.	89.7

Standard American Taps Used in Radio Manufacture

Size of Screw	Outside Dia. in Inches	Pitch Dia. in Inches	Root Dia. in Inches	Tap Drill Steel	Tap Drill Cast Iron	Tap Drill Commercial
2—56	.0860	.0744	.0628	No. 49 (.0730)	No. 49 (.0730)	No. 50 (.0700)
3—48	.0990	.0855	.0719	No. 44 (.0860)	No. 44 (.0860)	No. 47 (.0785)
4—40	.1120	.0958	.0795	No. 42 (.0935)	No. 43 (.0890)	No. 43 (.0890)
5—40	.1250	.1088	.0925	No. 34 (.1110)	No. 35 (.1110)	No. 38 (.1015)
6—32	.1380	.1177	.0974	No. 32 (.1160)	No. 33 (.1130)	No. 36 (.1065)
8—32	.1640	.1437	.1234	No. 27 (.1440)	No. 28 (.1405)	No. 29 (.1360)
10—24	.1900	.1625	.1359	No. 21 (.1509)	No. 22 (.1570)	No. 25 (.1495)
10—32	.1900	.1697	.1494	No. 19 (.1660)	No. 20 (.1610)	No. 21 (.1590)
12—24	.2160	.1889	.1619	No. 16 (.1770)	No. 17 (.1730)	No. 16 (.1770)
¼—20	.2500	.2175	1850	No. 7 (.2010)	No. 8 (.1990)	No. 7 (.2010)

Conversion

Factors for conversion — alphabetically arranged.

Multiply	By	To Get
Amperes	× 1,000,000,000,000	micromicroamperes
Amperes	× 1,000,000	microamperes
Amperes	× 1,000	milliamperes
Cycles	× .000,001	megacycles
Cycles	× .001	kilocycles
Farads	× 1,000,000,000,000	micromicrofarads
Farads	× 1,000,000	microfarads
Farads	× 1,000	millifarads
Henrys	× 1,000,000	microhenrys
Henrys	× 1,000	millihenrys
Kilocycles	× 1,000	cycles
Kilovolts	× 1,000	volts
Kilowatts	× 1,000	watts
Megacycles	× 1,000,000	cycles
Mhos	× 1,000,000	micromhos
Mhos	× 1,000	millimhos
Microamperes	× .000,001	amperes
Microfarads	× .000,001	farads
Microhenrys	× .000,001	henrys
Micromhos	× .000,001	mhos
Micro-ohms	× .000,001	ohms
Microvolts	× .000,001	volts
Microwatts	× .000,001	watts
Micromicrofarads	× .000,000,000,001	farads
Micromicro-ohms	× .000,000,000,001	ohms
Milliamperes	× .001	amperes
Millihenrys	× .001	henrys
Millimhos	× .001	mhos
Milliohms	× .001	ohms
Millivolts	× .001	volts
Milliwatts	× .001	watts
Ohms	× 1,000,000,000,000	micromicro-ohms
Ohms	× 1,000,000	micro-ohms
Ohms	× 1,000	milliohms
Volts	× 1,000,000	microvolts
Volts	× 1,000	millivolts
Watts	× 1,000,000	microwatts
Watts	× 1,000	milliwatts
Watts	× .001	kilowatts

METRIC EQUIVALENTS

Length

Cm. = .3937 In.	In. = 2.54 Cm.
Meter = 3.28 Ft.	Ft. = .305 Meter
Meter = 1.094 Yd.	Yd. = .914 Meter
Kilom. = .621 Mile	Mile = 1.61 Kilom.

Area

Sq. Cm. = 0.1550 Sq. in.	Sq. in. = 6.452 Sq. Cm.
Sq. M. = 10.764 Sq. ft.	Sq. ft. = .0929 Sq. M.
Sq. M. = 1.196 Sq. yd.	Sq. yd. = .836 Sq. M.
Hectare = 2.47 Acres	Acre = 0.405 Hectare
Sq. Kilom. = .386 Sq. mi.	Sq. mi. = 2.59 Sq. Kilom.

Volume

Cu. Cm. = .061 Cu. in.	Cu. in. = 16.4 Cu. Cm.
Cu. M. = 35.31 Cu. ft.	Cu. ft. = .028 Cu. M.
Cu. M. = 1.308 Cu. yd.	Cu. yd. = .765 Cu. M.

Capacity

Litre = .0353 Cu. ft.	Cu. ft. = 28.32 Litres
Litre = .2642 Gal. (U. S.)	Gal. = 3.785 Litres.
Litre = 61.023 Cu. in.	Cu. in. = .0164 Litre

Litre = 2.202 lb. of fresh water at 62° F.

Weight

Gram = 15.423 Grains	Grain = .0684 Gram
Gram = .0353 Ounce	Ounce = 28.35 Gram
Kilogram = 2.205 Lb.	Lb. = .454 Kilog'm
Kilogram = .0011 Ton(Sht)	Ton(Sht) = 907.03 Kilog'm
Met. Ton = 1.1025 Ton(Sht)	Ton(Sht) = .907 Met. Ton

Ton(Sht) = 2,000 Lb.

Pressure

Kilograms per square centimeter = 14.225 pounds per square inch.
Pounds per square inch = .0703 kilograms per square cm.
Kilograms per square meter = .205 pounds per square foot.
Pounds per square foot = 4.88 kilograms per square meter.
Kilograms per square centimeter = .968 atmosphere.
Atmosphere = 1.033 kilograms per square cm.

Miscellaneous

Kilogrammeter = 7.233 foot pounds.
Foot pound = .1383 kilogrammeter.
Metric horse power = .986 horse power.
Horse power = 1.014 metric horse power.
Litre per second = 2.12 cubic feet per minute.
Litre per second = 15.85 U. S. gallons per minute.

METRIC AND DECIMAL EQUIVALENTS OF COMMON FRACTIONS

Fractions of an inch	Decimals of an inch	Millimeters	Fractions of an inch	Decimals of an inch	Millimeters
1/64	.0156	0.397	33/64	.5156	13.097
1/32	.0313	0.794	17/32	.5313	13.494
3/64	.0469	1.191	35/64	.5469	13.891
1/16	.0625	1.588	9/16	.5625	14.287
5/64	.0781	1.985	37/64	.5781	14.684
3/32	.0938	2.381	19/32	.5938	15.081
7/64	.1094	2.778	39/64	.6094	15.478
1/8	.1250	3.175	5/8	.6250	15.875
9/64	.1406	3.572	41/64	.6406	16.272
5/32	.1563	3.969	21/32	.6563	16.688
11/64	.1719	4.366	43/64	.6719	17.085
3/16	.1875	4.762	11/16	.6875	17.462
13/64	.2031	5.159	45/64	.7031	17.859
7/32	.2188	5.556	23/32	.7188	18.256
15/64	.2344	5.953	47/64	.7344	18.653
1/4	.2500	6.350	3/4	.7500	19.050
17/64	.2656	6.747	49/64	.7656	19.447
9/32	.2813	7.144	25/32	.7813	19.843
19/64	.2969	7.541	51/64	.7969	20.240
5/16	.3135	7.937	13/16	.8125	20.637
21/64	.3281	8.334	53/64	.8281	21.034
11/32	.3438	8.731	27/32	.8438	21.430
23/64	.3594	9.128	55/64	.8594	21.827
3/8	.3750	9.525	7/8	.8750	22.224
25/64	.3906	9.922	57/64	.8906	22.621
13/32	.4063	10.319	29/32	.9063	23.018
27/64	.4219	10.716	59/64	.9219	23.415
7/16	.4375	11.12	15/16	.9375	23.812
29/64	.4531	11.509	61/64	.9531	24.209
15/32	.4688	11.906	31/32	.9688	24.606
31/64	.4844	12.303	63/64	.9844	25.003
1/2	.5000	12.700		1.0000	25.400

EQUIVALENTS OF ELECTRICAL UNITS

1 kilowatt = 1000 watts.
1 kilowatt = 1.34 H. P.
1 kilowatt = 44,257 foot-pounds per minute.
1 kilowatt = 56.87 B. t. u. per minute.
1 horse power = 746 watts.
1 horse power = 33,000 foot-pounds per minute.
1 horse power = 42.41 B. t. u. per minute.
1 B. t. u. (British thermal unit) = 778 foot-pounds.
1 B. t. u. = 0.2930 watt-hour.
1 joule = 1 watt-second.

Self-Indicating Resistance Chart

RESISTANCES-IN-OHMS

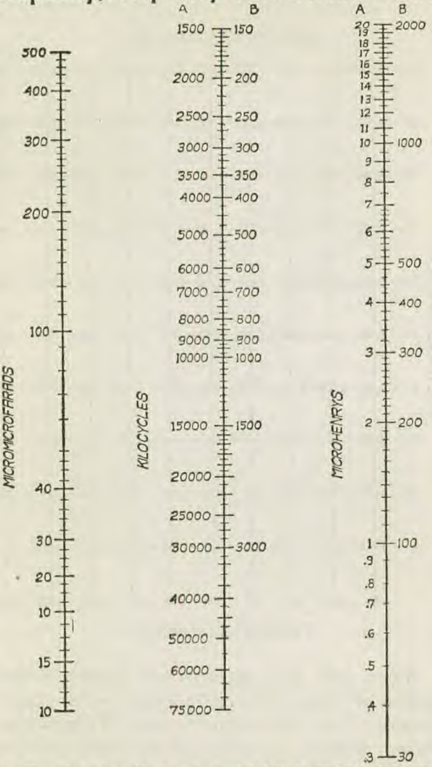
VOLTAGE-IN-VOLTS

10	10,000	5,000	3,333	2,500	2,000	1,666	1,428	1,250	1,111	1,00
9	9,000	4,500	3,000	2,250	1,800	1,500	1,285	1,125	1,000	90
8	8,000	4,000	2,666	2,000	1,600	1,333	1,142	1,000	888	80
7	7,000	3,500	2,333	1,750	1,400	1,166	1,000	875	777	70
6	6,000	3,000	2,000	1,500	1,200	1,000	857	750	666	60
5	5,000	2,500	1,666	1,250	1,000	833	714	625	555	50
4	4,000	2,000	1,333	1,000	800	666	572	500	444	40
3	3,000	1,500	1,000	750	600	500	428	375	333	30
2	2,000	1,000	666	500	400	333	286	250	222	20
1	1,000	500	333	250	200	166	143	125	111	10
	.001	.002	.003	.004	.005	.006	.007	.008	.009	.01

CURRENT-IN-AMPERES

When volts and amperes are known, intersection of voltage and current lines gives resistance in ohms. To extend scales: When multiplying voltage by any factor with current remaining fixed, multiply resistance by same factor. When multiplying current, voltage remaining fixed, divide resistance by same factor. When dividing voltage by any factor, current remaining fixed, divide resistance by same factor. When dividing current by any factor, multiply resistance by same factor.

Capacity, Frequency & Inductance Chart



Knowing capacity in micromicrofarads and the frequency in kilocycles to be covered by a condenser at maximum capacity the inductance required for a coil may be found by running a straight line from the micromicrofarads column through the kilocycle column, the line intersecting the inductance column.

Knowing the condenser capacity and the inductance of the coil, the frequency to which the coil will tune can be found by running a line from the micromicrofarads column to the microhenrys column, the point of intersection on the kilocycle column will be the frequency of coil and condenser.

Knowing the kilocycles and the inductance, the size of condenser to be used to cover that frequency can be found in the same manner indicated; extension of a straight line from microhenrys through kilocycles will terminate on the micro-

Conversion Table — Frequency to Wavelength

$$\text{Wavelength in Meters} = \frac{300{,}000}{\text{Frequency in Kilocycles}} \text{ or } \frac{300}{\text{Frequency in Megacycles}}$$

Long-Wave Broadcast Band		Short Waves	
Frequency Kilocycles	Wavelength Meters	Frequency Megacycles	Wavelength Meters
550	545	1.5	200
600	500	2	150
650	461	3	100
700	429	4	75.0
750	400	5	60.0
800	375	6	50.0
850	353	7	42.9
900	333	8	37.5
950	316	9	33.3
1000	300	10	30.0
1050	286	11	27.3
1100	273	12	25.0
1150	261	13	23.1
1200	250	14	21.4
1250	240	15	20.0
1300	231	16	18.8
1350	222	17	17.6
1400	214	18	16.7
1450	207	19	15.8
1500	200	20	15.0

Frequency Assignments in the High Frequency Radio Spectrum For United States

(Radiophone Stations Only)

Standard Broadcast	530 to 1600 kilocycles
Short Wave Broadcast	49 meters— 6000— 6150 kc.
	31 meters— 9500— 9600 kc.
	25 meters—11700—11900 kc.
	19 meters—15100—15350 kc.
	16 meters—17750—17800 kc.
	13 meters—21450—21550 kc.
	11 meters—25600—26600 kc.
Police	1600—1720 kc. (mostly State Police)
	2300—2500 kc. (Municipal Police)
	31000—41000 kc. (Municipal Police)
Aviation	2600—3500 Night
	4700—5700 Day
Amateur Phone	160 meters— 1800— 2000 kc.
	80 meters— 3900— 4000 kc.
	20 meters—14150—14250 kc.
	10 meters—28000—28500 kc.
	5 meters—56000—60000 kc.
Time Signals	
NAA, Washington, D.C.	64, 113, 690, 4525, 8410, 9050, 12615, 16820
NPG, San Francisco	42.8, 108, 8590, 12885
W9XAM, Elgin, Ill.	4797

Sales Aids That Help You Sell

Sales aids listed below are only a few of the many designed to tie in your store with RCA Radio Tube advertising and to enable you to share RCA prestige.

- Metal Flange Sign
- Electric Clock
- Tube Test Stickers
- New Travel-log
- Shop Coats and Shirts
- Direct Mail Cards
- Guarantee Certificates
- Service Order Pads
- Business Cards
- Repair Tickets
- Billheads
- Letterheads
- and many others

These aids may be obtained through your RCA Radiotron Distributor.

U. S. Broadcasting Stations . . .

Station	Location	Kilo-cycles	Station	Location	Kilo-cycles
KDKA	Pittsburgh, Pa.	980	KPO	S. Francisco, Calif.	680
KDYL	Salt Lake Cy, Utah	1290	KPRC	Houston, Texas	920
KECA	Los Angeles, Calif.	1430	KQW	San Jose, Calif.	1010
KEX	Portland, Oregon	1180	KRLD	Dallas, Texas	1040
KFAB	Lincoln, Nebr.	770	KROW	Oakland, Calif.	930
KFAC	Los Angeles, Calif.	1300	KSCJ	Sioux City, Iowa	1330
KFBB	Great Falls, Mont.	1280	KSD	St. Louis, Mo.	550
KFBI	Abilene, Kans.	1050	KSFO	S. Francisco, Calif.	560
KFBK	Sacramento, Calif.	1490	KSL	Salt Lake Cy, Utah	1130
KFDY	Brookings, S. D.	780	KSOO	Sioux Falls, S. D.	1110
KFEQ	St. Joseph, Mo.	680	KSTP	St. Paul, Minn.	1460
KFH	Wichita, Kans.	1300	KTAR	Phoenix, Ariz.	620
KFI	Los Angeles, Calif.	640	KTAT	Fort Worth, Texas	1240
KFKU	Lawrence, Kans.	1220	KTBS	Shreveport, La.	1450
KFOX	Long Beach, Calif.	1250	KTFI	Twin Falls, Idaho	1240
KFPY	Spokane, Wash.	890	KTHS	Hot Springs, Ark.	1060
KFRC	S. Francisco, Calif.	610	KTRH	Houston, Texas	1290
KFSD	San Diego, Calif.	600	KTSA	San Antonio, Tex.	550
KFWB	Hollywood, Calif.	950	KTW	Seattle, Wash.	1220
KFYR	Bismarck, N. D.	550	KUOA	Fayetteville, Ark.	1260
KGA	Spokane, Wash.	1470	KVI	Tacoma, Wash.	570
KGB	San Diego, Calif.	1330	KVOO	Tulsa, Okla.	1140
KGBZ	York, Nebr.	930	KVOR	Colo. Springs, Colo.	1270
KGDM	Stockton, Calif.	1100	KWK	St. Louis, Mo.	1350
KGER	Long Beach, Calif.	1360	KWKH	Shreveport, La.	1100
KGGF	Coffeyville, Kans.	1010	KWSC	Pullman, Wash.	1220
KGHL	Billings, Mont.	780	KWTO	Springfield, Mo.	560
KGIR	Butte, Mont.	1340	KXYZ	Houston, Texas	1440
KGNC	Amarillo, Texas	1410	KYA	S. Francisco, Calif.	1230
KGNF	N. Platte, Nebr.	1430	KYW	Philadelphia, Pa.	1020
KGO	S. Francisco, Calif.	790	WAAF	Chicago, Ill.	920
KGVO	Missoula, Mont.	1260	WABC	New York, N. Y.	860
KGW	Portland, Oregon	620	WADC	Tallmadge, Ohio	1320
KHJ	Los Angeles, Calif.	900	WAPI	Birmingham, Ala.	1140
KHQ	Spokane, Wash.	590	WAVE	Louisville, Ky.	940
KIDO	Boise, Idaho	1350	WBAL	Baltimore, Md.	1060
KJR	Seattle, Wash.	970	WBAP	Fort Worth, Texas	800
KLRA	Little Rock, Ark.	1390	WBBM	Chicago, Ill.	770
KLX	Oakland, Calif.	880	WBBR	Brooklyn, N. Y.	1300
KLZ	Denver, Col.	560	WBEN	Buffalo, N. Y.	900
KMA	Shenandoah, Iowa	930	WBOQ	New York, N. Y.	860
KMBC	Kansas City, Mo.	950	WBRC	Birmingham, Ala.	930
KMMJ	Clay Center, Nebr.	740	WBT	Charlotte, N. C.	1080
KMOX	St. Louis, Mo.	1090	WBZ	Boston, Mass.	990
KMTR	Los Angeles, Calif.	570	WBZA	Springfield, Mass.	990
KNX	Los Angeles, Calif.	1050	WCAE	Pittsburgh, Pa.	1220
KOA	Denver, Col.	830	WCAL	Northfield, Minn.	1250
KOAC	Corvallis, Ore.	550	WCAU	Philadelphia, Pa.	1170
KOB	Albuquerque, N. M.	1180	WCBD	Waukegan, Ill.	1080
KOIL	Council Bluffs, Ia.	1260	WCCO	Minneapolis, Minn.	810
KOIN	Portland, Oregon	940	WCFL	Chicago, Ill.	970
KOL	Seattle, Wash.	1270	WCKY	Covington, Ky.	1490
KOMA	Oklahoma City, Okla.	1480	WCSH	Portland, Maine	940
			WDAE	Tampa, Fla.	1220
KOMO	Seattle, Wash.	920	WDAF	Kansas City, Mo.	610

. . . . 1000 Watts or More

Station	Location	Kilo-cycles	Station	Location	Kilo-cycles
WDAY	Fargo, N. D.	940	WKY	Okla. City, Okla.	900
WDBJ	Roanoke, Va.	930	WKZO	Kalamazoo, Mich.	590
WDBO	Orlando, Fla.	580	WLAC	Nashville, Tenn.	1470
WDGY	Minneapolis, Minn.	1180	WLB	Minneapolis, Minn.	1250
WDOD	Chattanooga, Tenn.	1280	WLBL	Stevens Pt., Wisc.	900
WDRC	Hartford, Conn.	1330	WLS	Chicago, Ill.	870
WDSU	New Orleans, La.	1250	WLW	Cincinnati, Ohio	700
WEAF	New York, N. Y.	660	WLWL	New York, N. Y.	1100
WEBC	Superior, Wis.	1290	WMAQ	Chicago, Ill.	670
WEEI	Boston, Mass.	590	WMAZ	Macon, Ga.	1180
WEEU	Reading, Pa.	830	WMBF	Miami, Fla.	1300
WENR	Chicago, Ill.	870	WMBI	Chicago, Ill.	1080
WESG	Elmira, N. Y.	850	WMC	Memphis, Tenn.	780
WEVD	New York, N. Y.	1300	WMT	Cedar Rapids, Ia.	600
WEW	St. Louis, Mo.	760	WNAC	Boston, Mass.	1230
WFAA	Dallas, Texas	800	WNAD	Norman, Okla.	1010
WFAB	New York, N. Y.	1300	WNAX	Yankton, S. Dak.	570
WFBC	Greenville, S. C.	1300	WNBX	Springfield, Vt.	1260
WFBL	Syracuse, N. Y.	1360	WNEW	Newark, N. J.	1250
WFBM	Indianapolis, Ind.	1230	WNOX	Knoxville, Tenn.	1010
WFIL	Philadelphia, Pa.	560	WNYC	New York, N. Y.	810
WFLA	Clearwater, Fla.	620	WOAI	San Antonio, Texas	1190
WGN	Chicago, Ill.	720	WOI	Ames, Iowa	640
WGR	Buffalo, N. Y.	550	WOR	Newark, N. J.	710
WGST	Atlanta, Ga.	890	WORK	York, Pa.	1320
WGY	Schenectady, N. Y.	790	WOV	New York, N. Y.	1130
WHA	Madison, Wis.	940	WOW	Omaha, Nebr.	590
WHAM	Rochester, N. Y.	1150	WOWO	Fort Wayne, Ind.	1160
WHAS	Louisville, Ky.	820	WPG	Atlantic City, N. J.	1100
WHB	Kansas City, Mo.	860	WPTF	Raleigh, N. C.	680
WHBI	Newark, N. J.	1250	WQAM	Miami, Fla.	560
WHDH	Boston, Mass.	830	WQBC	Vicksburg, Miss.	1360
WHIO	Dayton, Ohio	1260	WREC	Memphis, Tenn.	600
WHK	Cleveland, Ohio	1390	WREN	Lawrence, Kans.	1220
WHN	New York, N. Y.	1010	WRUF	Gainesville, Fla.	830
WHO	Des Moines, Iowa	1000	WRVA	Richmond, Va.	1110
WIBA	Madison, Wis.	1280	WSAI	Cincinnati, Ohio	1330
WIBW	Topeka, Kans.	580	WSAR	Fall River, Mass.	1450
WIND	Gary, Ind.	560	WSAZ	Huntington, W.Va.	1190
WINS	New York, N. Y.	1180	WSB	Atlanta, Ga.	740
WIOD	Miami, Fla.	1300	WSM	Nashville, Tenn.	650
WIP	Philadelphia, Pa.	610	WSPA	Spartanburg, S. C.	920
WIS	Columbia, S. C.	560	WSPD	Toledo, Ohio	1340
WJAG	Norfolk, Nebr.	1060	WSUN	Clearwater, Fla.	620
WJAS	Pittsburgh, Pa.	1290	WTAM	Cleveland, Ohio	1070
WJAX	Jacksonville, Fla.	900	WTAQ	Eau Claire, Wisc.	1330
WJDX	Jackson, Miss.	1270	WTCN	Minneapolis, Minn.	1250
WJJD	Chicago, Ill.	1130	WTIC	Hartford, Conn.	1040
WJR	Detroit, Mich.	750	WTMJ	Milwaukee, Wis.	620
WJSV	Alexandria, Va.	1460	WTOC	Savannah, Ga.	1260
WJZ	New York, N. Y.	760	WWJ	Detroit, Mich.	920
WKAR	E. Lansing, Mich.	850	WWL	New Orleans, La.	850
WKBH	La Crosse, Wis.	1380	WWNC	Asheville, N. C.	570
WKBW	Buffalo, N. Y.	1480	WWVA	Wheeling, W. Va.	1160
WKRC	Cincinnati, Ohio	550	WXYZ	Detroit, Mich.	1240

IMPORTANT SHORT-WAVE STATIONS

Band	Station	Meters	Meg.	Location	Time of Broadcast (EST)	
49	XEBT	50.00	6.00	Mexico City, Mex.	Daily	10 a.m.-Midnight
	COCO	49.92	6.01	Havana, Cuba	Daily	9:30-11:30 a.m. & 4-11 p.m.
	DJC	49.83	6.02	Berlin, Germany	Daily	12 N-4:30 p.m. & 5:30-10:45 p.m.
	GSA	49.59	6.05	London, England	Daily	6-8 p.m.
	DJM	49.35	6.08	Berlin, Germany	Daily	7-10 p.m.
	I2RO1	49.30	6.09	Rome, Italy	Mon., Wed. & Sat.	1:30-5:15 & 6-7:30 p.m.
	CRCX	49.26	6.09	Toronto, Canada	Daily	4 p.m.-Midnight
	GSL	49.10	6.11	London, England	Daily	12:15-5:45 p.m.
	COCD	48.94	6.13	Havana, Cuba	Daily	6-10 p.m.
	CJRO	48.74	6.15	Winnipeg, Man., Canada	Daily	8 p.m.-Midnight
	YV5RB	48.74	6.15	Caracas, Venezuela	Daily	10:30 a.m.-1:30 p.m. & 4:30-10 p.m.
31	PRF5	31.58	9.50	Rio de Janeiro, Brazil	Daily	5:20-6:15 p.m.
	GSB	31.55	9.51	London, England	Daily	12:15-2:30 a.m. & 12:15-5:45 p.m.
	VK3ME	31.52	9.51	Melbourne, Australia	Sun. thru Fri.	4-7 a.m.
	DJN	31.45	9.54	Berlin, Germany	Daily	12 M-11 a.m. & 5-10:45 p.m.
	DJA	31.38	9.56	Berlin, Germany	Daily	12 M-4, 8-11 a.m. & 5-10:45 p.m.
	GSC	31.32	9.58	London, England	Daily	12:15-5:45, 6-8 & 10-11 p.m.
	VK3LR	31.32	9.58	Melbourne, Australia	Mon. thru Sat.	11 p.m.-2 a.m. & 4-7 a.m.
	VK2ME	31.28	9.59	Sidney, Australia	Daily	1-2, 3-8:30 & 10:30-11:30 a.m.
	HBL	31.26	9.59	Geneva, Switzerland	Sat.	5:30-6:15 p.m.

IMPORTANT SHORT-WAVE STATIONS

	Station	Meters	Meg.	Location	Time of Broadcast (EST)	
25	TPA-4	25.61	11.71	Paris, France	Daily	6:15-10 p.m. & 12 m.-1 a.m.
	CJRX	25.60	11.72	Winnipeg, Man., Canada	Daily	8 p.m.-Midnight
	PHI	25.58	11.73	Huizen, Holland	Thurs. thru Mon.	8-11 a.m.
	GSD	25.53	11.75	London, England	Daily	6-8:45 a.m.; 12:15-5:45, 6-8 & 10-11 p.m.
	DJD	25.49	11.77	Berlin, Germany	Daily	11 a.m.-11 p.m.
	I2RO4	25.40	11.81	Rome, Italy	Daily	8:15-9, 9:15-11 a.m. & 11:30 a.m.-12:15 p.m.
	HJ4ABA	25.40	11.81	Medellin, Colombia	Daily	11 a.m.-1 p.m. & 6-11 p.m.
	GSN	25.38	11.82	London, England	Daily	12:15-2:30 a.m.
	TPA-3	25.24	11.88	Paris, France	Daily	4-5 a.m. & 11:15 a.m.-6 p.m.
19	DJL	19.85	15.11	Berlin, Germany	Daily	6-8 a.m.
	HVJ	19.84	15.12	Vatican City, Italy	Daily	10:30-10:45 a.m. & 5-5:15 p.m.
	GSF	19.82	15.14	London, England	Daily	9 a.m.-12 Noon
	PCJ	19.71	15.22	Huizen, Holland	Wed.	6-11 a.m.
	TPA-2	19.68	15.24	Paris, France	Daily	7-11 a.m.
	LRU	19.62	15.29	Buenos Aires, Argentina	Daily	2-6:50 p.m.
	HAS3	19.52	15.37	Budapest, Hungary	Sun.	8-10 a.m.
16	DJE	16.89	17.76	Berlin, Germany	Daily	8-11 a.m.
	GSG	16.86	17.79	London, England	Daily	6-8:45 a.m. & 9 a.m.-12 Noon
13	GSJ	13.93	21.53	London, England	Daily	6-9 a.m.

Interchangeable Tube Types

RCA Radio Glass Tube types can be interchanged for tube types of other manufacturers as follows:

In general, the last two digits of a three-digit receiving tube type number are the significant type designation. Thus, the RCA-27 is interchangeable with the C-327. In the case of a suffixed letter, the same rule applies; for example, the RCA-71-A will replace the UX-171-A of our manufacture and also the FY-'71-A or AG-71-A, etc., of other manufacturers.

Exceptions to this rule include the following types, for which we do not have an interchangeable type: KR-20, KR-22, 59-B, G-84, 182B, 183, 401, 482B, 483, 484, 485, 985.

Spray-shielded tubes, having type numbers which correspond to RCA type numbers followed by the letter "S", can usually be replaced by the RCA type. When the replacement is made in an i-f or r-f stage where shielding is important, the RCA tube should be equipped with a close fitting tube shield.

Tubes having a glass bulb and an octal base have type numbers with the suffix G. Tubes having a glass bulb, enclosed in a metal shield, and an octal base use the suffix MG. Both the G and MG types can usually be replaced by the corresponding RCA all-metal type without change in the receiver. When the replacement is made in a pentagrid converter or mixer stage it may be necessary to realign the oscillator tuning condenser with the r-f tuning condenser.

The following list covers other cases of interchangeability. It shows the type numbers used by other manufacturers, together with the corresponding RCA Radio Tubes type numbers. The list also gives type numbers of tubes which supersede earlier tube models.

Other Manufacturers' Type No.	*RCA Radio Tubes Type No.*	*Other Manufacturers' Type No.*	*RCA Radio Tubes Type No.*
2A3H	2A3	65	39/44*
6Z3	1-v	65-A	39/44*
6Z4	84	67	37*
14Z3	12Z3	67-A	37*
25Z5MG	25Z6	68	38*
1	1-v	68-A	38*
'00	00-A	'71	71-A
'01	01-A	'71-B	71-A
'12	112-A	'80M	83**
'13	80	88	83**
'13-B	80	95	2A5
'16	81	98	84
'16-B	81	182A	71-A
'24	24-A	482A	71-A
25S	1B5/25S	585	50
27HM	56	586	50
'36-A	36	P-861	84
'37-A	37	951	1B4
'38-A	38	986	83**
'39	39/44	AD	1-v
'39-A	39/44	AF	82
43MG	25A6	AG	83
'44	39/44	KR-1	1-v
HZ50	12Z3	KR-5	6A4
'51	35	KR-25	2A5
56-A	76*	KR-28	84
57-A	6C6*	LA	6A4
58-A	6D6*	PZ	47
64	36*	PZH	2A5
64-A	36*		

**Except when heaters are connected in series.*
***When receiver's power transformer will stand additional filament current.*

RCA RADIO TUBE CHART

RADIO TUBES

TYPE	NAME	BASE	SOCKET CONNEC-TIONS	DIMENSIONS MAXIMUM OVERALL LENGTH x DIAMETER	CATHODE TYPE ■	RATING: FILAMENT OR HEATER VOLTS	RATING: FILAMENT OR HEATER AMPERES	RATING: PLATE MAX. VOLTS	RATING: SCREEN MAX. VOLTS	USE Values to right give operating conditions and characteristics for indicated typical use	PLATE SUP-PLY VOLTS	GRID BIAS ■ VOLTS	SCREEN SUPPLY VOLTS	SCREEN CUR-RENT MA.	PLATE CUR-RENT MA.	A-C PLATE RESIS-TANCE OHMS	TRANS-CONDUC-TANCE (GRID-PLATE) µMHOS	AMPLIFI-CATION FACTOR	LOAD FOR STATED POWER OUTPUT OHMS	POWER OUT-PUT WATTS	TYPE
00-A	DETECTOR TRIODE	MEDIUM 4-PIN Bayonet	4D	4 11/16" x 1 13/16"	D-C FILAMENT	5.0	0.25	45	—	GRID-LEAK DETECTOR	45	Grid Return to (−) Filament			1.5	30000	666	20	—	—	00-A
01-A	DETECTOR★ AMPLIFIER	MEDIUM 4-PIN Bayonet	4D	4 11/16" x 1 13/16"	D-C FILAMENT	5.0	0.25	135	—	CLASS A AMPLIFIER	90 135	− 4.5 − 9.0	—	—	2.5 3.0	11000 10000	725 800	8.0 8.0	—	—	01-A
1A4	SUPER-CONTROL R-F AMPLIFIER PENTODE	SMALL 4-PIN	4M	4 17/32" x 1 9/16"	D-C FILAMENT	2.0	0.06	180	67.5	CLASS A AMPLIFIER	90 180	− 3.0 min.	67.5 67.5	0.9 0.8	2.2 2.3	600000 1000000	720 750	425 750	—	—	1A4
1A6	PENTAGRID CONVERTER ●	SMALL 6-PIN	6L	4 17/32" x 1 9/16"	D-C FILAMENT	2.0	0.06	180	67.5	CONVERTER	135 180	− 3.0 min.	67.5 67.5	2.5 2.4	1.2 1.3	400000 500000	Anode-Grid (#2): 180 ■ max. volts, 2.3 ma. Oscillator-Grid (#1) Resistor ●. Conversion Conductance, 300 micromhos.				1A6
1B4	R-F AMPLIFIER PENTODE	SMALL 4-PIN	4M	4 17/32" x 1 9/16"	D-C FILAMENT	2.0	0.06	180	67.5	CLASS A AMPLIFIER	90 180	− 3.0 − 3.0	67.5 67.5	0.7 0.6	1.6 1.7	1000000 1500000	600 650	550 1000	—	—	1B4
1B5/25S	DUPLEX-DIODE TRIODE	SMALL 6-PIN	6M	4 1/4" x 1 9/16"	D-C FILAMENT	2.0	0.06	135	—	CLASS A AMPLIFIER	135	− 3.0	—	—	0.8	35000	575	20	—	—	1B5/25S
1C6	PENTAGRID CONVERTER ●	SMALL 6-PIN	6L	4 17/32" x 1 9/16"	D-C FILAMENT	2.0	0.12	180	67.5	CONVERTER	135 180	− 3.0 min.	67.5 67.5	2.0 2.0	1.3 1.5	550000 750000	Anode-Grid (#2): 180 ■ max. volts, 3.3 ma. Oscillator-Grid (#1) Resistor ●. Conversion Conductance, 325 micromhos.				1C6
1F4	POWER AMPLIFIER PENTODE	MEDIUM 5-PIN	5K	4 11/16" x 1 13/16"	D-C FILAMENT	2.0	0.12	135	135	CLASS A AMPLIFIER	135	− 4.5	135	2.6	8.0	200000	1700	340	16000	0.34	1F4
1F6	DUPLEX-DIODE PENTODE	SMALL 6-PIN	6W	4 17/32" x 1 9/16"	D-C FILAMENT	2.0	0.06	180	67.5	PENTODE UNIT AS R-F AMPLIFIER	180	− 1.5	67.5	0.6	2.0	1000000	650	650	—	—	1F6
										PENTODE UNIT AS A-F AMPLIFIER	135 ✱	− 2.0	Screen Supply, 135 volts applied through 0.8-megohm resistor. Grid Resistor, ✱✱ 1.0 megohm. Voltage Gain, 46.								
1-V	HALF-WAVE RECTIFIER	SMALL 4-PIN	4G	4 1/4" x 1 9/16"	HEATER	6.3	0.3	—	—	Maximum A-C Plate Voltage ... 350 Volts, RMS Maximum D-C Output Current ... 50 Milliamperes											1-V
2A3	POWER AMPLIFIER TRIODE	MEDIUM 4-PIN	4D	5 3/8" x 2 1/16"	FILAMENT	2.5	2.5	250	—	CLASS A AMPLIFIER	250	−45.0	—	—	60.0	800	5250	4.2	2500	3.5	2A3
								300	—	PUSH-PULL CLASS AB₁ AMPLIFIER	300 300	Self-bias, 780 ohms −62 volts, fixed bias			80.0 80.0	—	—	—	5000 3000	10.0† 15.0†	
2A5	POWER AMPLIFIER PENTODE	MEDIUM 6-PIN	6B	4 11/16" x 1 13/16"	HEATER	2.5	1.75	—	—	AMPLIFIER	For other ratings and characteristics, refer to Type 42.										2A5
2A6	DUPLEX-DIODE HIGH-MU TRIODE	SMALL 6-PIN	6G	4 17/32" x 1 9/16"	HEATER	2.5	0.8	250	—	TRIODE UNIT AS AMPLIFIER	For other characteristics, refer to Type 75.										2A6
2A7	PENTAGRID CONVERTER ●	SMALL 7-PIN	7C	4 17/32" x 1 9/16"	HEATER	2.5	0.8	250	100	CONVERTER	For other characteristics, refer to Type 6A7.										2A7
2B7	DUPLEX-DIODE PENTODE	SMALL 7-PIN	7D	4 17/32" x 1 9/16"	HEATER	2.5	0.8	250	125	AMPLIFIER	For other characteristics, refer to Type 6B7.										2B7

5W4	FULL-WAVE RECTIFIER	SMALL OCTAL 5-PIN	5T	3 1/4" x 1 5/16"	FILAMENT	5.0	1.5	—	—		Maximum A-C Voltage per Plate .... 350 Volts, RMS Maximum D-C Output Current .... 110 Milliamperes										5W4
5Z3	FULL-WAVE RECTIFIER	MEDIUM 4-PIN	4C	5 3/8" x 2 1/16"	FILAMENT	5.0	3.0	—	—		Maximum A-C Voltage per Plate .... 500 Volts, RMS Maximum D-C Output Current .... 250 Milliamperes										5Z3
5Z4	FULL-WAVE RECTIFIER	SMALL OCTAL 5-PIN	5L	3 1/4" x 1 5/16"	HEATER	5.0	2.0	—	—		Maximum A-C Voltage per Plate .... 400 Volts, RMS Maximum D-C Output Current .... 125 Milliamperes										5Z4
6A4/LA	POWER AMPLIFIER PENTODE	MEDIUM 5-PIN	5B	4 11/16" x 1 13/16"	FILAMENT	6.3	0.3	180	180	CLASS A AMPLIFIER	100 180	−6.5 −12.0	100 180	1.6 3.9	9.0 22.0	83250 45500	1200 2200	100 100	11000 8000	0.31 1.40	6A4/LA
6A6	TWIN-TRIODE AMPLIFIER	MEDIUM 7-PIN ✱	7B	4 11/16" x 1 13/16"	HEATER	6.3	0.8	300	—	AMPLIFIER	For other characteristics, refer to Type 6N7.										6A6
6A7	PENTAGRID CONVERTER ■	SMALL 7-PIN	7C	4 17/32" x 1 9/16"	HEATER	6.3	0.3	250	100	CONVERTER	100 250	(−3.0 min.)	50 100	2.5 2.2	1.3 3.5	600000 360000	Anode-Grid (#2): 250 ■ max. volts, 4.0 ma. Oscillator-Grid (#1) Resistor ■. Conversion Conductance, 520 micromhos.				6A7
6A8	PENTAGRID CONVERTER ■	SMALL OCTAL 8-PIN	8A	3 1/4" x 1 5/16"	HEATER	6.3	0.3	250	100	CONVERTER	100 250	(−3.0 min.)	50 100	1.5 3.2	1.2 3.3	600000 360000	Anode-Grid (#2): 250 ■ max. volts, 4.0 ma. Oscillator-Grid (#1) Resistor ■. Conversion Conductance, 500 micromhos.				6A8
6B7	DUPLEX-DIODE PENTODE	SMALL 7-PIN	7D	4 17/32" x 1 9/16"	HEATER	6.3	0.3	250	125	PENTODE UNIT AS R-F AMPLIFIER	100 250	−3.0 −3.0	100 125	1.7 2.3	5.8 9.0	300000 650000	950 1125	285 730	—	—	6B7
										PENTODE UNIT AS A-F AMPLIFIER	90 ✖ 300 ✖	Self-bias, 3500 ohms. Screen Resistor = 1.1 meg. Self-bias, 1600 ohms. Screen Resistor = 1.2 meg.					Grid Resistor,** 0.5 megohm.		Gain per stage = 55 Gain per stage = 79		
6B8	DUPLEX-DIODE PENTODE	SMALL OCTAL 8-PIN	8E	3 1/4" x 1 5/16"	HEATER	6.3	0.3	250	125	PENTODE UNIT AS R-F AMPLIFIER	250	−3.0	125	2.3	10.0	600000	1325	800	—	—	6B8
										PENTODE UNIT AS A-F AMPLIFIER	90 ✖ 300 ✖	Self-bias, 3500 ohms. Screen Resistor = 1.1 meg. Self-bias, 1600 ohms. Screen Resistor = 1.2 meg.					Grid Resistor,** 0.5 megohm.		Gain per stage = 55 Gain per stage = 79		
6C5	DETECTOR ✱ AMPLIFIER TRIODE	SMALL OCTAL 6-PIN	6Q	2 5/8" x 1 5/16"	HEATER	6.3	0.3	250	—	CLASS A AMPLIFIER	250 250 ▼	−8.0 −5.0	—	—	8.0 1.0	10000 Gain per stage = 14	2000	20	—	—	6C5
										BIAS DETECTOR	250	(−17.0 approx.)	—	—	Plate current to be adjusted to 0.2 milliampere with no signal.						
6C6	TRIPLE-GRID DETECTOR AMPLIFIER	SMALL 6-PIN	6F	4 17/32" x 1 9/16"	HEATER	6.3	0.3	250	100	AMPLIFIER DETECTOR	For other characteristics, refer to Type 6J7.										6C6
6D6	TRIPLE-GRID SUPER-CONTROL AMPLIFIER	SMALL 6-PIN	6F	4 17/32" x 1 9/16"	HEATER	6.3	0.3	250	100	SCREEN-GRID R-F AMPLIFIER	100 250	(−3.0 min.)	100 100	2.2 2.0	8.0 8.2	250000 800000	1500 1600	375 1280	—	—	6D6
										MIXER IN SUPERHETERODYNE	100 250	−10.0 −10.0	100 100	—	—	Oscillator Peak Volts = 7.0					
6E5	ELECTRON-RAY TUBE	SMALL 6-PIN	6R	4 1/4" x 1 5/16"	HEATER	6.3	0.3	250 ‡	—	VISUAL INDICATOR	Plate & Target Supply = 100 volts. Triode Plate Resistor = 0.5 meg. Target Current = 4.5 ma. Grid Bias, −3.3 volts; Shadow Angle, 0°. Bias, 0 volts; Angle, 90°; Plate Current, 0.19 ma. Plate & Target Supply = 250 volts. Triode Plate Resistor = 1.0 meg. Target Current = 4.5 ma. Grid Bias, −8.0 volts; Shadow Angle, 0°. Bias, 0 volts; Angle, 90°; Plate Current, 0.24 ma.										6E5
6F5	*HIGH-MU TRIODE	SMALL OCTAL 5-PIN	5M	3 1/4" x 1 5/16"	HEATER	6.3	0.3	250	—	CLASS A AMPLIFIER	250 250 ✖	−2.0 −0.3	—	—	0.9 0.4	66000 Grid Resistor, 0.25 meg.** Gain per stage = 52	1500	100	—	—	6F5
6F6	POWER AMPLIFIER PENTODE	SMALL OCTAL 7-PIN	7S	3 1/4" x 1 5/16"	HEATER	6.3	0.7	315	315	PENTODE CLASS A AMPLIFIER	250 315	−16.5 −22.0	250 315	6.5 8.0	34.0 42.0	80000 75000	2500 2650	200 200	7000 7000	3.0 5.0	6F6
								250	—	TRIODE □ CLASS A AMPLIFIER	250	−20.0	—	—	31.0	2600	2700	7	4000	0.85	
								375	250	PENTODE PUSH-PULL CLASS AB₁ AMPLIFIER	375 375	Self-bias −26.0	250 250	8.0 5.0	54.0 34.0	Self-Bias Resistor, 340 ohms —	— —	— —	10000 10000	19.0† 19.0†	
								350	—	TRIODE PUSH-PULL □ CLASS AB₂ AMPLIFIER	350 350	Self-bias −38.0	—	—	50.0 45.0	Self-Bias Resistor, 730 ohms —	— —	— —	10000 6000	14.0† 18.0†	

TYPE	NAME	BASE	SOCKET CONNECTIONS	DIMENSIONS MAXIMUM OVERALL LENGTH x DIAMETER	CATHODE TYPE ■	RATING: FILAMENT OR HEATER VOLTS	RATING: FILAMENT OR HEATER AMPERES	RATING: PLATE MAX. VOLTS	RATING: SCREEN MAX. VOLTS	USE Values to right give operating conditions and characteristics for indicated typical use	PLATE SUPPLY VOLTS	GRID BIAS ■ VOLTS	SCREEN SUPPLY VOLTS	SCREEN CURRENT MA.	PLATE CURRENT MA.	A-C PLATE RESISTANCE OHMS	TRANSCONDUCTANCE (GRID-PLATE) µMHOS	AMPLIFICATION FACTOR	LOAD FOR STATED POWER OUTPUT OHMS	POWER OUTPUT WATTS	TYPE
6F7	TRIODE-PENTODE	SMALL 7-PIN	7E	$4\frac{17}{32}$" x $1\frac{9}{16}$"	HEATER	6.3	0.3	100	—	TRIODE UNIT AS CLASS A AMPLIFIER	100	− 3.0	—	—	3.5	16000	500	8	—	—	6F7
								250	100	PENTODE UNIT AS CLASS A AMPLIFIER	100 250	− 3.0 min.	100 100	1.6 1.5	6.3 6.5	290000 850000	1050 1100	300 900	—	—	
								250	100	PENTODE UNIT AS MIXER	250	−10.0	100	0.6	2.8	Oscillator Peak Volts = 7.0. Conversion Conductance = 300 micromhos.					
6G5	ELECTRON-RAY TUBE	SMALL 6-PIN	6R	$4\frac{1}{4}$" x $1\frac{9}{16}$"	HEATER	6.3	0.3	250‡	—	VISUAL INDICATOR	Plate & Target Supply = 100 volts. Triode Plate Resistor = 0.5 meg. Target Current = 4.5 ma. Grid Bias, −8 volts; Shadow Angle, 0°. Bias, 0 volts; Angle, 90°; Plate Current, 0.19 ma.										6G5
											Plate & Target Supply = 250 volts. Triode Plate Resistor = 1.0 meg. Target Current = 4.5 ma. Grid Bias, −22 volts; Shadow Angle, 0°. Bias, 0 volts; Angle, 90°, Plate Current, 0.24 ma.										
6H6	TWIN DIODE	SMALL OCTAL 7-PIN	7Q	$1\frac{5}{8}$" x $1\frac{5}{16}$"	HEATER	6.3	0.3	—	—	TWIN-DIODE DETECTOR RECTIFIER	Maximum A-C Voltage per Plate..........100 Volts, RMS Maximum D-C Output Current..........4 Milliamperes										6H6
6J7	TRIPLE-GRID DETECTOR AMPLIFIER	SMALL OCTAL 7-PIN	7R	$3\frac{1}{4}$" x $1\frac{5}{16}$"	HEATER	6.3	0.3	250	125	SCREEN-GRID R-F AMPLIFIER	100 250	− 3.0 − 3.0	100 100	0.5 0.5	2.0 2.0	1000000 1.5+§	1185 1225	1185 1500+	—	—	6J7
										SCREEN-GRID A-F AMPLIFIER	90 ✕ 300 ✕	Self-bias, 2600 ohms. Screen Resistor = 1.2 meg. Self-bias, 1200 ohms. Screen Resistor = 1.2 meg.					Grid Resistor,** 0.5 megohm.		Gain per stage = 85 Gain per stage = 140		
										BIAS DETECTOR	250	− 4.3	100	Cathode current 0.43 ma.		—	Plate Resistor, 500000 ohms. Grid Resistor,** 250000 ohms.				
6K7	TRIPLE-GRID SUPER-CONTROL AMPLIFIER	SMALL OCTAL 7-PIN	7R	$3\frac{1}{4}$" x $1\frac{5}{16}$"	HEATER	6.3	0.3	250	125	SCREEN-GRID R-F AMPLIFIER	90 250	− 3.0 min.	90 125	1.3 2.6	5.4 10.5	315000 600000	1275 1650	400 990	—	—	6K7
										MIXER IN SUPERHETERODYNE	250	−10.0	100	—	—	Oscillator Peak Volts = 7.0					
6L6	BEAM POWER AMPLIFIER	SMALL OCTAL 7-PIN	7AC	$4\frac{5}{16}$" x $1\frac{5}{8}$"	HEATER	6.3	0.9	375	250	SINGLE-TUBE CLASS A_1 AMPLIFIER	250 250	−14.0 Self-bias	250 250	5.0 5.4	72.0 75.0	— Self-Bias Resistor, 170 ohms.	—	—	2500 2500	6.5 6.5	6L6
								375	250	PUSH-PULL CLASS A_1 AMPLIFIER	250 250	−16.0 Self-bias	250 250	10.0 10.0	120.0 120.0	— Self-Bias Resistor, 125 ohms.	—	—	5000 5000	14.5† 13.8†	
								400	300	PUSH-PULL CLASS AB_1 AMPLIFIER	400 400	−25.0 Self-bias	300 300	6.0 7.0	102.0 112.0	— Self-Bias Resistor, 200 ohms.	—	—	6600 6600	34.0† 32.0†	
								400	300	PUSH-PULL CLASS AB_2 AMPLIFIER	400 400	−20.0 −25.0	250 300	4.0 6.0	88.0 102.0	—	—	—	6000 3800	40.0† 60.0†	
6L7	PENTAGRID MIXER & AMPLIFIER	SMALL OCTAL 7-PIN	7T	$3\frac{1}{4}$" x $1\frac{5}{16}$"	HEATER	6.3	0.3	250	150	MIXER IN SUPERHETERODYNE	250	− 3.0	100	6.2	2.4	Oscillator-Grid (#3) Bias, −10 volts. Grid #3 Peak Swing, 12 volts min. Conversion Conductance, 350 micromhos.					6L7
								250	100	CLASS A AMPLIFIER	250	− 3.0 min.¶	100	5.5	5.3	800000	1100	880	—	—	
6N7	TWIN-TRIODE AMPLIFIER	SMALL OCTAL 8-PIN	8B	$3\frac{1}{4}$" x $1\frac{5}{16}$"	HEATER	6.3	0.8	300	—	CLASS A AMPLIFIER (As Driver)⊙	250 294	− 5.0 − 6.0	—	—	6.0 7.0	11300 11000	3100 3200	35 35	20000 or more	exceeds 0.4	6N7
										CLASS B AMPLIFIER	250 300	0 0	—	—	Power Output is for one tube at stated plate-to-plate load.				8000 10000	8.0 10.0	

6Q7	DUPLEX-DIODE HIGH-MU TRIODE	SMALL OCTAL 7-PIN	7V	3-1/8" x 1-5/16"	HEATER	6.3	0.3	250	—	TRIODE UNIT AS CLASS A AMPLIFIER	100 250	− 1.5 − 3.0	—	—	0.35 1.1	87500 58000	800 1200	70 70	—	—	6Q7
											100°° 250■	− 1.1 − 2.0	—	—	0.25 0.5	Grid Resistor, ** 0.5 megohm		Gain per stage = 35 Gain per stage = 43			
6R7	DUPLEX-DIODE TRIODE	SMALL OCTAL 7-PIN	7V	3-1/8" x 1-5/16"	HEATER	6.3	0.3	250	—	TRIODE UNIT AS CLASS A AMPLIFIER	250 250♥	− 9.0 − 6.0	—	—	9.5 1.3	8500 Grid Resistor, ** 0.5 meg. Gain per stage = 12	1900	16	10000	0.28	6R7
6X5	FULL-WAVE RECTIFIER	SMALL OCTAL 6-PIN	6S	3-1/4" x 1-5/16"	HEATER	6.3	0.6	—	—	Maximum A-C Voltage per Plate..........350 Volts, RMS Maximum D-C Output Current..........75 Milliamperes											6X5
10	POWER AMPLIFIER TRIODE	MEDIUM 4-PIN Bayonet	4D	5-5/8" x 2-3/16"	FILAMENT	7.5	1.25	425	—	CLASS A AMPLIFIER	350 425	−32.0 −40.0	—	—	16.0 18.0	5150 5000	1550 1600	8.0 8.0	11000 10200	0.9 1.6	10
11 12	DETECTOR★ AMPLIFIER TRIODE	WD 4-PIN MEDIUM 4-PIN Bayonet	4F 4D	4-1/8" x 1-3/16" 4-11/16" x 1-7/16"	D-C FILAMENT	1.1	0.25	135	—	CLASS A AMPLIFIER	90 135	− 4.5 −10.5	—	—	2.5 3.0	15500 15000	425 440	6.6 6.6	—	—	11 12
12Z3	HALF-WAVE RECTIFIER	SMALL 4-PIN	4G	4-1/4" x 1-9/16"	HEATER	12.6	0.3	—	—	Maximum A-C Plate Voltage..........250 Volts, RMS Maximum D-C Output Current..........60 Milliamperes											12Z3
15	R-F AMPLIFIER PENTODE	SMALL 5-PIN	5F	4-17/32" x 1-9/16"	HEATER	2.0	0.22	135	67.5	CLASS A AMPLIFIER	67.5 135	− 1.5 − 1.5	67.5 67.5	0.3 0.3	1.85 1.85	630000 800000	710 750	450 600	—	—	15
19	TWIN-TRIODE AMPLIFIER	SMALL 6-PIN	6C	4-1/4" x 1-9/16"	D-C FILAMENT	2.0	0.26	135	—	CLASS B AMPLIFIER	135 135	0 − 3.0	—	—	Power Output is for one tube at stated plate-to-plate load.				10000 10000	2.1 1.9	19
20	POWER AMPLIFIER TRIODE	SMALL 4-PIN	4D	4-1/8" x 1-3/16"	D-C FILAMENT	3.3	0.132	135	—	CLASS A AMPLIFIER	90 135	−16.5 −22.5	—	—	3.0 6.5	8000 6300	415 525	3.3 3.3	9600 6500	0.045 0.110	20
22	R-F AMPLIFIER TETRODE	MEDIUM 4-PIN	4K	5-17/32" x 1-13/16"	D-C FILAMENT	3.3	0.132	135	67.5	SCREEN-GRID R-F AMPLIFIER	135 135	− 1.5 − 1.5	45 67.5	0.6* 1.3*	1.7 3.7	725000 325000	375 500	270 160	—	—	22
24-A	R-F AMPLIFIER TETRODE	MEDIUM 5-PIN	5E	5-17/32" x 1-13/16"	HEATER	2.5	1.75	275	90	SCREEN-GRID R-F AMPLIFIER	180 250	− 3.0 − 3.0	90 90	1.7* 1.7*	4.0 4.0	400000 600000	1000 1050	400 630	—	—	24-A
										BIAS DETECTOR	250●	−5.0 (approx.)	20 to 45	—	Plate current to be adjusted to 0.1 milliampere with no signal.						
25A6	POWER AMPLIFIER PENTODE	SMALL OCTAL 7-PIN	7S	3-1/4" x 1-5/16"	HEATER	25.0	0.3	180	135	CLASS A AMPLIFIER	95 180	−15.0 −20.0	95 135	4.0 7.5	20.0 38.0	45000 40000	2000 2500	90 100	4500 5000	0.9 2.75	25A6
25Z5	RECTIFIER-DOUBLER	SMALL 6-PIN	6E	4-1/4" x 1-9/16"	HEATER	25.0	0.3	—	—	VOLTAGE DOUBLER	Maximum A-C Voltage per Plate..........125 Volts, RMS Maximum D-C Output Current..........100 Milliamperes										25Z5
										HALF-WAVE RECTIFIER	Maximum A-C Voltage per Plate ▼..........250 Volts, RMS Maximum D-C Output Current per Plate..........85 Milliamperes										
25Z6	RECTIFIER-DOUBLER	SMALL OCTAL 7-PIN	7Q	3-1/4" x 1-5/16"	HEATER	25.0	0.3	—	—	VOLTAGE DOUBLER	Maximum A-C Voltage per Plate..........125 Volts, RMS Maximum D-C Output Current..........85 Milliamperes										25Z6
										HALF-WAVE RECTIFIER	Maximum A-C Voltage per Plate ▼..........250 Volts, RMS Maximum D-C Output Current per Plate..........85 Milliamperes										
26	AMPLIFIER TRIODE	MEDIUM 4-PIN	4D	4-11/16" x 1-13/16"	FILAMENT	1.5	1.05	180	—	CLASS A AMPLIFIER	90 180	− 7.0 −14.5	—	—	2.9 6.2	8900 7300	935 1150	8.3 8.3	—	—	26
27	DETECTOR★ AMPLIFIER TRIODE	MEDIUM 5-PIN	5A	4-1/4" x 1-9/16"	HEATER	2.5	1.75	275	—	CLASS A AMPLIFIER	135 250	− 9.0 −21.0	—	—	4.5 5.2	9000 9250	1000 975	9.0 9.0	—	—	27
										BIAS DETECTOR	250	−30.0 (approx.)	—	—	Plate current to be adjusted to 0.2 milliampere with no signal.						
30	DETECTOR★ AMPLIFIER TRIODE	SMALL 4-PIN	4D	4-1/4" x 1-9/16"	D-C FILAMENT	2.0	0.06	180	—	CLASS A AMPLIFIER	90 135 180	− 4.5 − 9.0 −13.5	—	—	2.5 3.0 3.1	11000 10300 10300	850 900 900	9.3 9.3 9.3	—	—	30
										CLASS B AMPLIFIER	157.5	−15.0	—	—	1.0	—	—	—	8000	2.1†	

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TYPE	NAME	BASE	SOCKET CONNEC-TIONS	DIMENSIONS MAXIMUM OVERALL LENGTH x DIAMETER	CATHODE TYPE ■	RATING: FILAMENT OR HEATER VOLTS	RATING: FILAMENT OR HEATER AMPERES	RATING: PLATE MAX. VOLTS	RATING: SCREEN MAX. VOLTS	USE Values to right give operating conditions and characteristics for indicated typical use	PLATE SUP-PLY VOLTS	GRID BIAS ■ VOLTS	SCREEN SUPPLY VOLTS	SCREEN CUR-RENT MA.	PLATE CUR-RENT MA.	A-C PLATE RESIS-TANCE OHMS	TRANS-CONDUC-TANCE (GRID-PLATE) µMHOS	AMPLIFI-CATION FACTOR	LOAD FOR STATED POWER OUTPUT OHMS	POWER OUT-PUT WATTS	TYPE
31	POWER AMPLIFIER TRIODE	SMALL 4-PIN	4D	$4\frac{1}{4}$" x $1\frac{9}{16}$"	D-C FILAMENT	2.0	0.13	180	—	CLASS A AMPLIFIER	135 180	−22.5 −30.0	—	—	8.0 12.3	4100 3600	925 1050	3.8 3.8	7000 5700	0.185 0.375	31
32	R-F AMPLIFIER TETRODE	MEDIUM 4-PIN	4K	$5\frac{3}{32}$" x $1\frac{13}{16}$"	D-C FILAMENT	2.0	0.06	180	67.5	SCREEN-GRID R-F AMPLIFIER	135 180	− 3.0 − 3.0	67.5 67.5	0.4* 0.4*	1.7 1.7	950000 1200000	640 650	610 780	—	—	32
										BIAS DETECTOR	180♥	− 6.0 approx.	67.5	—	Plate current to be adjusted to 0.2 milliampere with no signal.						
33	POWER AMPLIFIER PENTODE	MEDIUM 5-PIN	5K	$4\frac{11}{16}$" x $1\frac{13}{16}$"	D-C FILAMENT	2.0	0.26	180	180	CLASS A AMPLIFIER	180	−18.0	180	5.0	22.0	55000	1700	90	6000	1.4	33
34	SUPER-CONTROL R-F AMPLIFIER PENTODE	MEDIUM 4-PIN	4M	$5\frac{3}{32}$" x $1\frac{13}{16}$"	D-C FILAMENT	2.0	0.06	180	67.5	SCREEN-GRID R-F AMPLIFIER	135 180	− 3.0 min.	67.5 67.5	1.0 1.0	2.8 2.8	600000 1000000	600 620	360 620	—	—	34
35	SUPER-CONTROL R-F AMPLIFIER TETRODE	MEDIUM 5-PIN	5E	$5\frac{3}{32}$" x $1\frac{13}{16}$"	HEATER	2.5	1.75	275	90	SCREEN-GRID R-F AMPLIFIER	180 250	− 3.0 min.	90 90	2.5* 2.5*	6.3 6.5	300000 400000	1020 1050	305 420	—	—	35
36	R-F AMPLIFIER TETRODE	SMALL 5-PIN	5E	$4\frac{17}{32}$" x $1\frac{9}{16}$"	HEATER	6.3	0.3	250	90	SCREEN-GRID R-F AMPLIFIER	100 250	− 1.5 − 3.0	55 90	— 1.7*	1.8 3.2	550000 550000	850 1080	470 595	—	—	36
										BIAS DETECTOR	100● 250●	− 5.0 − 8.0	55 90	—	Grid-bias values are approximate. Plate current to be adjusted to 0.1 milliampere with no signal.						
37	DETECTOR★ AMPLIFIER TRIODE	SMALL 5-PIN	5A	$4\frac{1}{4}$" x $1\frac{9}{16}$"	HEATER	6.3	0.3	250	—	CLASS A AMPLIFIER	90 250	− 6.0 −18.0	—	—	2.5 7.5	11500 8400	800 1100	9.2 9.2	—	—	37
										BIAS DETECTOR	90 250	−10.0 −28.0	—	—	Grid-bias values are approximate. Plate current to be adjusted to 0.2 milliampere with no signal.						
38	POWER AMPLIFIER PENTODE	SMALL 5-PIN	5F	$4\frac{17}{32}$" x $1\frac{9}{16}$"	HEATER	6.3	0.3	250	250	CLASS A AMPLIFIER	100 250	− 9.0 −25.0	100 250	1.2 3.8	7.0 22.0	140000 100000	875 1200	120 120	15000 10000	0.27 2.50	38
39/44	SUPER-CONTROL R-F AMPLIFIER PENTODE	SMALL 5-PIN	5F	$4\frac{17}{32}$" x $1\frac{9}{16}$"	HEATER	6.3	0.3	250	90	SCREEN-GRID R-F AMPLIFIER	90 250	− 3.0 min.	90 90	1.6 1.4	5.6 5.8	375000 1000000	960 1050	360 1050	—	—	39/44
40	VOLTAGE AMPLIFIER TRIODE	MEDIUM 4-PIN Bayonet	4D	$4\frac{11}{16}$" x $1\frac{13}{16}$"	D-C FILAMENT	5.0	0.25	180	—	CLASS A AMPLIFIER	135⌘ 180⌘	− 1.5 − 3.0	—	—	0.2 0.2	150000 150000	200 200	30 30	—	—	40
41	POWER AMPLIFIER PENTODE	SMALL 6-PIN	6B	$4\frac{1}{4}$" x $1\frac{9}{16}$"	HEATER	6.3	0.4	250	250	CLASS A AMPLIFIER	100 250	− 7.0 −18.0	100 250	1.6 5.5	9.0 32.0	103500 68000	1450 2200	150 150	12000 7600	0.33 3.40	41
42	POWER AMPLIFIER PENTODE	MEDIUM 6-PIN	6B	$4\frac{11}{16}$" x $1\frac{13}{16}$"	HEATER	6.3	0.7	315	315	PENTODE CLASS A AMPLIFIER	250 315	−16.5 −22.0	250 315	6.5 8.0	34.0 42.0	80000 100000	2350 2600	190 260	7000 7000	3.0 5.0	42
								315	—	TRIODE□ CLASS A AMPLIFIER	250	−20.0	—	—	31.0	2700	2300	6.2	3000	0.65	
								375	250	PENTODE PUSH-PULL CLASS AB_1 AMPLIFIER	375 375	Self-bias −26.0	250 250	8.0 5.0	54.0 34.0	Self-Bias Resistor, 340 ohms —	— —	— —	10000 10000	19.0† 19.0†	
								350	—	TRIODE PUSH-PULL□ CLASS AB_2 AMPLIFIER	350 350	Self-bias, 730 ohms −38.0 volts, fixed bias			50.0 45.0	—	—	—	10000 6000	14.0† 18.0†	
43	POWER AMPLIFIER PENTODE	MEDIUM 6-PIN	6B	$4\frac{11}{16}$" x $1\frac{13}{16}$"	HEATER	25.0	0.3	180	135	CLASS A AMPLIFIER	95 180	−15.0 −20.0	95 135	4.0 7.5	20.0 38.0	45000 40000	2000 2500	90 100	4500 5000	0.90 2.75	43

45	POWER AMPLIFIER TRIODE	MEDIUM 4-PIN	4D	4 11/16" x 1 13/16"	FILAMENT	2.5	1.5	275	—	CLASS A AMPLIFIER	180 275	−31.5 −56.0	—	—	31.0 36.0	1650 1700	2125 2050	3.5 3.5	2700 4600	0.82 2.00	45
										CLASS AB$_2$ AMPLIFIER	275 275	Self-bias, 775 ohms −68.0 volts, fixed bias			72.0 28.0	—	—	—	5060 3200	12.0† 18.0†	
46	DUAL-GRID POWER AMPLIFIER	MEDIUM 5-PIN	5C	5 3/8" x 2 3/16"	FILAMENT	2.5	1.75	250	—	CLASS A AMPLIFIER □	250	−33.0	—	—	22.0	2380	2350	5.6	6400	1.25	46
								400	—	CLASS B AMPLIFIER ♦	300 400	0 0	—	—	8.0 12.0	—	—	—	5200 5800	16.0† 20.0†	
47	POWER AMPLIFIER PENTODE	MEDIUM 5-PIN	5B	5 3/8" x 2 3/16"	FILAMENT	2.5	1.75	250	250	CLASS A AMPLIFIER	250	−16.5	250	6.0	31.0	60000	2500	150	7000	2.7	47
48	POWER AMPLIFIER TETRODE	MEDIUM 6-PIN	6A	5 3/8" x 2 1/16"	D-C HEATER	30.0	0.4	125	100	TETRODE CLASS A AMPLIFIER	96 125	−19.0 −20.0	96 100	9.0 9.5	52.0 56.0	— —	3800 3900	— —	1500 1500	2.0 2.5	48
										TETRODE PUSH-PULL CLASS A AMPLIFIER	125	−20.0	100	—	100.0	—	—	—	3000	5.0†	
49	DUAL-GRID POWER AMPLIFIER	MEDIUM 5-PIN	5C	4 11/16" x 1 13/16"	D-C FILAMENT	2.0	0.12	135	—	CLASS A AMPLIFIER □	135	−20.0	—	—	6.0	4175	1125	4.7	11000	0.17	49
								180	—	CLASS B AMPLIFIER ♦	180	0	—	—	4.0	—	—	—	12000	3.5†	
50	POWER AMPLIFIER TRIODE	MEDIUM 4-PIN Bayonet	4D	6 1/4" x 2 7/16"	FILAMENT	7.5	1.25	450	—	CLASS A AMPLIFIER	300 400 450	−54.0 −70.0 −84.0	—	—	35.0 55.0 55.0	2000 1800 1800	1900 2100 2100	3.8 3.8 3.8	4600 3670 4350	1.6 3.4 4.6	50
53	TWIN-TRIODE AMPLIFIER	MEDIUM 7-PIN#	7B	4 11/16" x 1 13/16"	HEATER	2.5	2.0	300	—	AMPLIFIER	For other characteristics, refer to Type 6N7.										53
55	DUPLEX-DIODE TRIODE	SMALL 6-PIN	6G	4 11/32" x 1 9/16"	HEATER	2.5	1.0	250	—	TRIODE UNIT AS AMPLIFIER	For other characteristics, refer to Type 85.										55
56	SUPER-TRIODE AMPLIFIER DETECTOR★	SMALL 5-PIN	5A	4 1/4" x 1 9/16"	HEATER	2.5	1.0	250	—	AMPLIFIER DETECTOR	For other characteristics, refer to Type 76.										56
57	TRIPLE-GRID DETECTOR AMPLIFIER	SMALL 6-PIN	6F	4 11/16" x 1 9/16"	HEATER	2.5	1.0	250	100	AMPLIFIER DETECTOR	For other characteristics, refer to Type 6J7.										57
58	TRIPLE-GRID SUPER-CONTROL AMPLIFIER	SMALL 6-PIN	6F	4 11/16" x 1 9/16"	HEATER	2.5	1.0	250	100	AMPLIFIER MIXER	For other characteristics, refer to Type 6D6.										58
59	TRIPLE-GRID POWER AMPLIFIER	MEDIUM 7-PIN#	7A	5 3/8" x 2 1/16"	HEATER	2.5	2.0	250	—	TRIODE § CLASS A AMPLIFIER	250	−28.0	—	—	26.0	2300	2600	6.0	5000	1.25	59
								250	250	PENTODE** CLASS A AMPLIFIER	250	−18.0	250	9.0	35.0	40000	2500	100	6000	3.0	
								400	—	TRIODE● CLASS B AMPLIFIER	300 400	0 0	—	—	20.0 26.0	—	—	—	4600 6000	15.0† 20.0†	
71-A	POWER AMPLIFIER TRIODE	MEDIUM 4-PIN Bayonet	4D	4 11/16" x 1 13/16"	FILAMENT	5.0	0.25	180	—	CLASS A AMPLIFIER	90 180	−19.0 −43.0	—	—	10.0 20.0	2170 1750	1400 1700	3.0 3.0	3000 4800	0.125 0.790	71-A
75	DUPLEX-DIODE HIGH-MU TRIODE	SMALL 6-PIN	6G	4 11/32" x 1 9/16"	HEATER	6.3	0.3	250	—	TRIODE UNIT AS CLASS A AMPLIFIER	250✖	− 1.35	—	—	0.4	—	—	Gain per stage = 50-60			75
76	SUPER-TRIODE AMPLIFIER DETECTOR★	SMALL 5-PIN	5A	4 1/4" x 1 9/16"	HEATER	6.3	0.3	250	—	CLASS A AMPLIFIER	100 250 250♥	− 5.0 −13.5 − 9.0	—	—	2.5 5.0 1.0	12000 9500 —	1150 1450 —	13.8 13.8 —	—	—	76
										BIAS DETECTOR	250	−20.0 approx.	—	—	Plate current to be adjusted to 0.2 milliampere with no signal.						
77	TRIPLE-GRID DETECTOR AMPLIFIER	SMALL 6-PIN	6F	4 17/32" x 1 9/16"	HEATER	6.3	0.3	250	100	SCREEN-GRID R-F AMPLIFIER	100 250	− 1.5 − 3.0	60 100	0.4 0.5	1.7 2.3	650000 1500000	1100 1250	715 1500	—	—	77
										BIAS DETECTOR	250	− 1.95	50	Cathode current 0.65 ma.		—	Plate Resistor, 250000 ohms. Grid Resistor,** 250000 ohms.				

TYPE	NAME	BASE	SOCKET CONNECTIONS	DIMENSIONS MAXIMUM OVERALL LENGTH x DIAMETER	CATHODE TYPE ■	RATING				USE Values to right give operating conditions and characteristics for indicated typical use	PLATE SUPPLY VOLTS	GRID BIAS ■ VOLTS	SCREEN SUPPLY VOLTS	SCREEN CURRENT MA.	PLATE CURRENT MA.	A-C PLATE RESISTANCE OHMS	TRANSCONDUCTANCE (GRID-PLATE) µMHOS	AMPLIFICATION FACTOR	LOAD FOR STATED POWER OUTPUT OHMS	POWER OUTPUT WATTS	TYPE
						FILAMENT OR HEATER VOLTS	FILAMENT OR HEATER AMPERES	PLATE MAX. VOLTS	SCREEN MAX. VOLTS												
78	TRIPLE-GRID SUPER-CONTROL AMPLIFIER	SMALL 6-PIN	6F	4 17/32" x 1 9/16"	HEATER	6.3	0.3	250	125	AMPLIFIER MIXER	For other characteristics, refer to Type 6K7.										78
79	TWIN-TRIODE AMPLIFIER	SMALL 6-PIN	6H	4 17/32" x 1 9/16"	HEATER	6.3	0.6	250	—	CLASS B AMPLIFIER	180 250	0 0	—	—	Power Output is for one tube at stated plate-to-plate load.				7000 14000	5.5 8.0	79
80	FULL-WAVE RECTIFIER	MEDIUM 4-PIN	4C	4 11/16" x 1 13/16"	FILAMENT	5.0	2.0	—	—	A-C Voltage per Plate (Volts RMS)........ 350 400 550 D-C Output Current (Maximum MA.) 125 110 135					The 550-volt rating applies to filter circuits having an input choke of at least 20 henries.						80
81	HALF-WAVE RECTIFIER	MEDIUM 4-PIN Bayonet	4B	6 1/4" x 2 7/16"	FILAMENT	7.5	1.25	—	—	Maximum A-C Plate Voltage........700 Volts, RMS Maximum D-C Output Current........85 Milliamperes											81
82	FULL-WAVE ► RECTIFIER	MEDIUM 4-PIN	4C	4 11/16" x 1 13/16"	FILAMENT	2.5	3.0	—	—	Maximum A-C Voltage per Plate......500 Volts, RMS Maximum D-C Output Current........125 Milliamperes					Maximum Peak Inverse Voltage......1400 Volts Maximum Peak Plate Current........400 Milliamperes						82
83	FULL-WAVE ► RECTIFIER	MEDIUM 4-PIN	4C	5 3/8" x 2 1/16"	FILAMENT	5.0	3.0	—	—	Maximum A-C Voltage per Plate......500 Volts, RMS Maximum D-C Output Current........250 Milliamperes					Maximum Peak Inverse Voltage......1400 Volts Maximum Peak Plate Current........800 Milliamperes						83
83-V	FULL-WAVE RECTIFIER	MEDIUM 4-PIN	4L	4 11/16" x 1 13/16"	HEATER	5.0	2.0	—	—	Maximum A-C Voltage per Plate........400 Volts, RMS Maximum D-C Output Current........200 Milliamperes											83-V
84/6Z4	FULL-WAVE RECTIFIER	SMALL 5-PIN	5D	4 1/4" x 1 9/16"	HEATER	6.3	0.5	—	—	Maximum A-C Voltage per Plate........350 Volts, RMS Maximum D-C Output Current........60 Milliamperes											84/6Z4
85	DUPLEX-DIODE TRIODE	SMALL 6-PIN	6G	4 17/32" x 1 9/16"	HEATER	6.3	0.3	250	—	TRIODE UNIT AS CLASS A AMPLIFIER	135 250	−10.5 −20.0	—	—	3.7 8.0	11000 7500	750 1100	8.3 8.3	25000 20000	0.075 0.350	85
89	TRIPLE-GRID POWER AMPLIFIER	SMALL 6-PIN	6F	4 17/32" x 1 9/16"	HEATER	6.3	0.4	250	—	AS TRIODE ¶ CLASS A AMPLIFIER	160 250	−20.0 −31.0	—	—	17.0 32.0	3300 2600	1425 1800	4.7 4.7	7000 5500	0.30 0.90	89
								250	250	AS PENTODE ** CLASS A AMPLIFIER	100 250	−10.0 −25.0	100 250	1.6 5.5	9.5 32.0	104000 7000	1200 1800	125 125	10700 6750	0.33 3.40	
								250	—	AS TRIODE ● CLASS B AMPLIFIER	180	0	—	—	6.0	—	—	—	13600 9400	2.50† 3.50†	
V-99 X-99	DETECTOR★ AMPLIFIER TRIODE	SMALL 4-NUB SMALL 4-PIN	4E 4D	3 1/2" x 1 1/16" 4" x 1 3/16"	D-C FILAMENT	3.3	0.063	90	—	CLASS A AMPLIFIER	90	− 4.5	—	—	2.5	15500	425	6.6	—	—	V-99 X-99
112-A	DETECTOR★ AMPLIFIER TRIODE	MEDIUM 4-PIN Bayonet	4D	4 11/16" x 1 13/16"	D-C FILAMENT	5.0	0.25	180	—	CLASS A AMPLIFIER	90 180	− 4.5 −13.5	—	—	5.0 7.7	5400 4700	1575 1800	8.5 8.5	—	—	112-A
874	VOLTAGE REGULATOR	MEDIUM 4-PIN Bayonet	4S	5 3/8" x 2 3/16"	—	—	—	—	—	Minimum D-C Starting Supply Voltage......125 Volts D-C Operating Voltage........90 Volts					D-C Operating Current........10-50 Ma. Maximum Current (Continuous)........50 Ma.						874
876	CURRENT REGULATOR	MOGUL SCREW	—	8" x 2 1/16"	FILAMENT	—	—	—	—	Voltage Range........40 to 60 Volts					Operating Current........1.7 Amperes						876
886	CURRENT REGULATOR	MOGUL SCREW	—	8" x 2 1/16"	FILAMENT	—	—	—	—	Voltage Range........40 to 60 Volts					Operating Current........2.05 Amperes						886

★For Grid-leak Detection—plate volts 45, grid return to + filament or to cathode.
■Either A. C. or D. C. may be used on filament or heater, except as specifically noted. For use of D.C. on A-C filament types, decrease stated grid volts by ½ (approx.) of filament voltage.
● Supply voltage applied through 20000-ohm voltage-dropping resistor.
▶Mercury-Vapor Type.
••Grid #1 is control grid. Grid #2 is screen. Grid #3 tied to cathode.
¶Grid #1 is control grid. Grids #2 and #3 tied to plate.
■Grids #1 and #2 connected together. Grid #3 tied to plate.
◘Grids #3 and #5 are screen. Grid #4 is signal-input control grid.
ΔGrids #2 and #4 are screen. Grid #1 is signal-input control grid.
+Triode Plate-Supply Voltage and Max. Target Voltage; Min. Target Voltage = 90 volts.
° Both grids connected together; likewise, both plates.
†Power output is for two tubes at stated plate-to-plate load.

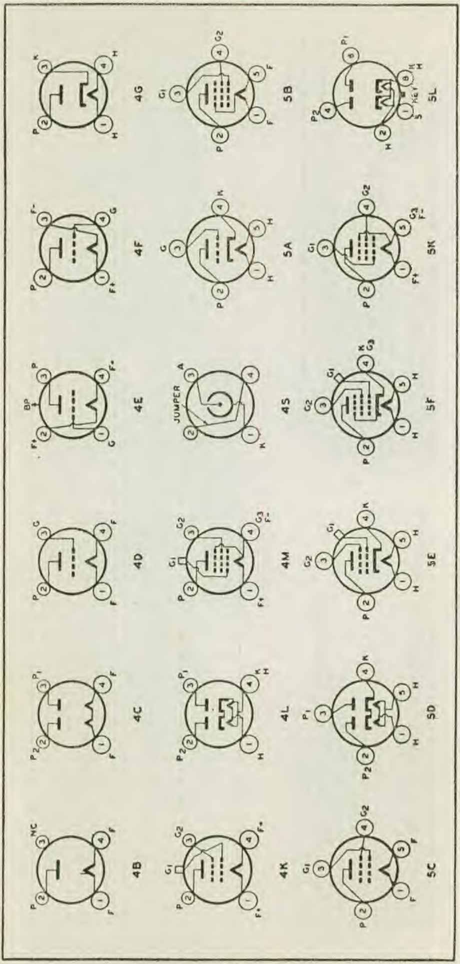
● Applied through plate resistor of 250000 ohms or 500-henry choke shunted by 0.25-megohm resistor.
♥Applied through plate resistor of 100000 ohms.
✖ Applied through plate resistor of 250000 ohms.
▬ 50000 ohms.
■ Requires different socket from small 7-pin.
□Grid #2 tied to plate. ♦Grids #1 and #2 tied together. **For grid of following tube.
♦ Plate voltages greater than 125 volts RMS require 100-ohm series-plate resistor.
ºº Applied through plate resistor of 150000 ohms.
◀ For signal-input control-grid (#1); control-grid #3 bias, -3 volts.
▣ Applied through 200000-ohm plate resistor.
Note 1: Types with octal bases have *Miniature Metal Cap;* all others have *Small Metal Cap.*
Note 2: Subscript 1 on class of amplifier service (as AB_1) indicates that grid current does not flow during any part of input cycle.
Subscript 2 on class of amplifier service (as AB_2) indicates that grid current flows during some part of the input cycle.

*Maximum.
‡Megohms.

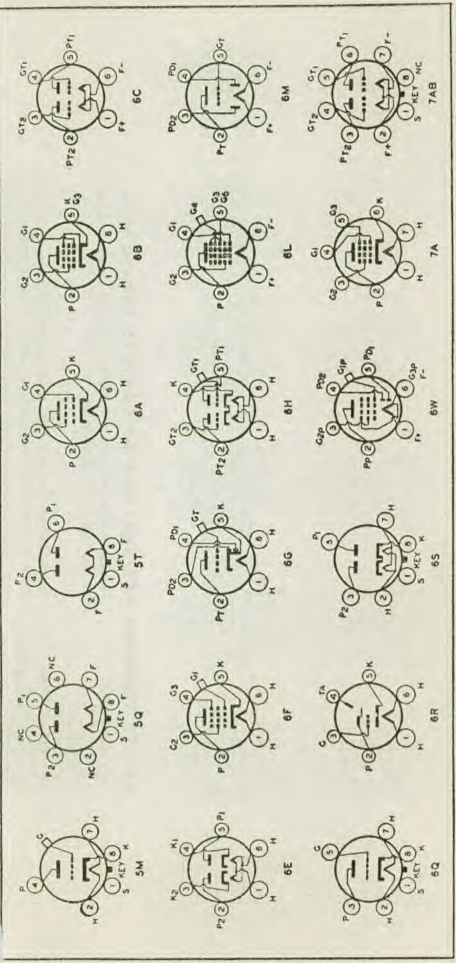
INDEX OF TYPES BY USE AND BY CATHODE VOLTAGE

Tubes of All-Metal construction are shown in BOLD FACE

CATHODE VOLTS	RECTIFIERS	VOLTAGE AMPLIFIERS *Including Duplex-Diode Types*	POWER AMPLIFIERS	CONVERTERS IN SUPERHETERODYNES	DETECTORS	MIXER TUBES IN SUPERHETERODYNES	INDICATORS (Visual)	CATHODE VOLTS
1.1	—	11, 12	—	—	11, 12	—	—	1.1
1.5	—	26	—	—	—	—	—	1.5
2.0	—	1A4, 1A6, 1B4, 1B5/25S, 1F6, 15, 30, 32, 34	1F4, 19, 31, 33, 49	1A6, 1C6	1A6, 1B5/25S, 1F6, 30, 32	1A6, 1C6, 34	—	2.0
2.5	82	2A6, 2B7, 24-A, 27, 35, 55, 56, 57, 58	2A3, 2A5, 45, 46, 47, 53, 59	2A7	2A6, 2B7, 24-A, 27, 55, 56, 57	2A7, 35, 58	—	2.5
3.3	—	22, 99	20	—	99	—	—	3.3
5.0	**5W4**, 5Z3, **5Z4**, 80, 83, 83-v	01-A, 40, 112-A	71-A, 112-A	—	00-A, 01-A, 40, 112-A	—	—	5.0
6.3	**6H6**, **6X5**, 1-v, 84/6Z4	6B7, **6B8**, **6C5**, 6C6, 6D6, **6F5**, 6F7, **6J7**, **6K7**, 6L7, **6Q7**, **6R7**, 36, 37, 39/44, 75, 76, 77, 78, 85	6A4, 6A6, **6F6**, **6L6**, **6N7**, 38, 41, 42, 79, 89	6A7, **6A8**	6B7, **6B8**, **6C5**, 6C6, 6F7, **6J7**, **6H6**, **6Q7**, **6R7**, 36, 37, 75, 76, 77, 85	6A7, **6A8**, 6D6, **6K7**, **6L7**, 39/44, 78	6E5, 6G5	6.3
7.5	81	—	10, 50	—	—	—	—	7.5
12.6	12Z3	—	—	—	—	—	—	12.6
25.0	25Z5, 25Z6	—	**25A6**, 43	—	—	—	—	25.0
30.0	—	—	48	—	—	—	—	30.0



4B
4C
4D
4E
4F
4G
4K
4L
4M
4S
5A
5B
5C
5D
5E
5F
5K
5L


5M
5Q
5T
6A
6B
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6E
6F
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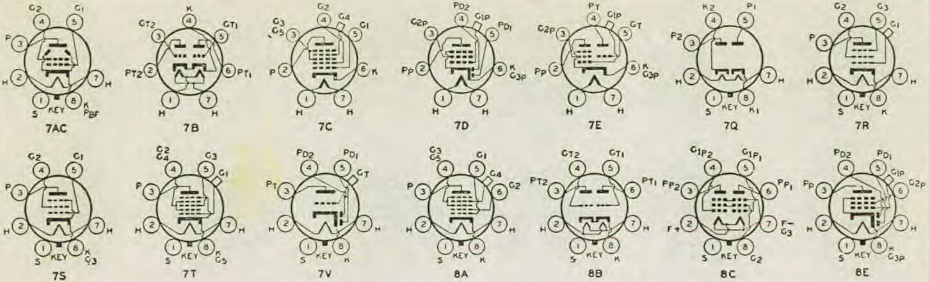
6H
6L
6M
6Q
6R
6S
6W
7A
7AB



KEY TO TERMINAL DESIGNATIONS OF SOCKETS (Bottom Views)

BP = Bayonet Pin
F = Filament
G = Grid
H = Heater
K = Cathode
NC = No Connection
P = Plate
P_{BF} = Beam Forming Plate
TA = Target

Alphabetical subscripts D, P, and T indicate, respectively, diode unit, pentode unit, and triode unit in multi-unit types.

Numerical subscripts are used (1) in multi-grid types to indicate relative position of grids to cathode or filament, and (2) in multi-unit types to differentiate between two identical electrodes which would otherwise have the same designation.

RCA G-TYPE RADIO TUBES (Octal-Base, Glass-Bulb Types)

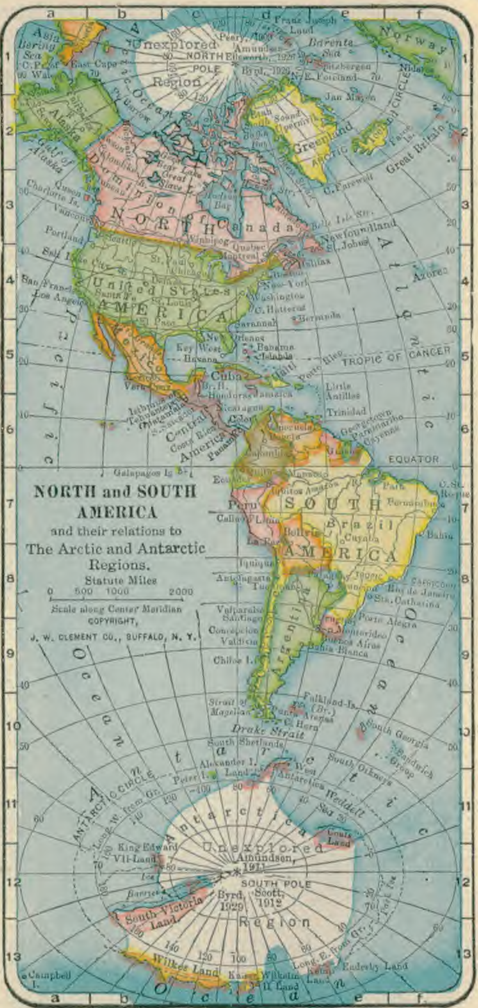
In addition to the types of tubes shown on pages 52 to 58, the following octal-base, glass-bulb types are also available. These types are identified by the letter "G" following the type number. For each of these types, the corresponding glass or metal types are indicated below, together with socket connections and overall dimensions. Characteristic data for the G-types are the same as those for the corresponding types on pages 52 to 58.

G-Series Type	Corresponding		Socket Connections	Max. Overall Dimensions Length x Diam.
	Glass Type	Metal Type		
1E7-G	‡	....	8C**	$4\frac{1}{8}'' \times 1\frac{9}{16}''$
1J6-G	19†	....	7AB**	$4\frac{1}{8}'' \times 1\frac{9}{16}''$
5V4-G	83-v	....	5L**	$4\frac{5}{8}'' \times 1\frac{13}{16}''$
5X4-G	5Z3	....	5Q**	$5\frac{5}{16}'' \times 2\frac{1}{16}''$
5Y3-G	80	....	5T**	$4\frac{5}{8}'' \times 1\frac{13}{16}''$
6A8-G	....	6A8	8A*	$4\frac{15}{32}'' \times 1\frac{9}{16}''$
6C5-G	....	6C5	6Q*	$4\frac{1}{8}'' \times 1\frac{9}{16}''$
6F5-G	....	6F5	5M#	$4\frac{15}{32}'' \times 1\frac{9}{16}''$
6F6-G	....	6F6	7S#	$4\frac{5}{8}'' \times 1\frac{13}{16}''$
6H6-G	....	6H6	7Q¶	$4\frac{1}{8}'' \times 1\frac{9}{16}''$
6J7-G	....	6J7	7R#	$4\frac{15}{32}'' \times 1\frac{9}{16}''$
6K6-G	41	....	7S**	$4\frac{1}{8}'' \times 1\frac{9}{16}''$
6K7-G	....	6K7	7R*	$4\frac{15}{32}'' \times 1\frac{9}{16}''$
6L6-G	....	6L6	7AC*	$5\frac{5}{16}'' \times 2\frac{1}{16}''$
6L7-G	....	6L7	7T*	$4\frac{15}{32}'' \times 1\frac{9}{16}''$
6N7-G	....	6N7	8B*	$4\frac{5}{8}'' \times 1\frac{13}{16}''$
6Q7-G	....	6Q7	7V*	$4\frac{15}{32}'' \times 1\frac{9}{16}''$
6R7-G	....	6R7	7V*	$4\frac{15}{32}'' \times 1\frac{9}{16}''$
6X5-G	....	6X5	6S*	$4\frac{1}{8}'' \times 1\frac{9}{16}''$
25A6-G	....	25A6	7S*	$4\frac{5}{8}'' \times 1\frac{13}{16}''$
25Z6-G	....	25Z6	7Q*	$4\frac{1}{8}'' \times 1\frac{9}{16}''$

** Except that Pin No. 1 has no connection.
* Except that Pin No. 1 has no connection.
¶ Except that Pin No. 1 is connected to shield between diode units.
† Except that filament current is 0.24 ampere.
‡ Two 1F4's in the same bulb.
# Except that Pin No. 1 is connected to shield external to plate.

RADIO LOG

Call Letters	Location	Dial Setting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EQUATOR
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Weddell Sea
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Byrd, 1929
Scott, 1912
South Victoria Land
Wilkes Land
King Edward VII Land
ANTARCTIC CIRCLE
ARCTIC CIRCLE
Falkland Is.
South Georgia
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Bering Strait
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G. of Alaska
Dixon Entrance
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Las Tunas
Camaguey
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Santa Cruz
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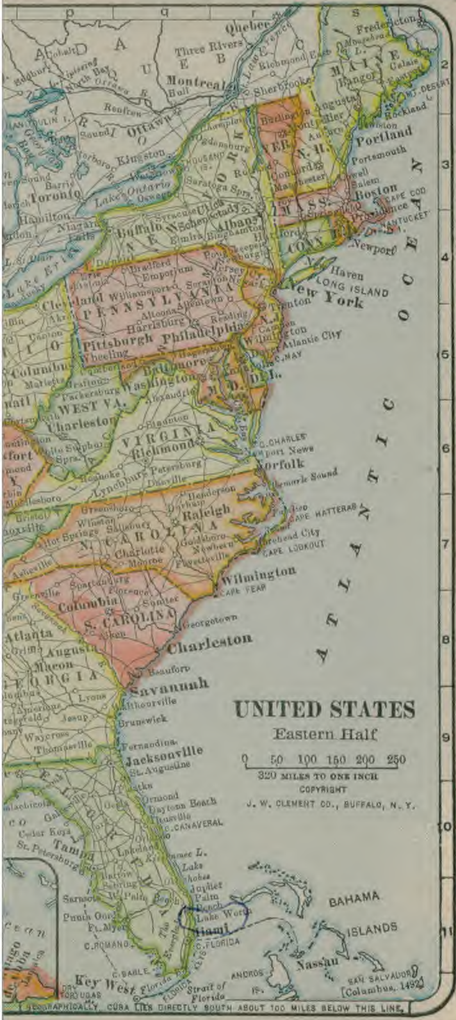
CABO CRUZ
El Cobre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Nassau
BAHAMA ISLANDS
SAN SALVADOR (Columbus, 1492)
ATLANTIC OCEAN
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Yenisei R.
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Okhotsk
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MIDWAY (U. S.)
TROPIC
FORMOSA (TAIWAN)
Hongkong (Br.)
South China Sea
LUZON
Manila
MARIANAS
WAKE I. (U. S.)
American
International Date Line
Monday
Sunday
PHILIPPINE ISLANDS (U. S.)
GUAM (U. S.)
PACIFIC
MARSHALL IS.
CAROLINE IS.
JAPANESE MANDATE
PONAPE
PALMYRA
GILBERT IS. (Br.)
HOWLAND
BORNEO Dutch
Brunei
BISMARCK ARCHIPELAGO
AUST. MANDATE
BRITISH MANDATE
BAKER I. (U. S.)
Makassar
NEW GUINEA
SOLOMON IS.
ELLICE IS. (Br.)
JAVA
TIMOR
SANTA CRUZ IS. (Br.)
Palmerston
LOUISIADE ARCH.
Coral Sea
NEW HEBRIDES (Ang.-Fr.)
ROTUMAN
HORNE IS
FIJI IS. (Br.)
INDIAN OCEAN
NOR. AUS.
Cooktown
Broome
Townsville
NEW CALEDONIA
LOYALTY IS (Fr.)
TONGA IS. (Br.)
CENT. AUS.
QUEENSLAND
Rockhampton
WESTERN AUSTRALIA
AUSTRALIA
SOUTH AUSTRALIA
Brisbane
Perth
NORFOLK
NEW SOUTH WALES
Fremantle
Albany
Sydney
1275 M.
Auckland
NEW ZEALAND
Adelaide
VICTORIA
Melbourne
Canberra
Tasman Sea
Wellington
C. TOWN TO WELLINGTON 7270 MILES 24 DAYS
TASMANIA
Hobart
Christchurch
ANTIPODES
COPYRIGHT, J. W. CLEMENT CO. BUFFALO, N. Y.
ROYAL COMPANY IS.
AUCKLAND IS.
CAMPBELL I.
Distances in Nautical Miles sav
0 2000 4000 6000 8000 10000 12000
San Francisco Magellan 13,090 Panama 5,299
7,791 miles saved
Honolulu Magellan 13,269 Panama 6,687
6,582 miles saved
Manila, P. I. Suez 11,644 Panama 11,379
265 m.
Pacific Ocean
Panama
Miraflores Locks
Pedro Miguel Lock
Culebra
Obispo
+55
SEA LEVEL
BOTTOM OF CANAL-45'
Section of
0 5 10 15 20

DOMINION OF CANADA
Hudson Bay
Labrador
GREENLAND
Dawson
Skagway
Edmonton
Vancouver
Regina
Winnipeg
Quebec
Halifax
Seattle
Portland
San Francisco
St. Paul
Chicago
St. Louis
Salt Lake City
Santa Fe
UNITED STATES
New York
Washington
Boston
Charleston
Savannah
El Paso
Los Angeles
New Orleans
Gulf of Mexico
Havana
CUBA
Mexico
Acapulco
Isthmus of Tehuantepec
Magdalena Bay
Mazatlan
Gulf of Honduras
CENTRAL AMERICA
Colon
Panama
Panama Canal
Honolulu
HAWAII (U. S.)
CANCER
SHORT ROUTE TO THE EAST VIA PANAMA CANAL
OCEAN
EQUATOR
WASHINGTON I.
FANNING I.
CHRISTMAS I.
GALAPAGOS IS. (Ecuador)
Guayaquil
SOUTH AMERICA
Lima
Callao
Iquique
MARQUESAS IS. (Fr.)
SHORT ROUTE TO AUSTRALIA VIA PANAMA CANAL
MANAHIKI IS.
SOCIETY IS.
COOK IS.
TAHITI (Fr.)
PAUMOTU OR LOW ARCH.
TROPIC OF CAPRICORN
TUBUAI IS. (Fr.)
PITCAIRN I.
DUCIE I.
PACIFIC OCEAN
EASTER I.
Valparaiso
JUAN FERNANDEZ IS.
Patagonia
FALKLAND IS.
Punta Arenas
Strait of Magellan
C. Horn
0 500 1000 2000
SCALE OF NAUTICAL MILES
0 500 1000 2000 3000
ENGLISH STATUTE MILES
Railroads: ——— Steamship Lines: - - - -
Telegraph and Cable Lines:
All Distances are given in Nautical Miles
WELLINGTON TO STR. OF MAGELLAN 4600 MILES 15 DAYS
from New York via Panama Canal
Yokohama Suez 13,040 Panama 9,835 3,205 miles saved
Hongkong Suez 11,460 Panama 11,415 45 miles saved
Sydney Magellan 12,548 Panama 9,814 2,734 miles saved
San Pablo
Bohio
Summit Elevation 85 Feet
Depth of Canal 41′ to 45′
Gatun Locks
NORMAL WATER LEVEL+85′
BOTTOM OF CANAL+40′
Colon
Atlantic Ocean
SEA LEVEL
BOTTOM OF CANAL -41′
Panama Canal
25 30 35 40 45 50 MILES

MAP OF CENTRAL EUROPE

Scale of Statute Miles

0 100 200 300


Helsingfors
Gulf of Finland
Kronstadt
Tallinn
ESTONIA
Stockholm
Upsala
Norrköping
Nyköping
SWEDEN
Gotland
Oland
Kalmar
Karlskrona
Kristianstad
Cimbrishamn
Bornholm
Baltic Sea
Gulf of Riga
Riga
LATVIA
Libau
Mitau
Memel
Tilsit
Shavli
LITHUANIA
Kovno
Königsberg
Insterburg
Danzig
Elbing
RUSSIA
(U. S. S. R.)
Ostrof
Opochka
Rezhitsa
Dvinsk
Polotsk
Vitebsk
Orsha
Borisov
Bobruisk
Minsk
Baranovichi
Luninez
Pripet
Kiev
Berdichef
Bielostok
Grodno
Brest Litovsk
Pinsk
Kovel
Rovno
Warsaw
Vistula
POLAND
Lublin
Radom
Kielce
Posen
Thorn
Kalisz
Breslau
Krakow
Przemysl
Lemberg
Tarnopol
Stanislau
Kolomea
Czernowitz
Botoshani
Jassy
Prague
CZECHO-SLOVAKIA
Pilsen
Iglau
Brünn
Kaschau
Pressburg
Vienna
Budapest
HUNGARY
Debreczin
Grosswardein
Klausenburg
Szegedin
Temesvar
RUMANIA
Kronstadt
Hermannstadt
Transylvanian Alps
Turnu-Severin
Krajova
Danube
Bucharest
Giurgevo
Rustchuk
Fokshani
Graz
Klagenfurt
Trieste
Fiume
JUGO-SLAVIA
Agram
Belgrade
Banjaluka
Serajevo
Mostar
Spalato
Cattaro
Cettinje
Durazzo
Tirana
Widdin
Nish
Sofia
Uskup
BULGARIA
Pleven
Balkan Mts.
Varna
Sliven
Burgas
Philippopolis
Adrianople
Constantinople
Sea of Marmora
Gallipoli
Dardanelles
Saloniki
Olympus
Mytilene
Aegean
Chios
Euboea
Sea
GREECE
Athens
Piraeus
Cyclades
Melos
Patras
Zante
Cephalonia
Ionian Islands
Gulf of Arcadia
Kalamata
Corfu
Arta
Ionian Sea
Ancona
Ascoli Piceno
Pescara
Chieti
Campobasso
Foggia
Bari
Brindisi
Otranto
Mt. Vesuvius
Salerno
Potenza
Taranto
Gulf of Taranto
C. S. Maria di Leuca
Cosenza
Catanzaro
Reggio di Calabria
Strait of Messina
Messina
Stromboli
Lipari Is.
Catania
Caltanissetta
Sicily
ITALY


EUROPE, ASIA,
AFRICA AND AUSTRALIA.
Railroads :——— Steamship Lines:——— Submarine Cables : ———
Distances on Map are in Nautical Miles.
References.
1 Denmark.
2 Netherlands.
3 Belgium.
4 Switzerland.
5 Austria.
6 Hungary
7 Czecho-Slovakia
8 Poland
9 Rumania
10 Jugo-Slavia
11 Bulgaria
12 Lithuania
13 Latvia
14 Esthonia
SPITZBERGEN
Arctic
NOVA ZEMBLA
Kara Sea
NORTH CAPE
Hammerfest
Vardö
JAN MAYEN I.
LOFOTEN IS.
ICELAND
Reykjavik
FAROE IS.
Nidaros
Oslo
Stockholm
Helsingfors
Leningrad
Archangel
ARCTIC
UNION
EUROPE
RUSSIA
Perm
Nizhni Novgorod
Omsk
Moscow
BRITISH ISLES
North Sea
Copenhagen
Hamburg
Berlin
Warsaw
Kiev
London
Southampton
Queenstown
Paris
Bordeaux
Vienna
Budapest
Odessa
Astrakhan
RUSSIAN TURKESTAN
Aral Sea
Khiva
Bokhara
Black Sea
Caspian Sea
PORTUGAL
Lisbon
Madrid
SPAIN
Rome
Genoa
Constantinople
Smyrna
Baku
Teheran
PERSIA
AFGHANISTAN
Ispahan
Delhi
Kelat
Mediterranean Sea
Tunis
Algiers
Gibraltar
AZORES
MADEIRA IS.
Port.
MOROCCO
ALGERIA
TUNIS
LIBYA
EGYPT
Jerusalem
Port Said
Cairo
Persian Gulf
ARABIA
Red Sea
Mocha
Muscat
Bombay
Arabian Sea
CANARY IS.
Sp.
RIO DE ORO
Villa Cisneros
C. VERDE IS.
Port.
St. Louis
Bathurst
SAHARA
AFRICA
SUDAN
ANGLO-EGYPT. SUDAN
ABYSSINIA
NIGERIA
Lagos
SENEGAL
Freetown
Monrovia
LIBERIA
SOKOTRA
LACCADIVE IS.
Br.
Colombo
MALDIVE IS.
Br.
KENYA
BELGIAN KONGO
Leopoldville
ASCENSION I.
Br.
Loanda
Benguela
Mossamedes
ANGOLA
SEYCHELLES IS.
Br.
CHAGOS IS.
Br.
Zanzibar
Mombasa
Mozambique
ST. HELENA
Br.
S.W.
Walvis Bay
UNION OF SOUTH AFRICA
Johannesburg
Durban
Port Nolloth
CAPE OF GOOD HOPE
Cape Town
Port Elizabeth
MADAGASCAR
Tamatave
RODRIGUEZ
MAURITIUS
REUNION
TROPIC
Lourenço Marques
TRISTAN DA CUNHA
Br.
ST. PAUL
KERGUELEN I.
Atlantic Ocean
Indian Ocean
MUSTAGH ATA
MT. ELBRUZ
KENIA
MT. BLANC
JUNGFRAU
KILIMANJARO
MALADETTA
EUROPE
MT. ETNA
JEBEL AKDAR
SEA LEVEL
AFRICA
ARABIA
Arabian Sea
ASIA
Vertical Scale 200 times
the Horizontal Scale.
Section along the

East from Greenwich
C. SHELYUSKIN
Ocean
NEW SIBERIA IS.
WRANGEL I.
Bering Strait
EAST CAPE
SIBERIA
CIRCLE
OF SOCIALIST SOVIET REPUBLICS
(RUSSIA)
Yakutsk
Lena
Tomsk
ASIA
Sea of Okhotsk
KAMCHATKA
Bering Sea
ALEUTIAN IS.
L. Baikal
Irkutsk
Nikolaievsk
SAKHALIN I.
KURIL IS.
Urga
MONGOLIA
MANCHURIA
Amur
Vladivostok
YEZO
Hakodate
SINKIANG
Peiping
KOREA (CHOSEN)
Japan Sea
JAPAN
Kashgar
Yarkand
Port Arthur (Jap.)
Seoul
Tokio
Yokohama
TIBET
Nanking
Chengtu
Hankow
Shanghai
CHINA
Foochow
Canton
NANSEI IS.
MARCUS
Pacific
FORMOSA (TAIWAN)
TROPIC OF CANCER
Benares
INDIA
Calcutta
BURMA
Rangoon
Hongkong
Bay of Bengal
Madras
LUZON
MARIANAS IS.
PHILIPPINE IS.
SAMAR (U.S.)
Ocean
GUAM (U.S.)
MARSHALL IS.
Manila
China Sea
PALAWAN
MINDANAO
YAP
PELEW IS.
JAPANESE
CAROLINE IS.
MANDATE
NICOBAR IS.
CEYLON
STRAITS SET.
BORNEO
NEW IRELAND
GILBERT IS.
EQUATOR
Singapore
CELEBES
MOLUCCA
ADMIRALTY IS.
AUST. MAN.
PLEASANT (Br.)
BR. MANDATE
SUMATRA
Sunda Str.
CERAM
NEW GUINEA
ELLICE IS.
Macassar
SOLOMON IS. (Br.)
JAVA
DUTCH EAST INDIES
TIMOR
Torres Str.
NEW BRITAIN
SANTA CRUZ IS.
Indian
Darwin
Cooktown
NEW HEBRIDES
FIJI IS.
Suva
Broome
NOR. AUS.
LOYALTY IS.
OF CAPRICORN
WESTERN
CENT. AUS.
QUEENSLAND
NEW CALEDONIA
AUSTRALIA
Brisbane
Ocean
SOUTH AUST.
NEW SOUTH WALES
Perth
1284
1040
VICTORIA
Sydney
Auckland
Albany
Adelaide
Melbourne
NEW
TO MELBOURNE
6030
Bass Str.
TASMANIA
Hobart
Wellington
ZEALAND
SCALES ALONG THE EQUATOR.
0 1000 2000 STATUTE MILES.
0 1000 2000 NAUTICAL MILES.
0 1000 2000 KILOMETERS.
COPYRIGHT J. W. CLEMENT CO., BUFFALO, N. Y.
25,000′
KANCHANJANGA
20,000′
CHARLES LOUIS MTS.
15,000′
HIMALAYA MTS.
MT. MORRISON
FUJIYAMA
10,000′
INDIA
New Guinea
MT. BALBI
5,000′
Formosa
Rasa
SEA LEVEL
0′
Marcus I.
5,000′
Pacific Ocean
10,000′
ASIA
15,000′
Tropic of Cancer.
30,930′
Greatest Depth
25,000′


ALASKA
and the
KLONDIKE REGION.
SCALE OF MILES.
KILOMETERS.
KLONDIKE GOLD REGION
Dawson
Ft. Reliance (Ruins)
Forty Mile
Sixty Mile Post
Ogilvie
Stewart R.
CANADA
ASIA
Nome
St. Michael
Fairbanks
Gulf of Alaska
Bering Sea
Bristol Bay
Dutch Harbor
Unalaska
Juneau
Sitka
ALEXANDER ARCHIPELAGO
Vancouver
Victoria
Pacific Ocean
HAWAII.
SCALE OF MILES.
Honolulu
OAHU
MOLOKAI
MAUI
LANAI
KAHOOLAWE
HAWAII
Longitude West from Greenwich
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